Inventory optimization in the cigarette industry

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Abstract. The increasing cigarette industry makes cigarette-producing companies continue to make improvements in inventory planning determination continuously in order to improve the effectiveness and efficiency of the company. The company sets the number of production based on a rough estimate of consumer demand in previous periods. This causes an imbalance between the company’s production capacity and the number of demands for consumers. A large accumulation of inventory causes a high carrying cost. The incompatibility in the number of demands with the quantity produced results in the emergence of the other costs so that the company loses the opportunity to get maximum profit. Therefore, it is necessary to analyse the inventory quantity to reduce carrying costs. The company optimizes the inventory quantity based on the concept of the Economic Order Quantity using the quantity of safety stock as a minimum inventory point so that the company can plan the production number in the next periods. The results showed that with the proposed inventory system a total cost savings carrying cost of IDR 722,795,625 obtained.

1. Introduction

Company competition in the industry world requires companies to win competition among similar companies. In today global market, companies are always looking for growth and opportunities to reduce their investment with the lowest cost. The achievement of many business is related of their capability to provide goods and services at right time and in right place. Dissimilar organization implement their own strategy to compete with the other companies. At the beginning of the 19th century, companies had to keep large amounts of inventory to survive. During subsequent times, disadvantages of over-inventory were clearly understood by companies. In the 20th century, the importance of the cost inventory was understood. Therefore, companies-implemented based inventory control methods to manufacture with low quantity inventories [1].

Inventory in question is the supply of raw materials, semi-finished goods called goods in process and finished goods, which are managed by the organization to meet their operational needs. It has considerable investment and potential waste sources that need to be controlled carefully. The amount of inventory that must fall to signal that an order must be made to refill an item [2]. Inventory of raw materials in a company is an important requirement in carrying out a goods production. If raw materials are unavailable, the production process cannot be carried out. Therefore, it is necessary to provide raw materials by the company. The quantity of raw material needed by the company is influenced by the size of the company's production. While the company's production costs are influenced by the level of demand for a product produced by the company so that in the company's inventory determination must always consider the quantity of raw materials used in a period. In order to inventory cost to be as much as possible, in a period the quantity of raw materials supply must be in accordance with the quantity of raw materials usage[3][4]. Inventory has been considered as one of the major cost drivers in manufacturing operation [5]. Inventory management is one of the most important factors in organization and the percentage of inventories to whole asset largely varies between 15 to 25%. Inventory
management system has mainly two concerns, one is level of customer service in order to have right goods, in right place and at right time and other is cost of ordering and carrying inventories [6]. Inventory is a major asset that sell or manufacture products. In inventory management involves balance between customer service, or product availability and inventory cost. There are a number of factors that influence inventory-decision making. In addition, inventory management manufacturing, wholesaling, retailing, importing/exporting, and other fields, inventory constitutes one of the largest controllable assets of business [7].

Companies engaged in cigarette production are still experiencing problems in the optimal inventory quantity determination. The company applies inventory roughly so that there is an imbalance between production capacity and total inventory. This results in a high carrying cost. Each inventory cost is expected to be less than 15% while in reality the total inventory storage costs reach 40% of the total inventory cost. One approach to determine the optimal quantity of inventory is by the Economic Order Quantity (EOQ) to minimize carrying costs based on safety stock. EOQ on paper by James A. Cargal obviously describes the fundamental theory of the Economic Order Quantity. EOQ model adopts that demand is constant, and that deprived inventory at a fixed rate until it ranges zero [8]. EOQ has been a well-known formula that calculates the most favourable Economic Order Quantity. Engineers study the EOQ formula in engineering economics and industrial engineering courses. On the other hand, business discipline studies the EOQ in both operational and financial courses. In both, EOQ formulas have practical and exact applications in defining concepts of cost trade-offs; as well as specific application in inventory [9]. The quantity of an economic order is the quantity at which noted costs are low. Registered costs are costs associated with costs incurred for storing inventory items in the store. That be contingent on the amount and period of time until the inventory will be warehoused. This contains storage costs, damage costs, depreciation, handling fees, insurance costs, etc. [10]. Carrying costs and EOQ are influenced by the value of safety stock. Safety stock is inventory that is reserved as a safeguard from the continuity of the company's production process. Safety stock is needed because in reality the quantity of raw material needed for the production process is not always as planned. Safety stocks are used to maintain uncertainty, improve service levels and increase the stability in planning and controlling systems [11].

Research to overcome the problem of inventory planning has been done before. The study was conducted by Eka Febryan Prayitno et al. 2016 in a fertilizer industry company which produces two types of products phosphate and dolomite. However, in raw manufacturing process still has disadvantage like there is no control in specific inventory of raw materials which could make disruption production process in financial loses. EOQ method is used to provide the quantity of raw materials. The data showed the EOQ value, the Safety Stock and the Reorder Point on each form automatically. It was made the raw material inventory control process scheduled without interrupting the production process [12]. Another studies presented a research using EOQ method to determine the inventory management in Automotive Service Industry in Malaysia. This method is planned to be implemented in the independence automotive services workshop as an alternative to the high cost investment of the system in the selected industry. Based on the results, the data that predicted by Simple Moving Average technique gives the most accurate data and this EOQ method is selected in the determination of optimal number inventory model [13].

2. Methodology
The research was conducted in one of the industries in the Medan city that produce cigarettes. The object examined in this study is the accumulation of high inventory quantity. Research begins with observations to observe and see the state of the industry. After observation, the topic and purpose of the study are determined according to the conditions on the production floor. Then data collection is needed to overcome the problem of the inventory quantity that occurs. Data collected in the form of production capacity data, the number of demands and the inventory quantity. The data collected is then processed using the EOQ approach based on safety stock and carrying cost. EOQ calculation is done with the following formula:
EOQ = \sqrt{\frac{2C_0D}{CiU}} \tag{1}

Where, \( C_0 \) = ordering cost, \( C_i \) = Carrying cost per year, \( D \) = number of demands per year and \( U \) = production cost. Safety stock value is obtained by the following formula.

Safety Stock = \( k \times \sigma_c \) \tag{2}

Where \( k \) is the factor that corresponds with \( f(k) \) and \( \sigma_c \) is deviation standard combination. Calculation of \( \sigma_c \) by the following formula.

\[ f(k) = (1-SL) \times \frac{Q}{\sigma_c} \] \tag{3}

Where \( k = \) a function of the normal curve shows the right area of the normal distribution, \( SL = \) level of product availability (assumption= 99%), \( \sigma_c \) = deviation standard combination and \( Q \) = procurement quantity (obtained by EOQ formula). After obtaining the EOQ, Safety Stock and Corresponding Factor to the final calculation is carrying cost. Carrying costs can be calculated with the following formula.

\[ \text{Carrying Cost} = \sum_{i=1}^{n} X_i \times (1-SL) \times \frac{15\%}{12\ \text{month}} \times P \] \tag{4}

Where \( X_i = \) Inventory quantity per month, 15% is carrying cost condition for 1 year and \( P \) = cost of finished goods. The last step is to compare the actual carrying cost and after the EOQ approach is carried out.

3. Result and discussion

3.1. Actual inventory

Actual company inventory in graphical form can be seen in Figure 1.

![Figure 1. Inventory actual of company for 1 year.](image1)

Based on the graph above, the company's actual inventory fluctuates with a high quantity of inventory.

3.2. Proposed inventory

Proposed company inventory in graphical form can be seen in Figure 2.

![Figure 2. Inventory proposed of company for 1 year.](image2)
Inventory in the chart above is obtained based on EOQ and Safety Stock calculations. Based on the graph above, the company’s proposed inventory experiences a significant inventory quantity reduction. Inventory proposed in the form of existing inventory utilization without production again.

3.3. Calculation of carrying cost in actual inventory
Recapitulation of the calculation results in actual carrying cost of inventory shown in Table 1.

| Month   | Inventory (ton) | Carrying Cost (IDR) |
|---------|----------------|---------------------|
| January | 906            | 96,828,750          |
| February| 888            | 94,905,000          |
| March   | 890            | 95,118,750          |
| April   | 881            | 94,156,875          |
| May     | 874            | 93,408,750          |
| June    | 765            | 81,759,375          |
| July    | 742            | 79,301,250          |
| August  | 663            | 70,858,125          |
| September| 688          | 73,530,000          |
| October | 690            | 73,745,750          |
| November| 705            | 75,346,875          |
| December| 711            | 75,988,125          |
| Total   | 1,004,945,625  |                     |

The table above shows the results of the calculation of high carrying cost of IDR 1,004,945,625 which is resulted in company losses. This is because the quantity of actual company inventories is very high.

3.4. Calculation of carrying cost in proposed inventory
Recapitulation of the calculation results in carrying cost of the proposed inventory can be seen in Table 2.

| Month   | Inventory (ton) | Carrying Cost (IDR) |
|---------|----------------|---------------------|
| January | 726            | 77,591,250          |
| February| 563            | 60,170,625          |
| March   | 481            | 51,406,875          |
| April   | 337            | 36,016,875          |
| May     | 218            | 23,298,750          |
| June    | 45             | 4,809,375           |
| July    | 45             | 4,809,375           |
| August  | 45             | 4,809,375           |
| September| 45           | 4,809,375           |
| October | 45             | 4,809,375           |
| November| 45             | 4,809,375           |
| December| 45             | 4,809,375           |
| Total   | 282,150,000    |                     |
Based on the calculation of safety stock, the total inventory for June to December is 45. The EOQ calculation in inventory can minimize the cost of carrying costs from IDR 1,004,945,625 to IDR 282,150,000. By calculating the EOQ by the company experienced a carrying cost savings of IDR 722,795,625.

4. Conclusion

EOQ calculation based on safety stock and carrying cost calculation is used by the company to determine the optimal inventory quantity by maximizing the quantity of available inventory without production again. Based on EOQ calculation and safety stock the inventories quantity in June to December changed to 45. Calculation of carrying cost with the quantity of proposed inventory was IDR 282,150,000 while the calculation of carrying cost with actual inventory cost IDR 1,004,945,625. Cost savings with carrying costs based on the quantity of proposed inventory is IDR 722,795,625.

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