COLLABORATIVE MANAGEMENT OF INVENTORY AND REPLENISHMENT STRATEGIES IN PERISHABLE PRODUCTS SUPPLY CHAINS

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易腐產品供應鏈中庫存及補貨策略的協同管理

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Abstract

One of the important characteristics of perishable products, like eggs, milk, dairy products, vegetables, etc., is their biotic energy; the period of time for which their quality remains acceptable is very short, which means they are easily perishable in the course of transportation and storage. Perishability is one of the important factors that needs to be taken into account in management of perishable products; it is crucial that management of inventory and procurement of perishable products take into consideration the perishability of the products. On one hand, the price of perishable products is time-sensitive, implying that the price decreases dramatically as the end of the product’s life approaches. On the other hand, a shortage of perishable products while there is demand for the products may result in significant loss of revenue. Establishing an efficient and effective inventory and procurement system to obtain the right quantity, of products of the right quality, from the right source, and to have the products delivered to the right place at the right time with right price can have a positive influence on a company’s profitability and competitive advantage. However, achieving this is constrained by issues of competition, profitability, product harvest and other relevant conditions.

Because of the stochastic nature of factors that affect perishable products demand and supply, it is very difficult for a simple model to improve forecasting accuracy. In this thesis, to resolve this problem, many indeterminable factors affecting the future demand for perishable products are considered in the dynamic forecasting model. Because supply and demand of perishable products are dynamic (i.e. volatile) in nature, it is advisable to use the integrated collaborative forecasting method, a CPFR (Collaborative planning, forecasting and replenishment) management method, to increase the accuracy of forecasts of supply-demand in supply chains with perishable products. The purpose of using this model is also to build a scientific strategic foundation for dealing with the inventory replenishment problem. The significance of this research is that it provides new concepts for managing perishable products procurement and inventory decisions that help improve the rationality of inventory replenishment in practical situations by accurately forecasting demand, which leads to more intelligent decision making.
First, we give an introduction of CPFR, and analyse the applicability of CPFR management strategies to perishable products supply chain management.

Second, an investment game model is built and two classifications of equilibrium, i.e. interior equilibrium and boundary equilibrium, are defined, and their existence is proved. The notion of equilibrium stability is put forward, and the stability solution of the investment game model is also given.

Third, a collaborative (between a retailer and a supplier) forecasting model is constructed. In this model, evolution of demand forecasts for perishable products is analysed, taking into consideration forecast adjustment variable $\psi_{n,i}$, correlation $\rho$ between adjustment variables $\psi_{n,i}$ and $\psi_{n,j}$, and the forecasting capability $\eta$.

Furthermore, an inventory replenishment model is put forward by introducing collaborative forecasting model to inventory replenishment strategies of the retailer and the supplier. Simulation of this model shows that when both the supplier and the retailer follow collaborative forecasting rules, inventory level decreases and the cost of supply chain as a whole reduces significantly. Another inventory replenishment model that aims at achieving the highest profit for the whole supply chain is also studied in detail. While demand and the lead time of order are all stochastic, price discounts for perishable products are included, and shortage of goods is allowed.

Finally, a three-level supply chain model with perishable products that includes a supplier, a producer and a retailer is constructed. We introduce a cost sharing contract to achieve efficient cooperation between partners of the supply chain dealing in perishable products. Such an integrated approach can reduce each partner’s cost compared to costs incurred when partners take independent decisions. The model can help enhance collaboration in, and profitability of, supply chains.
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