Impact and Optimization Analysis of Supply Chain Collaborative Inventory Management—A Case Study of Traditional Retail

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***Abstract*—Driven by the development of the digital economy and consumption upgrading, traditional retail is shifting from a product-centric model to a consumer-centric model, with consumers placing higher demands on product availability and delivery timeliness. However, the fragmentation of inventory data across all links in the traditional retail supply chain will cause supply-demand mismatches. This can result in either overestimating demand and causing overstocked inventory, or underestimating demand and causing supply shortages and stockouts. This paper takes traditional retail as its research object and conducts a systematic study on supply chain collaborative inventory management, explaining the core impact of this model on traditional retail. It also analyzes the practical difficulties encountered in its implementation, including the low willingness of supply chain participants to share information and engage in collaboration, inconsistent standards for cross-entity and cross-channel inventory data, and a lack of standardized evaluation mechanisms for supplier selection. To solve the above practical problems, this paper puts forward optimization strategies from three dimensions: information security protection, unified data standards and standardized supplier management. The study clarifies the core value of supply chain collaborative inventory management in cost control within the traditional retail supply chain and identifies key obstacles and solutions for its implementation.**

***Keywords*—Retail, Supply chain management, information security, Collaborative Planning Forecasting & Replenishment**

I. Introduction

With the rapid development of Internet e-commerce and the continuous innovation of new retail business models, traditional retail enterprises and their competitors are not only competing in the fields of products and prices, but also in the core competitive field of supply chain management. The level of supply chain control directly affects the market competitiveness and sustainable development capability of retail enterprises. As the core link of retail supply chain management, inventory management is the key link to improve the level of enterprise supply chain management. Collaborative Planning, Forecasting and Replenishment (CPFR) is an inventory management mode where all node enterprises in the supply chain, under the premise of full trust, build an information sharing platform through the Internet, share core historical data such as sales records, inventory data, production data and transportation logistics information, and cooperate in various links such as negotiation, forecasting and replenishment (Sun, 2023). It is the key to reducing supply chain costs and improving supply chain efficiency. In the existing research on supply chain collaborative inventory management, scholar Pan Shide studied the inventory management and optimization of enterprises from the perspective of supply chain collaboration and concluded that a scientific and reasonable inventory allocation mechanism and inventory management strategy can not only effectively cope with the uncertainty of market demand, but also enhance the overall elasticity and risk resistance of the supply chain (Pan, 2025). Scholars Li Ran et al. used the Shapley value method to analyze the profit distribution of collaborative supply chain inventory management in detail (Li, Yang, & Liu, L. 2025.). Existing studies mainly concentrate on the theoretical connotation and general practical application of collaborative inventory management, and the research on the application of collaborative supply chain inventory management to traditional retail industry still needs to be deepened. Based on this, this paper takes traditional retail industry as the research object, focuses on the collaborative supply chain inventory management model, systematically explains its impact on retail industry, analyzes the practical difficulties in its implementation process, and proposes practical optimization solutions. This paper deepens the cross-research of collaborative supply chain inventory management and traditional retail industry, and provides guidance for traditional retail industry to implement collaborative inventory management model, improve supply chain management level, and accurately respond to market demand uncertainty.

II. The Impact of Supply Chain Collaborative Inventory Management on Traditional Retail

Transaction cost theory, a core economic theory proposed by Nobel laureate Ronald Coase, emphasizes that using market mechanisms for commodity transactions is not without costs. In addition to the commodity price itself, various hidden transaction costs will be generated, such as negotiation costs and contract signing fees. Supply chain inventory collaboration typically builds a stable collaborative ecosystem. Both parties usually sign long-term framework agreements, specifying overall inventory strategies, replenishment schedules, and settlement rules, reducing frequent short-term negotiations and thus lowering ordering costs in the retail industry. Supply chain inventory collaboration breaks down the barriers of non-circulation through inventory sharing, integrates inventory resources scattered across online platforms, physical stores and other channels into a unified shared inventory resource pool, connects inventory data from various channels, realizes real-time information synchronization and flexible allocation of inventory resources, thereby supporting the

efficient operation of the omnichannel sales scenario. Through this efficient inventory coordination mechanism, retail enterprises can effectively reduce the overall inventory backlog risk, accelerate capital turnover efficiency, and better satisfy consumers' demand for instant purchase and instant delivery of goods (Zhang, 2025). Scholar Wang Xiaohui pointed out that intelligent warehousing cost management can help enterprises prepare goods in advance to cope with the fluctuation of commodity demand and reduce the cost of stockouts. Digital order forecasting technology is also conducive to enterprises to transfer goods before orders are generated, allocate goods to areas closer to customers in advance, reduce the pressure of warehousing transfer caused by insufficient transportation capacity, and reduce transfer costs through real-time monitoring and reasonable allocation of goods inventory and sales status (Wang, 2026). Scholar Wang Xinyu pointed out in the research on cost control and optimization schemes of enterprise supply chain that the collaborative supply chain inventory management model covers the whole cooperation process of the supply chain, takes mutual benefit and win-win as the principle, focuses on inventory management as the core work, and optimizes the cooperative relationship between distributors and suppliers by jointly formulating and implementing relevant plans. This model focuses on improving forecast accuracy, and with the help of information sharing and collaborative forecasting, it can quickly respond to market changes, help enterprises prepare in advance, and maintain market competitive advantage (Wang, 2025.).

III. The Real Challenges of Achieving Collaborative Inventory Management in the Supply Chain

In current practice, the interest game among the entities in the supply chain, the fragmentation of unified data standards, and the lack of supplier evaluation mechanisms severely restrict the release of collaborative management effectiveness. Analyzing the causes and manifestations of these difficulties is of significant practical importance for building a highly collaborative supply chain inventory management system.

A. Low Willingness to Share and Collaborate Among Supply Chain Entities

Supply chain collaboration involves the in-depth sharing and coordination of inventory information between suppliers and retailers, breaking down information silos and enabling a dynamic and rapid replenishment supply chain management model. However, each entity has its own interests at play. For example, when a company shares its real-time inventory information with suppliers—which represents sales data and indicates which product category sells better in which region—suppliers, for their own benefit, may share the company's inventory and sales information with other companies to expand their own supply and sales volume. However, for the sharing companies, while this improves the real-time supply rate, their own product sales are leaked, harming their own interests. Once information is shared, there is a risk of misuse. Therefore, the willingness to share inventory among supply chain entities is low.

B. Inconsistent Data Standards Among Supply Chain Entities

There are significant gaps in the standardized systems for inventory-related data across different channels within an enterprise, including online platforms, offline stores, and various functional departments, as well as among upstream and downstream suppliers and distributors in the supply chain. The statistical definitions and calculation rules for core data such as inventory levels, stockout rates, and sales volumes differ significantly among entities. The coding systems for data such as product SKUs, inventory status, and warehouse location are independent, with the same information corresponding to different identifiers in different systems. Furthermore, there is no unified agreement on the frequency, methods, and dimensions of data collection, resulting in inconsistent collection standards for data such as inventory counts and in-transit inventory. This lack of unified industry standards and agreements among entities leads to a loss of consistency and comparability in inventory data, becoming the root cause of low-quality subsequent information sharing. It also directly hinders the efficient data integration of inventory sharing platforms, creating critical data vulnerabilities for inventory allocation and demand forecasting.

C. Lack of Standardized Evaluation Mechanisms in Supplier Selection

Supply chain inventory collaboration requires high-quality suppliers. High-quality suppliers can provide excellent products and services, preventing customer loss due to product defects. They can also ensure the timely supply of goods or raw materials, preventing losses due to stockout rates. Supply chain inventory collaboration requires cooperation with a large number of suppliers. However, many collaborative systems in the retail industry currently suffer from numerous problems in supplier evaluation. These problems mainly manifest in a single evaluation dimension, an overemphasis on price and payment terms, neglect of comprehensive capabilities such as product quality, delivery timeliness, service level, and compliance, and a lack of dynamic updating and elimination mechanisms. The evaluation system lacks standardized and quantifiable indicators, and goods inspection is often based on sampling or manual inspection, which is highly susceptible to subjective influence.

IV. Recommendations for Supply Chain Collaborative Inventory Management

With the deep integration of digital technology into the supply chain, enterprises can leverage digital tools including private cloud platforms and standardized data practices to ensure the security and controllability of inventory information sharing while eliminating barriers to data transmission. Simultaneously, a comprehensive supplier evaluation system can help enterprises optimize the quality of their partners from the source. The implementation of these strategies will effectively improve the response speed among various entities in the supply chain, providing a feasible path for enterprises to reduce costs, increase

efficiency, and enhance market competitiveness.

A. Utilizing Enterprise Private Cloud Technology to Enhance Information Sharing Security

The core principle of this technology is to encrypt data during terminal generation, with the data sender and receiver controlling the encryption key. The intermediate transmission node and storage medium only have ciphertext contact and cannot decrypt the original information. In this process, transmission encryption can use the Transmission Encryption Protocol (TLS 1.3 protocol) combined with dynamic certificate verification. When building an encrypted channel between virtual machines, host machines, and nodes, the ECC-elliptic curve encryption algorithm is used to generate temporary session keys, effectively avoiding the risk of key transmission (Tang, 2025). Shared exclusive resources among multiple enterprises are only made public to partners. Inventory data is not entered into the public cloud and is only visible to partners, which can achieve data security and controllability.

B. Establish a Unified Inventory Information Standard Across Enterprises to Improve the Quality of Information Sharing

Enterprises need to establish a unified and standardized data format standard and apply it across the entire data lifecycle, covering all stages of data collection, storage, processing, analysis and application. By clarifying a unified data standard, the accuracy and consistency of data can be guaranteed from the source, promoting the efficient and accurate circulation and use of data within and across industries, thereby breaking down information silos. At the same time, a unified data exchange protocol should be formulated to clarify the rules and processes for data interaction between different systems and platforms, so as to achieve seamless data connection. Strict data quality standards should be established to quantify key indicators such as data integrity, accuracy and timeliness, providing a scientific basis for data quality assessment and control, thereby reducing resource waste and inefficiency caused by inconsistent standards (Yang & Dong, 2025).

C. Establish an Effective Supplier Assessment Indicator System

A comprehensive assessment indicator system needs to be established to ensure the integrity and comprehensiveness of the assessment work. The indicator system needs to cover multiple core dimensions such as product quality, delivery time, price, service level, and innovation capability. Among these dimensions, the product quality dimension focuses on evaluating key indicators including the qualification rate, defect rate, quality stability and quality improvement capability. At the same time, the concept of product quality cost is introduced to comprehensively calculate various costs such as rework, scrap and customer complaint handling caused by quality problems. The delivery time dimension assesses the on-time delivery rate and the actual impact of early or delayed delivery on the production plan. The price dimension focuses on the rationality of the purchase price, price fluctuation, price comparison with similar products in the market and the timeliness of price adjustment. The service level dimension assesses the after-sales service response speed, problem-solving ability, customer satisfaction survey results and the actual effectiveness of technical support (Zhou, 2026).

V. Conclusion

Taking the retail industry as the research object, this paper conducts a systematic analysis of the impact, practical challenges and optimization strategies of supply chain collaborative inventory management. It clarifies the core value of collaborative inventory management in retail supply chain cost control and identifies key challenges and solutions for its implementation. The main research conclusions are as follows: First, supply chain collaborative inventory management can effectively reduce negotiation costs between retail enterprises and suppliers, and reduce out of stock rates and improve inventory turnover efficiency through information sharing. Second, the retail industry faces multi-dimensional practical difficulties in implementing supply chain collaborative inventory management. Low willingness to share and collaborate due to profit considerations and information security concerns among stakeholders is a core obstacle. Inconsistent inventory data standards across enterprises directly affect the quality of information sharing and inventory allocation efficiency, representing a technical bottleneck for collaborative implementation. The lack of standardized evaluation mechanisms in supplier selection lays the foundation for future problems in promoting collaborative inventory management. Third, to address the practical challenges of collaborative inventory management in the retail supply chain, enterprise private cloud technology can be used to ensure the security of inventory information sharing and eliminate concerns about information sharing among stakeholders; a unified inventory information standard and data exchange protocol can be established across enterprises to improve the quality of information sharing from the source; and a supplier evaluation index system covering multiple dimensions such as product quality, delivery time, and price can be built to achieve quantitative evaluation of suppliers and select high-quality collaborative partners. This study is primarily based on pure theoretical analysis, lacks empirical data support, and fails to conduct an in-depth analysis of the product categories within the retail industry. Future research could further segment the product categories sold in the retail industry, analyze the impact of collaborative inventory management on different product categories, and combine relevant data and case studies for analysis.

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