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Research on raw material inventory management of liquor production enterprises based on EOQ model

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Abstract: With the recovery of the economy, China's liquor industry has shown strong recovery force, the scale of the liquor industry has been rising since 2018, but the output and sales volume have declined, and the competition in the liquor industry has become increasingly fierce, which has put forward higher operating requirements for various liquor companies. This paper analyzes the raw material (wheat) demand and inventory cost data of "Hengkang" liquor enterprises in the past three years, and uses the EOQ model to calculate its economic order quantity. Compared with the fixed order quantity method currently adopted by "Hengkang", it is found that the order quantity obtained by the EOQ model can reduce the inventory management cost of the enterprise. On this basis, some suggestions for inventory management of liquor enterprises are proposed.

Keywords: EOQ model, Liquor industry, Inventory management.

1. Introduction

Since 2017, the liquor industry has entered the stage of quality improvement and quantity reduction, and various enterprises have begun to reduce production and improve quality, and the situation of the liquor industry has become complicated. Head liquor enterprises began to increase brand building and marketing, through the launch of custom wine, high-end wine series still maintained positive revenue growth; For other small and medium-sized liquor enterprises, survival in such a complex situation can not follow the practice of the head enterprises, small and medium-sized liquor enterprises focus on the control of production costs, through the control of production costs to expand their profit space, so as to ensure the survival of enterprises.

According to the data of the National Bureau of Statistics, the number of liquor enterprises above the national scale has dropped from 1,593 in 2017 to 963 in 2022, and the competition in the liquor industry has become increasingly fierce, not only small and medium-sized enterprises are difficult to survive, although the head enterprises still maintain revenue growth, but all enterprises have maintained a high degree of consistency in inventory growth. The backlog of finished products puts forward higher requirements for inventory, which requires enterprises to make more reasonable inventory management in production.

2. Theoretical Review

An important problem of inventory management is to determine the order quantity and order quantity, and to maintain a stock and order quantity that can minimize the total cost. In 1913, Ford W. Harris [1] published an article "How much is Needed at a time" and introduced the Economic Order Quantity (EOQ) model. Since then, inventory management models and theories have been widely used in inventory management. Bierman and Thomas (1977) [2] fully considered the impact of time cost when establishing the EOQ model. Based on the traditional EOQ model, Yi Wen Lok, Siti Suzlin Supadi and Kok Bin Wong consider the incompleteness of items and put forward corresponding countermeasures. Birbil et al. [3] considered the EOQ model when the factors such as demand, purchase price and ordering cost did not change in the case of inventory shortage. Zheng Huili and Da Qingli [4] studied the EOQ model based on the change of purchase price over time. Zhang Xumei et al. [5] established an EOQ model in which replenishment capacity affects the demand of spoiled goods while replenishing, and the lag rate of partial shortage quantity is affected. Luo Bing et al. [6] established an EOQ model considering the delay of partial shortage based on the classic EOQ model that allows a certain amount of shortage while production is demand. At present, the application of EOQ model in liquor production enterprises has not been studied through relevant databases such as CNKI.

3. Analysis of Inventory Management Status of Renhuai Hengkang Wine Co., LTD

Hengkang Wine Co., LTD. (hereinafter referred to as "Hengkang"), located in Shangping Village, Maotai Town, Renhuai City, Zunyi City, Guizhou Province, was established in 2015. It is an enterprise integrating liquor production, packaging, sales and service. "Hengkang" is the formation of Hengkang series of wines, categories, varieties, developed into a research and development, production, sales as one of the modern enterprises specializing in the production and sales of liquor, the main production of liquor brands are Shou, Hengkang burning Fang, Qianzhou Dadi, Zhongxing Prince wine and so on. The main business of the company is the production of liquor and the supply of base wine, the products have passed the national standard QB/T 5711-2022 test, the company's brand wine and base wine are sold all over the country.

3.1. Characteristics of Raw Material Inventory Cost of "Hengkang" Liquor Enterprise

Due to the characteristics of long production cycle, discontinuous production and unstable material quantity, liquor enterprises often have large inventory resource occupation and high ordering cost, which leads to the increase

of production cost. In this case, how to improve the inventory management of "Hengkang" white spirits production raw materials is particularly important. Before the formal inventory management study, we first analyze the inventory cost structure of "Hengkang" production raw materials.

3.2. Cost Structure of Raw Material Inventory Of "Hengkang" Liquor Enterprise

Generally speaking, the raw material inventory cost of liquor production enterprises consists of procurement cost, ordering cost, storage cost of materials, opportunity cost caused by stock shortage, etc. However, due to the way of advance ordering adopted by Hengkang, this paper does not consider the opportunity cost caused by stock shortage, but only considers procurement cost, ordering cost and storage cost of materials.

(1) Procurement cost. The procurement cost is the cost of the raw materials used in the production of liquor. In the liquor production enterprises, the procurement cost of raw materials accounts for between 40% and 80%, and the average proportion is about 60%. The purchase cost of "Hengkang" accounts for about 60% of the cost of sales. The influencing factors of procurement cost are relatively fixed. In the process of procurement cost, Hengkang usually goes through the process of searching, inquiry, negotiation, constant communication, reaching intentions, signing orders, purchasing personnel management, etc., and generates related costs.

(2) Ordering cost. Ordering cost is the cost generated when the market determines the demand first, the production workshop sets the demand, and then the logistics department or logistics department acquires the raw materials. The raw materials required by liquor production enterprises are often not produced by their own production department, and "Hengkang" does not have its own raw material production department and specialized supply department. The ordering cost is the supplier payment, logistics handling, material storage and other costs incurred when ordering the required raw materials from upstream suppliers of the enterprise. The order cost is generally the same one-time cost each time, and this cost will not change under normal circumstances.

(3) Cost of storage. The cost of storage in the library is the cost of saving an item for a period of time, which is usually related to the time and space of storage, and it is worth considering in time and space. The storage cost of "Hengkang" is mainly related to the level of raw material inventory, which is mainly determined by the storage time of wheat and the inventory space occupied by the size of the storage volume, mainly including the time and space cost of raw material holding, the cost of capital occupation, and the cost of inventory management.

a) The time and space cost of holding raw materials. The cost of time and space occupied by "Hengkang" when saving raw materials, space cost is mainly the cost of occupying warehouse space, including warehouse leasing fees, personnel management costs, etc., time cost is mainly due to the cumulative cost of space costs. b) The occupancy cost of funds. The cost of capital occupation is mainly due to the reduction of capital turnover caused by the holding of raw materials, the insufficiency of other aspects of circulation caused by the insufficiency of capital turnover, and the additional personnel management cost caused by the insufficiency of capital circulation. c) Inventory management costs. Inventory management costs in "Hengkang" mainly include warehouse maintenance costs, raw material maintenance costs, raw material loss costs, warehouse handling costs, insurance costs paid to prevent warehouse accidents, and so on.

4. EOQ Inventory Management Model

4.1. Introduction to EOQ Models

EOQ inventory management model is used to determine the quantity of each order in a production cycle. When the cost between the order quantity of a certain quantity and a certain order time associated with it is exactly balanced, the sum of the purchase cost and the cost kept in the warehouse is the smallest, that is, the total cost is the smallest, and the order quantity at this time is the economic order quantity or the economic batch. EOQ inventory management model can not only help enterprises reduce inventory and reduce risks, but also ensure the normal production of enterprises and the completion of established production plans. EOQ inventory management model is also a mature inventory management model, and the application and implementation of enterprises will not be too difficult.

4.2. Fixed Batch Method

As the name suggests, the fixed batch model means that the order quantity is the same each time, but the order cycle may not be the same. At the same time, the fixed batch method needs to be compared with the demand of the material requirement plan to meet the demand plan, and the larger quantity is taken as the fixed batch. However, the fixed batch is often determined by the intuitive analysis and empirical judgment of the relevant personnel, which is easy to cause material backlog in many cases, and may also cause the order quantity to be too large or too small because of the inaccurate judgment.

4.3. EOQ Inventory Management Model and Quick Response Model (QR)

In the manufacturing industry, QR refers to a model that determines the time required for an item by coordinating the relationship between suppliers, manufacturers and sellers, so as to minimize the inventory level. However, for liquor production enterprises, product production planning cannot be carried out according to the needs of customers, so there are certain problems in the application of QR. Compared with QR, EOQ can optimize not only inventory costs, but also procurement costs to minimize the total cost. On the other hand, for liquor enterprises, there is no definite customer demand for reference in the production plan, because liquor sales are highly volatile. Therefore, the application of EOQ model to carry out the minimum total cost planning is the demand of liquor production enterprises.

4.4. EOQ Model Analysis

At present, the difficulty encountered in the inventory management of liquor production enterprises is how to determine the appropriate order quantity, order point and order cycle. In the EOQ model, there is an intersection between the storage cost and the order cost, and the corresponding total cost curve at the intersection is the lowest point, that is, the minimum total cost is reached. At this time, the order quantity is the economic order quantity we ask for. Therefore, it is recommended to adopt the classical EOQ

model or EOQ model under increased constraints as the basis for inventory management.

4.5. EOQ Model Assumptions

In order to simplify the process of determining the order quantity, we need to transform the business problem into a mathematical problem and analyze the data by means of mathematical operations. In order to conduct the analysis, we propose the following assumptions and parameter design:

(1) Assumptions: a) Do not consider the market demand, only the cost analysis. b) The order can arrive at the warehouse in time, there is no shortage. c) When ordering is instant replenishment, regardless of time. d) The cost of each order is fixed. e) There is no substitute for related products.

(2) Parameters:

T- Production cycle (year or month or day);

T_c- Total cost in a single production cycle (yuan);

D- Total demand (tons) in a single production cycle;

Q- Quantity of each order (tons);

C_p- Single order cost (Yuan/ton * year or Yuan/ton * month or yuan/ton * day);

C_h- Unit storage cost (Yuan/ton * year or yuan/ton * month or yuan/ton * day);

P- Material unit price (Yuan/ton);

4.6. EOQ Model Solving

Suppose that the production cycle of the enterprise is fixed, the production cycle demand is D, the order quantity is Q, the material ordering unit price is P, the cost of each order is CP, and the unit inventory cost is Ch. At this time, the order times are equal to D/Q, and the average inventory is Q/2, then:

Total cost $T_c = D*P + \frac{D}{Q}*C_p + \frac{Q}{2}*C_h$

Ordering cost=$\frac{D}{Q}*C_p$

Cost of keeping in the library=$\frac{Q}{2}*C_h$

Through calculation, we can see: $Q = \sqrt{\frac{2D*C_p}{C_h}}$

5. Application of EOQ Model in Hengkang Wine Co., LTD

The long-term inventory material of "Hengkang" in production is mainly wheat. The demand for wheat is shown in Table 1, and the demand shows an increasing trend year by year. The average annual demand for raw wheat is 546 tons and the average monthly demand is 45.48 tons.

Table 1. Demand of "Hengkang" raw material wheat (tons)

	The year 2020	The year 2021	The year 2022	The year 2020-The year 2022
January	38	40	41	39.67
February	40	43	44	42.33
March	46	48	52	48.67
April	42	52	60	51.33
May	55	60	60	58.33
June	59	63	63	61.67
July	63	52	56	57.00
August	0	0	0	0.00
September	0	0	0	0.00
October	62	56	65	61.00
November	66	63	68	65.67
December	59	60	62	60.33
Total	530	537	571	546
Average	44.12	44.75	47.58	45.48

5.1. Hengkang's Economic Order Quantity based on EOQ

The production demand of liquor production enterprises is stable and does not fluctuate too much due to the external market, and it has increased year by year in recent years. At the same time, Hengkang has established a good cooperative relationship with upstream wheat suppliers, so when there is an order demand, we assume that raw materials will arrive at the warehouse instantaneously, and raw wheat has no related alternative products.

According to the company's internal data, it is known that the wheat single order cost CP is fixed at 1500 yuan/time, the unit storage cost Ch=37.3 yuan/ton/day, and the wheat price is 3820 yuan/ton. Bring relevant data into equation (2) to calculate Q* under EOQ model:

$$Q^* = \sqrt{\frac{2\times D\times C_p}{C_h}} = \sqrt{\frac{2\times 546\times 1500}{37.3}} = 210(\text{ton})$$

Since the purchase price of raw materials will not be affected, this paper only analyzes the two parts of ordering cost and storage cost, and brings Q* into formula (1) for calculation:

$$T_c = D*P + \frac{D}{Q}*C_p + \frac{Q}{2}*C_h = 2093536.5(\text{yuan})$$

5.2. "Hengkang" Order Quantity Determination Method Comparative Analysis

At present, "Hengkang" adopts the method of ordering with a fixed order quantity, the order quantity is 60 tons/time, in this case, the total cost value is:

$$T_c = D*P + \frac{D}{Q}*C_p + \frac{Q}{2}*C_h = 2100489(\text{yuan})$$

Since the annual demand and wheat price are the same in both cases, in order to make a comparison, the procurement cost and storage cost are separately compared as follows:

Under EOQ model: $\frac{D}{Q^*}\times C_p + \frac{Q^*}{2}\times C_h = 7816.5(\text{yuan})$

Under the current "Hengkang" quantitative ordering

method: $\frac{D}{Q}\times C_{\mathrm{p}}+\frac{Q}{2}\times C_{\mathrm{h}}=14769(\text{yuan})>7816.5(\text{yuan})$

By comparing the economic order quantity under EOQ model, the sum of procurement cost and storage cost can be greatly reduced, and EOQ model can minimize the sum of procurement cost and storage cost. EOQ model can be used not only to analyze wheat, but also to analyze other items stored in the library.

6. Conclusion

Raw material inventory management is very important for liquor production enterprises. At present, the production focus of liquor enterprises often focuses on price negotiation and sales expansion. When all liquor enterprises focus on raw material price negotiation, it is difficult for each enterprise to gain an advantage in raw material purchase price. At this time, the correct inventory management can help liquor enterprises to obtain a certain competitive advantage. At present, liquor enterprises do not pay enough attention to inventory management. This paper optimizes the inventory management of "Hengkang" through EOQ model and reduces certain costs, which further indicates that liquor enterprises should find an inventory management method suitable for their own needs and lay a foundation for further development by constantly improving the management method.

Liquor enterprises need large raw materials, inventory is not easy to inventory, enterprises should not blindly pursue a variety of emerging systems or technologies for inventory management, should find a suitable for their own management system or technology, but also choose the right inventory management model for analysis, and strengthen the training of inventory management personnel to improve the professional level of personnel. Strengthen contact with suppliers to ensure the transportation of raw materials into storage; Strengthen the information sharing between suppliers and sellers, ensure the acquisition of more accurate market demand, specify the production demand plan and then specify the inventory plan, and reduce the sum of raw material procurement costs and storage costs in various ways.

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