

Construction and Optimization of Digital Control System Model of Agricultural Wholesale Product Supply Chain Based on Cost Constraints

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Abstract: With the help of the value chain theory and the principle of sharing economy, this paper innovates the traditional wholesale market of agricultural products from the aspects of operation management, new technical means and circulation value-added, and constructs a sharing and cooperation platform integrating production and marketing, so as to realize the low-cost supply of agricultural wholesale products, and eradicate the management problems that the traditional wholesale production of agricultural products is out of touch with the market, and there are many circulation links and high costs. Based on the existing supply chain cost analysis tools, a set of supply chain cost calculation method for agricultural wholesale products is improved and designed, which can trace the resources consumed by the supply chain back to the operation activities and the final output, so as to evaluate the supply chain cost status conveniently. Provide the optimal cost allocation scheme under the goal of maximizing profits. The model constructed in this paper can realize the construction and reconstruction of supply chain with optimal cost, which can provide some guidance for coordinated decision-making in supply chain environment.

1. Introduction

Under the increasingly fierce competition in the global market, supply chain management has become a hot spot in the operation and management of enterprises in the new century. Whether the supply chain can be effectively managed is one of the important signs of the success of enterprises. The supply chain of agricultural wholesale products includes all activities related to the production and transformation of agricultural products from the stage of agricultural means of production to the final consumption. The object of supply chain cost management of agricultural wholesale products is the part that can be expressed in money in the live labor and materialized labor that occurs in the whole supply chain of agricultural wholesale products [1]. The production cycle of agricultural products is longer than that of industrial products, and the production investment of agricultural products is large [2]. At the same time, agricultural products warehousing, information systems and other logistics systems have large investment, slow recovery, and great resistance for enterprises to enter and leave, so the degree of asset specificity of agricultural products is higher than that of industrial products.

Based on the existing supply chain cost analysis tools, this paper improves and designs a set of supply chain cost calculation method for agricultural wholesale products, which can trace the resources consumed by the supply chain back to the operation activities and the final output, so as to evaluate the current situation of supply chain cost conveniently. Finally, based on the analysis of supply chain activities, a quantitative cost analysis model is established to provide the optimal cost allocation scheme under the goal of maximizing profits.

2. Division of Supply Chain Cost Hierarchy

Cost management includes all the control and measurement that affect the prior cost structure and cost behavior, and the cost of the value chain is determined, planned, controlled and evaluated through these activities [3-4]. Traditional cost management only considers the internal costs of enterprises, including direct costs and indirect costs, which are managed separately according to the

causes of these costs. Most cost management methods only pay attention to the internal costs of enterprises, and the cost of cooperation with suppliers and customers must be considered in supply chain decision-making. The supply chain cost is divided into three cost levels [5-6]: direct cost, activity-based cost and transaction cost.

Direct cost is related to the product production of a single enterprise, which constitutes various expenditures of product entities, including raw materials and labor machine costs. These costs are mainly determined by the prices of raw materials and labor. Activity-based cost is not directly related to product production, but the cost caused by manufacturing and distribution process activities. These costs vary greatly due to the different production activities and organizational structures of enterprises. Transaction costs include all costs incurred in processing information with suppliers and customers. These costs are affected by the interaction between supply chain partners.

Compared with traditional cost management, supply chain cost management transcends organizational boundaries and pays more attention to the optimization of activity cost and transaction cost in supply chain. The theoretical basis of supply chain cost management mainly includes strategic cost management, transaction cost theory, principal-agent theory, cross-organizational cost management, life cycle cost theory, activity-based costing and target costing [7]. The main function of the wholesale market of origin is to establish a trading platform where wholesalers, distributors and retailers of agricultural products gather. The consumer service layer mainly refers to bazaars, supermarkets and retailers, which directly provide agricultural products to urban families.

3. Digital Control System Model of Agricultural Wholesale Product Supply Chain

From the whole process of integration, supply chain integration is to strengthen the tightness between different subjects and within the supply chain system by coordinating and managing the business processes within and between subjects, so as to achieve efficient results. The core of supply chain management is demand management. The core of Guangzhou traditional agricultural wholesale product supply chain is product management, but in the buyer's market, customers are the core and the main market driving force, and they dominate the production and sales activities of enterprises [8]. Guangzhou's traditional management mode focuses on functional management, while supply chain management pays more attention to process management, which makes the functional activities of all links in the supply chain reach a coordinated and unified state. It can be said that the competition mode of supply chain is a process rather than a structure. In supply chain management, from product design to production, sales and final use, it is a process of interlocking and increasing value.

The traditional circulation channel of agricultural products is that agricultural products pass through two links: from farmers to wholesale markets and from wholesale markets to consumers. Except for a few agricultural products sold directly to consumers in wholesale markets, most agricultural products are sold to consumers through farmers' markets and roadside vendors (see Figure 1).

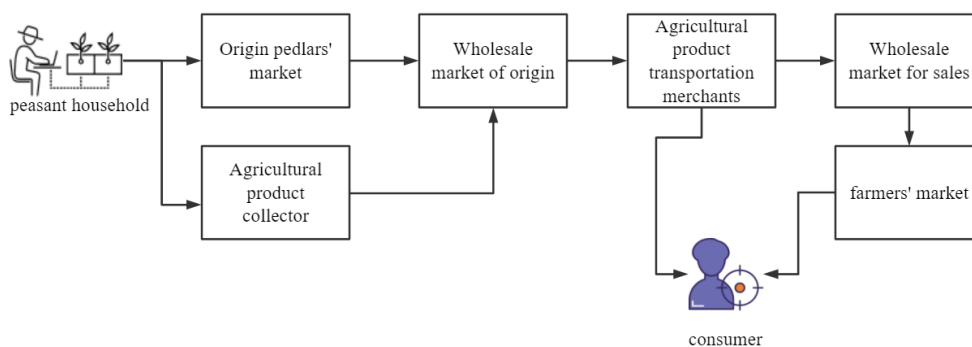


Fig.1 Traditional Agricultural Products Circulation Channel Map

The supply chain of agricultural wholesale products covers the production, circulation and

consumption fields related to agricultural products. It is a material chain, a capital chain, an information chain and a value-added chain connecting agricultural product suppliers to final consumers. Product supply chain management is the concrete application of supply chain management theory in agricultural field, which manages the relationship between participants in raw material supply, product production and processing, product logistics and sales. Agricultural production is different from industry and service industry. Because agricultural products are fresh, regional, seasonal and decentralized, the supply chain of agricultural wholesale products is different from that of industrial products [9].

Reducing cost is one of the most important goals of supply chain management and an important achievement of effective supply chain management [10]. The traditional enterprise is a vertical functional organization, and the managers of each department only pay attention to optimizing the cost of their own departments, without considering the upstream and downstream costs, which leads to the increase of the total cost of the supply chain. In addition to effectively managing the internal supply chain, the supply chain management team must set specific goals and measures to achieve them in important places, such as order turnover time, inventory turnover, on-time delivery, procurement, effective communication methods and cooperation between enterprises and supply chain partners, and coordinate the external supply chain to optimize the entire agricultural wholesale product supply chain.

The goal of reducing the total cost of agricultural wholesale product supply chain requires that in the process of agricultural industrial structure adjustment and agricultural standardization, agricultural wholesale product supply chain enterprises cooperate closely, share information, share supply chain risks and benefits on the basis of trust, and integrate the above cost management methods into the supply chain cost of agricultural wholesale products. With the help of the value chain theory and the principle of sharing economy, this paper innovates the traditional wholesale market of agricultural products, and constructs the digital control system model of the supply chain of agricultural wholesale products from the aspects of operation management, new technical means and circulation appreciation, as shown in Figure 2.

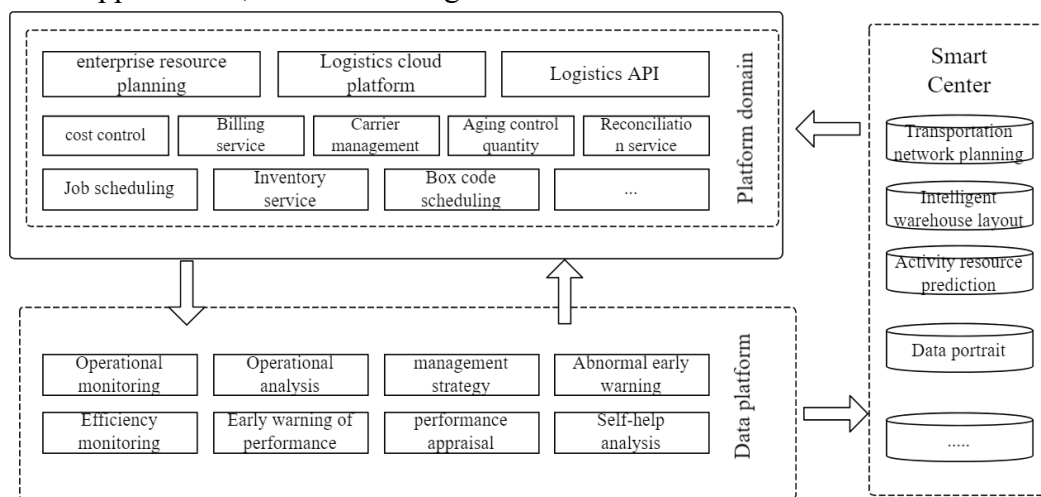


Fig.2 Digital Control System Model of Agricultural Wholesale Product Supply Chain

The target cost method of agricultural wholesale products supply chain plays an important role in the design stage of agricultural products production. The target cost method determines the product cost that enterprises can accept in order to realize profit target under the current market environment at the expected product price or contract price. Activity-based costing runs through the whole supply chain of agricultural wholesale products. It can not only provide the information needed to set the target cost and standard cost, but also help to provide guidance for activity chain to rebuild the supply chain of agricultural wholesale products.

Local optimization is carried out in each stage of the supply chain, regardless of the impact of its decision on the whole supply chain. On the contrary, the goal of global optimization is to coordinate the activities of the whole supply chain and realize the overall optimization of the supply chain.

Because the managers in different stages of the supply chain have different goals, it is necessary to coordinate the activities in different stages of the supply chain and balance the costs of the supply chain as much as possible, so as to achieve the goal of reducing the total cost.

4. Supply Chain Model Optimization

In recent years, Guangzhou has made great efforts to make farmers' professional cooperatives bigger and stronger by strengthening policy support, promoting standardized construction, increasing government agricultural support and strengthening farmers' training and guidance, so that farmers' cooperatives can be continuously upgraded and developed well. By providing new ideas, new technologies and new information to fruit farmers, guiding them to expand their production scale, taking the road of brand technology development, improving the economic benefits of planting, guiding them to introduce and popularize new varieties, and helping them expand their markets.

However, there are many individual logistics in Guangzhou agricultural wholesale product supply chain, with low organizational efficiency, high cost, serious loss and waste, low professional and technical level of agricultural product logistics and insufficient investment in logistics special funds, which affects the value preservation and appreciation of agricultural wholesale product supply chain in the logistics process and greatly affects the market competitiveness of agricultural products. The overall information level of the supply chain is not very high, the logistics standards and quality and safety standards are not unified, and the safety supervision of agricultural products is not systematic enough.

The cost calculation of supply chain provides a mechanism, which can establish a cost-based performance measurement system for the activities that constitute the key processes in the supply chain and continuously develop the system to optimize the cost. In order to calculate the cost of the whole supply chain, unlike other methods, the method we designed includes all kinds of transaction costs, information costs, physical flow costs and inventory handling costs, so it is also different from other cost calculation methods.

Consider a two-level supply chain system consisting of a distributor and several retailers for a single variety of fresh agricultural products. Distributors are supplied by a single upstream supplier and deliver goods to retailers through distribution centers. For the direct chain model, the optimization goal is to seek the optimal ordering time and quantity of distributors and retailers, as well as the optimal route of delivery vehicles, so as to maximize the total average profit of the supply chain system.

The goal is to maximize the profits of the whole supply chain. Cost is the total cost of resources consumed by all activities in all links of the whole supply chain in order to provide these products and services. It is feasible for the supply chain to maintain a certain reaction speed and maximize its own profits within its power. The following is a specific model:

$$\begin{aligned}
 \max &= \sum_{i=1}^m p_i q_i - \sum_{i=1}^m \sum_{j=1}^n q_i a_{ij} C_j(T_j) \\
 s.t & \quad \sum_{i=1}^m \sum_{j=1}^n q_i a_{ij} C_j(T_j) \leq C_t \\
 & \quad \left[\sum_{i=1}^n A_i T_i \right] \leq T
 \end{aligned} \tag{1}$$

Among them, C_t represents the total amount of capital available to the enterprise, $C_j(T_j)$ represents the time cost converted into a monetary cost function, and T represents the reaction speed that must be achieved in order to maintain a certain degree of customer satisfaction.

The different costs incurred by enterprises in choosing different superior suppliers generally include conversion costs due to quality, lead time and transaction costs. The calculation of

additional cost is very flexible, and the calculation formula can be determined by converting the evaluation index of the superior supplier by the enterprise. Take the wholesale market as the core node, strengthen the cooperation between the wholesale market of agricultural products and the members at all levels of the supply chain, and realize vertical cooperation. After information is collected, screened and sorted in the wholesale market, it is transmitted at all levels to realize the process of vertical integration of supply chain.

The cost constraint methods discussed above need to be applied to the whole supply chain driven by the core enterprises of the supply chain to achieve the best results. However, due to the author's limited energy and ability, only a large wholesale supermarket of agricultural products is selected as the research object to preliminarily explain the application of the cost management method of agricultural products supply chain in practical work.

The supermarket in October, 2022 is selected as a sample, and its information is shown in Table 1 (relevant information is mainly obtained through interviews, internal data analysis, field visits, etc.).

Table 1 Profitability Data

	rice and wheat flour	Fresh food	edible oil
main business income	18167	38284	21386
Main business cost	10101	24460	14638
Cost of sales	2491	6721	4075
Total cost	12592	31181	18713
trading profit	5575	7103	2673

This method of allocating sales expenses according to the main business cost is too simple, and supermarket staff think that the sales costs consumed by various products are very different. After a comprehensive study of the operation process of the supermarket, the supermarket managers introduced the cost constraint method to better measure the profitability of various products. As shown in Table 2:

Table 2 Profitability of Optimized Products

	rice and wheat flour	Fresh food	edible oil
main business income	18167	38284	21386
Main business cost	10101	24460	14638
procurement cost	450	1100	500
transportation cost	350	1300	680
Storage cost	170	1500	890
Service cost	260	1500	950
Total cost	11331	29860	17658
trading profit	6836	8424	3728

At present, the sales expenses of fresh products are underestimated in the traditional cost calculation method, which makes the gross profit rate calculated by the traditional cost calculation method seriously deviate from the real situation. Using methods can better reflect the situation of resource consumption, so that enterprises can make better decisions. Activity-based cost management can be used to analyze whether the four kinds of activities in the supermarket are value-added activities, so as to reasonably structure the supermarket activity chain and reduce the operating cost of the supermarket.

5. Conclusions

The production cycle of agricultural products is longer than that of industrial products, and the production investment of agricultural products is large. At the same time, agricultural products warehousing, information systems and other logistics systems have large investment, slow recovery, and great resistance for enterprises to enter and leave, so the degree of asset specificity of agricultural products is higher than that of industrial products. From the whole process of

integration, supply chain integration is to strengthen the tightness between different subjects and within the supply chain system by coordinating and managing the business processes within and between subjects, so as to achieve efficient results. The core of supply chain management is demand management. The digital control system model of agricultural wholesale product supply chain based on cost constraints constructed in this paper can realize the construction and reconstruction of the supply chain with the best cost, which can provide some guidance for coordinated decision-making in the supply chain environment.

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