A Kind of Backwards Thinking-fast Moving Consumer Goods (FMCG) Stock-controlling Analysis

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Abstract: *To control the material purchase of a fast moving consumer goods (FMCG) enterprise warehouse and solve the problem of purchase planning, this paper formulates an integrated system of reverse logistics operated with a demand forecast model and an economic storage model. This is based on the supply chain and focused on the marketing terminal. By analyzing the integrated system reverse logistics and the timely information from the marketing terminal, the purpose is to effectively alleviate or solve the terminal stock-out which needs to replenish and oversupply which needs to return. According to the system, it can provide a theoretical basis for the enterprise inventory cost control.*

Key words: reverse logistics; material purchase; inventory control; marketing terminal

1 Introduction

Along with increasing market competition, enterprises have changed the traditional extensive management to intensive management, and raised new requirements for inventory management, and then scholars put forward the reverse logistics theory. Reverse Logistics (RL) is the process of planning, implementing and controlling the efficient and effective flow of materials, products and information to the points of consumption from the point of origin for the purpose of recapturing value or proper disposal (Rogers and Tibben-Lembke 1999) [1]. In the reverse logistics field, inventory control decision is an important research content, and has made many research results. Toktay *et al* [2] studies the factors which influence the inventory control, including the demand information structure, delay in delivery, demand rate and product life cycle, etc. Dobos [3] has put into using the principles and methods of modern control theory to solve the problem of reverse logistics inventory management, Zhang Ping *et al* [4] scholars through the Bayes algorithm to determine the raw material demand. The above study is based on the recyclable are the waste products, by-products or defective products which need them to regenerate or remanufacture.

To ensure the enterprise continuous production and maintain the sustainable management, all kinds of material inventory turnover must obtain a certain amount of assurance. But, in the supply chain, each node enterprise (the suppliers, manufacturers, wholesalers, retailers) only according to the needs of the downstream enterprises information to produce or make the selling decision. Influencing by various uncertainty factors, the demand information also can appear deviation, distortion, and then result to inflation or shortages of social needs [5], this situation will lead to poor stock. According to the characteristics

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of the fast moving consumer goods, the above mentioned issue is a huge challenge for the enterprises. Consequently, it is a quite difficult problem to solve that how much the inventory quantity is the most appropriate among the fast moving consumer goods enterprises.

To solve the above problems, besides using the demand forecast model and economic inventory model, we should also consider the problem in view of the supply chain. The key points of the reverse thoughts of the integration controlling inventory cost strategies are to keep the sales and market feedback as the main parts and the starting point, with the market demands to decide the production, and finally optimize the enterprise inventory cost.

2 Reverse logistics channels and analysis

Reverse logistics is the process of coordinating efficient and effective materials and products[6]. The reverse logistics system framework is shown in Figure 1. The raw materials are supplied by the suppliers; after processing by the enterprise, the production is finished for sale. But the uncertain market environment will make the product demand change; therefore, the enterprises must collect and lead back the market terminal information timely through the sales channels, do analysis and filter promptly, take corresponding measures to achieve a complete and timely satisfaction and balance the market demand. This system integrates the demand forecasting model and the economic inventory model, to finally determines the best inventories and realizes the optimal inventory cost.

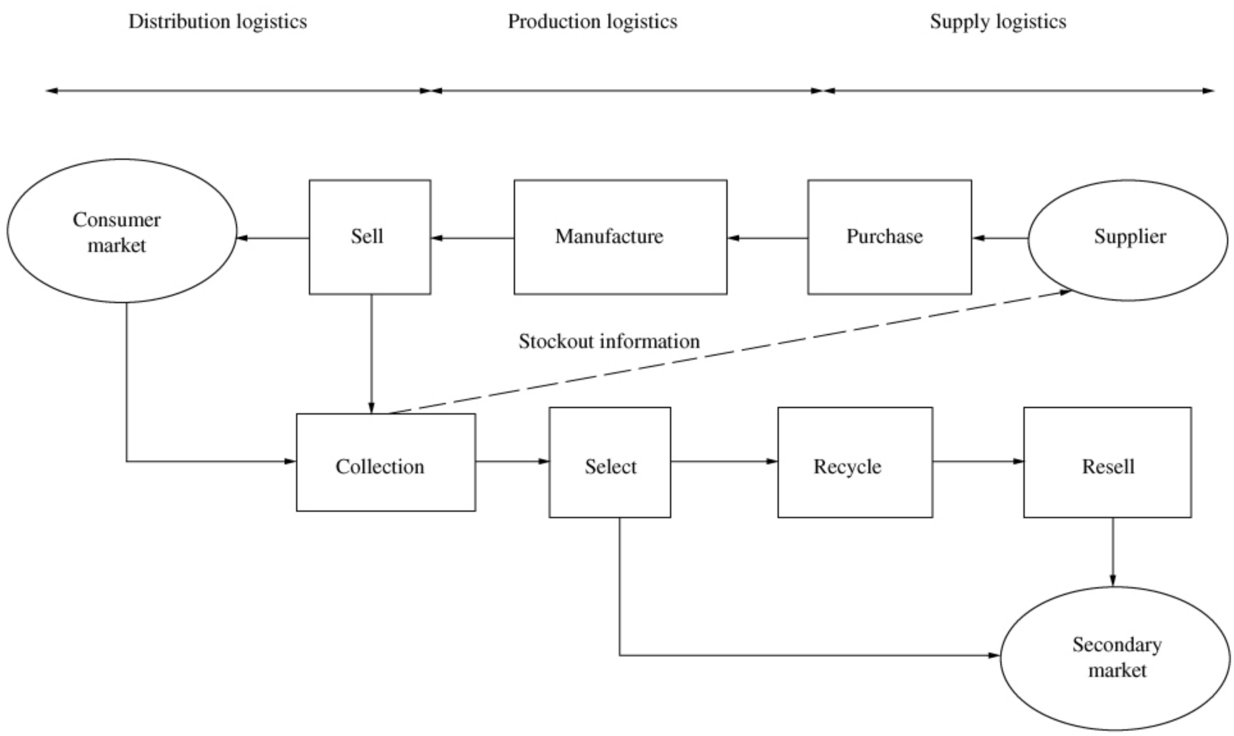

Figure 1 Reverse logistics channel

Through the above analysis, the present integrated reverse logistics system is shown in Figure 2.

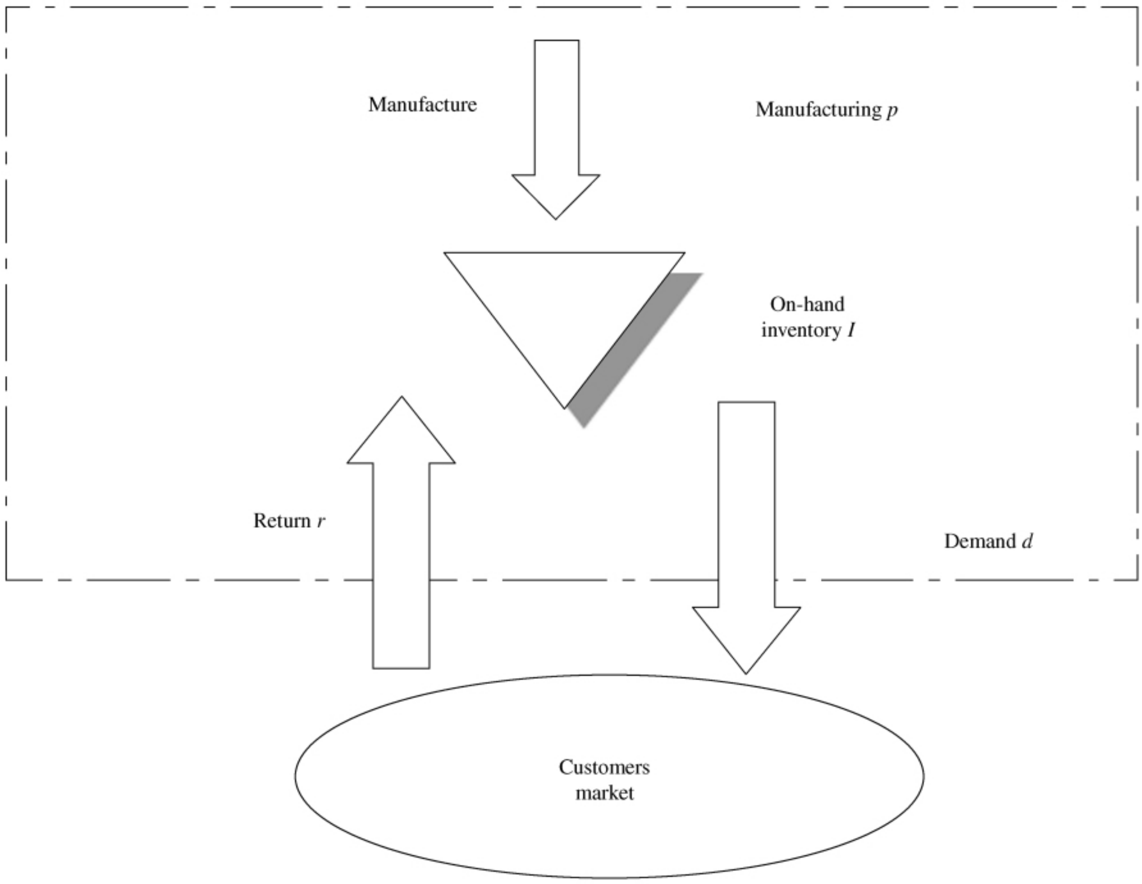

Figure 2 An integrated reverse logistics system

2.1 Demand forecast model

Fast moving consumer goods demand forecast of the raw materials is generally a short-term quantitative prediction. Charts, trend extrapolation, exponential smoothing, and other methods to establish the mathematical model are used to predict.

In practical work of the fast moving consumer goods, the observed demand data fluctuations of the production of supporting materials are volatile and it is difficult to find an ideal curve fitting, therefore, the moving averages can be adopted to describe the demand trends or the quantitative prediction that take out the least date from a time series date to calculate the average, and then link the average points one by one in chronological order to finally constitutes a moving average [7]. The corresponding times t_1, t_2, t_3, $\cdots$, observations d_1, d_2, d_3, $\cdots$, and the moving average expressed μ_i, namely:

$$\mu_i = \frac{d_i + d_{i-1} + \cdots + d_{i-k+1}}{k} \tag{1}$$

The demand of the quantitative forecast is on the basis of the moving average, and then uses the smoothed data to predict and finally amends the demand with the tendencies numeric. The smooth date here is point to moving average; it reduces the random fluctuations to a certain extent. The extrapolation formula of the moving average is:

$$\bar{\mu}_{n+1} = w_1\mu_{n-k} + w_2\mu_{n-k+1} + \cdots + w_{k-1}\mu_{n-1} + w_k\mu_n \quad (2)$$

Where μ_n, μ_{n-1}, $\cdots$, μ_{n-k} is the moving average, and be calculated by Equation (1); w_1, w_2, $\cdots$, w_k is the forecast weight coefficient, its fitting polynomial time is 1, the number of the date point is k, the forecast point is 1, namely,

$$w_{n-k} = \frac{1}{(n+1)} + \frac{12}{(n+1)[(n+1)^2-1]}\left(\frac{n}{2}+r\right)\left(\frac{n}{2}-k\right)$$
$$k = 0,1,2,\cdots,n \quad (3)$$

The modified formula can be deduced from Equation (1)

$$\bar{d}_{n+1} = k\bar{\mu}_{n+1} - (d_n + d_{n-1} + \cdots + d_{n-k+1}) \quad (4)$$

Not difficult to verify, the d_{n+1} th prediction at the point $n+1$ with the $k-1$ previous observations is the average $\bar{\mu}_{n+1}$.

2.2 Economic storage model

The economic storage model mainly includes the economic order quantity (EOQ), shortage cost, return cost, etc [8,9].

2.2.1 Economic order quantity (EOQ)

The economic order quantity is the one that minimizes the total inventory cost with the order quantity. According to the demand forecast model (leaving aside the shortage cost), the total inventory cost equals the order cost plus the average keeping cost. The order cost is proportional to the order times, but the average keeping cost shows an inverse correlation with the order times. The order cost is equal to the keeping cost when the total inventory cost is lowest, as shown in Figure 3.

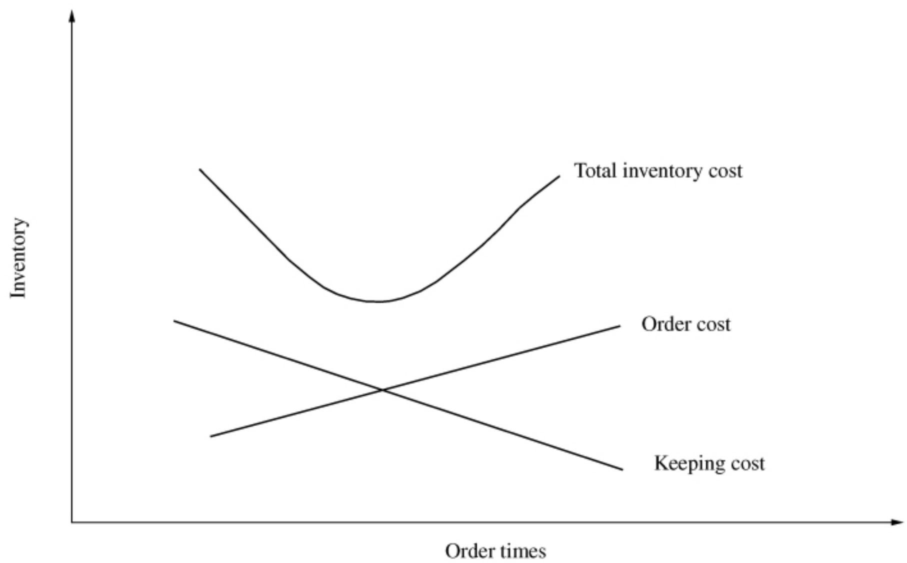

Figure 3 Economic order quantity

The economic order quantity is determined by the best time of order or the optimum order quantity.

1) The best order times

Set $d = A$ is the total demand of a kind of material in a forecast period; P is the every order cost; C is the unit keeping cost; m is the order times.

So, the total cost is

$$F(m) = mP + \left(\frac{A}{2m}\right) C \tag{5}$$

We get the first-order derivative m from Equation (5), make the derivative equal zero, and solve the equation, we can get the best time of order m:

$$m = \sqrt{\frac{AC}{2P}} \tag{6}$$

So, the economic order quantity is A/m

2) The optimum order quantity

Set $d = A$ is the total demand of a kind of material in a forecast period; P is the every order cost; R is the unit price; C is the unit keeping cost; Q is the every batch quantity. The order cost is proportional to the order times, but the average keeping cost shows an inverse correlation with the order times. In the case of certainty (demand A), the order cost is in direct proportion to Q, the average keeping cost has an inverse association with Q.

So, the total inventory cost is

$$f(Q) = \left(\frac{A}{Q}\right) P + \left(\frac{QR}{2}\right) C \tag{7}$$

We get the first-order derivative m from Equation (7), make the derivative equal to zero, solve the equation, and we can get the optimum order quantity Q.

$$Q = \sqrt{\frac{2AP}{RC}} \tag{8}$$

2.2.2 Shortage cost

Shortage cost, also known as the deficit costs, is the loss caused by the inventory supply disruptions, including downtime losses by the material supply disruptions, default shipments losses by the finished goods inventory shortages, losses sales opportunities (should also include a subjective estimate of the goodwill loss), etc. This is because once appears a shortage, despite paying for the high purchasing cost (because of the emergency procurement), still may make the production line to shut down and result in economic losses, or even lead to the enterprise to pay for the liquidated damages. The more potential loss is losing the customer resource.

It is complicated to exactly calculate the shortage cost, so we can choose simple estimation methods in the inventory management information system. Here, in addition to statistics of historical shortage data, we also need accurate market information from the feedback to the terminal market.

1) According to the historical material statistics it is assumed that there are n kinds of levels of shortage quantity as $L_1, L_2, \cdots, L_n$ the shortage probability $p_1, p_2, \cdots, p_n$ (with experience to determine the size of the n, until that p_n is 0, which means no shortage).

2) Calculating the extra unit cost when the shortage happens $E_{a1}, E_{a2}, \cdots, E_{an}$

3) Calculating the direct economic losses $E_{b1}, E_{b2}, \cdots, E_{bn}$, the probability $p_{a1}, p_{b2}, \cdots, p_{bn}$

which leads to the production line shut down (corresponding Step 1).

4) Calculating the liquidated damages $E_{c1}, E_{c2}, \cdots, E_{cn}$, the probability $p_{c1}, p_{c2}, \cdots, p_{cn}$ (because of the breach of contract corresponding to Step 1).

5) According to the market terminal feedback, we should consider an emergency procurement cost for the shortage of the raw materials, $M_1, M_2, M_3, \cdots, M_n$

The shortage cost of shortage quantity TS_i follows as:

$$TS_i = L_i E_{ai} p_i + E_{bi} p_i p_{bi} + E_{ci} p_i p_{ci} + M_i \tag{9}$$

We use TC to represent the inventory cost, and the total procurement cost of raw materials is

$$TC = T_C + T_Q + \sum_i TS_i \tag{10}$$

Where T_C is the raw material purchasing cost under normal circumstances; T_Q is the storage cost (no longer explanation in detail); TS_i is the purchase cost under the stockout.

2.2.3 Return cost

Different types of enterprises' return cost involved different operation processes, and we refer to the fast moving consumer goods industry in this paper. We know from Figure 1 that this type of enterprise reverse logistics links involving collection, sorting, recycle or destroy and resell. Enterprises recover the excess products by market saturation or quality problems goods, and then detect and classify. The intact products regain new value and gets into the channel of distribution after the secondary processing (on condition that it does not affect the use quality), and in the face of the consumer, the useless products (for technical or other reasons), are destroyed. The process constitutes the return of enterprise cost.

1) The cost of collect product stage includes recovery, transport and storage, it can be the calculated

$$C_{1i} = \sum_i (C_{ai} + C_{bi} + C_{ci}) \qquad (11)$$

Where C_{ai} is the batch of products i unit recovery cost; C_{bi} is the batch of products i unit transportation cost; C_{ci} is the batch of products i storage cost; W_i is the amounts of the batch products i.

2) The cost of sorting stage calculation formula has the following expression

$$C_{2i} = \sum_i (C_{ti} + C_{ji}) \qquad (12)$$

Where C_{ti} is the batch of products i unit testing cost; C_{ji} is the batch of products i unit selection cost; W_i is the total amount of the batch of products i.

3) The cost of recovery or destroyed stage is divided into two parts, for the recycled products; the intact products regain new value after the secondary processing and the useless products are destroyed. Its cost calculation formula is:

$$C_{3i} = \sum_i C_{pi} \times M_i + C_{di} \qquad (13)$$

Where C_{pi} is reutilization unit processing cost; M_i is total amount; C_{di} is the unit destroying cost; N_i is total amount, $M_i + N_i = W_i$.

4) In the distribution stage we should consider the transportation cost, C_{si} is secondary processing products.

$$C_{4i} = \sum_i C_{si} \qquad (14)$$

Integrated in the above analysis, the enterprise return cost can be written as follow:

$$C_r = \sum_i C_{1i} + C_{2i} + C_{3i} \qquad (15)$$

3 Conclusions

Through the above system analysis, we can solve the problems the enterprise's best order times, optimum order quantity and minimum inventory cost. For the fast moving consumer goods industry, the market demand terminal feedback is a very important part. This paper has established an integrated reverse logistics system with a demand forecast model and an economic storage model based on the supply chain and focused on the marketing terminal and analyzed it. According to the system, it can provide an important theory reference for the enterprise inventory cost control. Limitations of this paper includes that the system is rather used in fast moving consumer goods industries than the large equipment manufacturing industry. What's more, this system has a strong theory tendency, so in the practical use, not only needs the enterprise to collect the historical data, but also disposal of the information from the marketing terminal timely. This will increase the enterprise market cost and this point is not consider in this paper.

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