Minimizing inventory cost of dried food materials availability: An analyzing in teaching hospital

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Abstract. Excess stock of dried food materials directly proportional to the increase in inventory cost. Average overstock in Teaching Hospital during February 2019 - April 2019 is 39,3% with total capital invested of the overstock of IDR 13,702,247. In addition, an overstock caused by an average total damage of 18,31% which is resulted in a loss of 29,73% of the capital invested in dried food material overstocked. Dried food material excess stock is caused by the absence of a reference limit for orders and the optimal number of orders. The number of orders are not optimal will cause the order frequency to increase and make order costs also increase. The purpose of this research is to prove whether there is a cost minimization of the cost of dried food material which is higher than the Economic Order Quantity (EOQ) model when compared to the actual dried food inventory model. EOQ was used to calculate the optimal number of orders for dried food, safety stock and reorder points calculation. In the total cost of inventory calculation based on actual conditions when compared with the total cost of inventories using the EOQ method for dried food, a saving efficiency of 44,22% is obtained.

1. Introduction

Inventory can be defined as idle resources. This idle resource has not been used because it is waiting for further processing [1]. Dried food material are food materials have a very low Activity Water (AW), namely 0,065. Where at this number bacteria or fungi cannot grow. Types of dried food / groceries are flour, noodles, rice, dried seasoning, various pastas, and several seasonings. Dried food materials used for food production have certain criteria, such as good quality, hygiene, clean and scales, proper storage methods, the quantity is always in stock and the stock is never empty and easy to distinguish from other goods [2].

Inventory control is a very important managerial function, where the majority of companies gives a high invest in the inventory aspect of 20% to 60%. This causes a dilemma for the company. If the inventory is excess, the storage and capital costs will also increase and when the company invests too much capital in the inventory it will cause the excess storage costs [3].

This method applies two types of cost, carrying cost and ordering cost that make the total inventory cost become more economically [4]. The inventory holding cost was very considerably and directly related to the number of storage items, but storage cost are imposed on the system due to a sudden increase.[5]. Ordering materials to inventory sometimes have a several problem, including the condition of defective items, lack of or not according to orders, difficulty managing accounting records manually, processing inventory data manually in the warehouse and difficulty in identifying the period when ordering materials [6] all product may have a poor quality and must be checked [7].
Inventory level using EOQ gets optimal results because the number of orders with EOQ can meet all needs. From the comparison of company policy and EOQ policy, it is found that the inventory cost according to the EOQ method is smaller than the total cost according to company policy [8].

Inventory management is an activity carried out by a company which is indispensable in making decisions so that the company's material needs can be met optimally with the least possible risk. Inventory that is too large (overstock) is a waste because it causes storage and maintenance costs that are too high while stored in the warehouse [9]. Managers must be able to apply the most appropriate inventory management techniques into their business operations. Therefore, the EOQ model is used to determine how inventory should be managed [10].

Inventory control is characterized by having to estimate demand before customer order because the waiting time to restocking is usually longer. This means that additional stock must be based on estimates. Since such estimates are always more or less wrong, shortage will occasionally occur. To be able to maintain stable and competitive performance, safety stock must be used. However, a safety stock means capital cost that tied up in stock. An important problem of inventory control is to establish an efficient relationship between the level of service required to customers and the capital cost that tied up in safety stock [11].

At the teaching hospital in an overstock or excess quantity of dried food stock, where there is excess stock of all types of dried food material, especially such as plain jelly, rice, biscuits and others. The average number of overstocks in February 2019 - April 2019 was 39.3% or with an invested capital of IDR 13,702,247. The large quantity of overstock and capital cause concern for the teaching hospital of the risks to dried food storage. The impact of excessive storage of dried food material causes an average damage of 18.31% with a total loss of 29.73% of the capital invested in an overstocked dried food material or IDR 4,074,233.

Overstock is the impact of the dried food inventory system has been implemented so far in the teaching hospital does not have a limit reference for goods ordering and is only based on data checking for dried food materials in the warehouse which is carried out once a week without any consideration of the optimum order quantity of each type of dried food. Planning to minimize inventory costs, one of them is by calculating the Economic Order Quantity (EOQ) method, which is the calculation of the optimal number of dried food orders to see whether this method will be able to reduce inventory costs, safety stock calculations are made to anticipate fluctuations in demand and the calculation of the reorder point is made to serve as a reference for the schedule or limit for ordering dried food inventory at the teaching hospital.

2. Research methodology
This type of research is descriptive research. Data obtained from the results of research on actual dried food inventory management will be collected and compared with the results of dried food inventory management using the EOQ method based on the cost aspect.

The objects observed are dried food inventory in teaching hospitals, which is an effort to see whether the use of the EOQ method in inventory control is more effective in reducing the cost of inventory in teaching hospital. The variables contained in this study are:

1. Independent variables consist of the type of dried food stock, the quantity of order stock for each dried food materials, the dried food stock cost, the quantity of each dried food materials usage, and the frequency of ordering dried food stock.
2. Dependent Variable, namely the cost minimization of the dried food material inventory at the Teaching Hospital.

Data processing is carried out using the economic order quantity (EOQ) method. Data processing is carried out as follows:
1. Classifying dried food materials based on the amount of budget used
2. Calculation of Total Inventory Cost
   - Calculation of Actual Total Cost of Selected Dried Food Materials
Calculation of Total Inventory Costs using the Economic Order Quantity (EOQ) Method on Selected Dried Food Materials

3. Calculation of Safety Stock
4. Calculation of Reorder Point
5. Comparison of the Total Inventory Cost of the Actual Condition and the Total Cost of Inventory Using the EOQ Method on Selected Dried Food Materials in Teaching Hospital

3. Result and Discussion

In calculation the cost of inventory control, there are several variables affect it. So that in the inventory cost calculation there are two types of fluctuate costs, namely the saving cost and ordering costs. The saving cost is influenced by the amount of stock inventory. Meanwhile, the ordering cost is influenced by the frequency of orders made on the material.

The following are costs affect inventory costs as follows.

a. Saving cost

The formula used in the saving cost calculation is as follows [13].

\[
\text{Saving cost} = \frac{Q}{2} \times H \quad (1)
\]

Where:
- \(Q\) = Number of Items per Order
- \(H\) = Saving cost

Storage costs are assumed to be 20% of the goods cost based on considerations of shelf life, warehouse conditions, maintenance costs, material turnover cycles, and damage costs. The following is the calculation result of storage costs.

| No | Food Material | Dried Food Material Unit | Cost per Unit Dried Food Material Usage | Storage Cost |
|----|---------------|--------------------------|---------------------------------------|--------------|
| 1  | Rice          | Kg                       | IDR 11.000                            | IDR 2.200    |
| 2  | Cooking Oil   | L                        | IDR 13.000                            | IDR 2.600    |
| 3  | Sugar         | Kg                       | IDR 15.500                            | IDR 3.100    |
| 4  | Diet Salt     | pack                     | IDR 38.000                            | IDR 7.600    |
| 5  | Fried Onions  | pack                     | IDR 70.000                            | IDR 14.000   |

b. Ordering cost

The formula used in ordering costs calculation is as follows [13].

\[
\text{Ordering Cost} = \frac{D}{Q} \times S \quad (2)
\]

Ordering costs consist of several costs, namely, administrative costs, loading and unloading costs, telephone costs, and transportation costs paid in one year of IDR 33.300.000 with coverage of 216 orders a year for 31 types of dried food material.

3.1. Calculation of The Selected Dry Food Inventory Cost in Actual Conditions

Teaching hospital until now has not calculate the optimization of the number of orders yet and the reference for the order limit as well as the costs calculation incurred in the dried food inventory. The calculations carried out in finding the inventory costs are as follows [13].

\[
\text{TIC} = \left(\frac{D}{Q} \times S\right) + \left(\frac{Q}{2} \times H\right) \quad (3)
\]
The calculation of the rice inventory cost are as follows.

\[
\text{Cost} = \left( \frac{5200}{433.3} \times \text{Rp 152.778} \right) + \left( \frac{433.3}{2} \times \text{Rp 2.200} \right)
\]

\[
= \text{IDR 1.833.336} + \text{IDR 476.667}
\]

\[
= \text{IDR 2.310.003}
\]

The following is a recapitulation of the selected dried food inventory cost based on actual conditions.

**Table 2. Recapitulation of inventory cost calculation results in actual conditions**

| No | Food Material | Dried Food Material Unit | Number of Order | Order Average | Order Frequency | Usage Total | Cost per Unit Dried Food Material Usage | TIC |
|----|---------------|--------------------------|-----------------|---------------|----------------|------------|----------------------------------------|-----|
| 1  | Rice          | Kg                       | 5200            | 520,0         | 12             | 5405       | IDR 11.000                               | IDR 2.310.003 |
| 2  | Cooking Oil   | L                        | 790             | 65,8          | 12             | 801        | IDR 13.000                               | IDR 1.944.447 |
| 3  | Sugar         | Kg                       | 436             | 54,5          | 8              | 448        | IDR 15.500                               | IDR 1.340.338 |
| 4  | Diet Salt     | Pack                     | 173             | 14,4          | 12             | 154        | IDR 38.000                               | IDR 1.686.770 |
| 5  | Fried Onions  | Pack                     | 62              | 15,5          | 4              | 67         | IDR 70.000                               | IDR 768.895  |

**Total**

| IDR 8.050.453 |

3.2. Calculation of Total Inventory Costs Using The Economic Order Quantity (EOQ) Method On Selected Dried Food Materials

The calculation of inventory control costs is carried out using the Economic Order Quantity (EOQ) method. It has several assumptions and influence steps.

The steps for the EOQ method calculation are as follows

1. Determination of Demand
2. Determination the Quantity of Variable Cost Consist of Ordering Cost and Saving Cost
3. Calculation of EOQ [13].

\[
\text{EOQ} = \left( \frac{2SD}{H} \right)^{1/2}
\]

4. Determination of Optimum Order Frequency [13].
5. Calculation of Inventory Cost using the EOQ Method

The results of the recapitulation of the total inventory cost calculation based on the EOQ method on selected dried food materials are as follows.

Example : Rice

\[
\text{TIC} = \left( \frac{D}{Q} \times S \right) + \left( \frac{Q}{2} \times H \right)
\]

The calculation of inventory costs is as follows.

\[
= \left( \frac{5410}{870} \times \text{Rp 152.778} \right) + \left( \frac{870}{2} \times \text{Rp 2.200} \right)
\]

\[
= \text{IDR 950.033} + \text{Rp 957.000}
\]

\[
= \text{IDR 1.907.033}
\]

The following is a recapitulation of the calculation results of the inventory total cost based on the EOQ method on selected dried food materials.
Table 3. Recapitulation of selected dried food material inventory cost calculation results based on the EOQ method

| No | Food Material | Dried Food Material Unit | EOQ | Total Needs | Order Frequency | Number of Order | Cost per Unit | TIC |
|----|---------------|--------------------------|-----|-------------|----------------|----------------|---------------|-----|
| 1  | Rice          | Kg                       | 870 | 5410        | 7              | 5200           | IDR 11.000    | IDR 1.907.033|
| 2  | Cooking Oil   | L                        | 308 | 802         | 3              | 790            | IDR 13.000    | IDR 798.218  |
| 3  | Sugar         | Kg                       | 211 | 448         | 3              | 436            | IDR 15.500    | IDR 651.432  |
| 4  | Diet Salt     | Pack                     | 79  | 154         | 2              | 173            | IDR 38.000    | IDR 598.020  |
| 5  | Fried Onions  | Pack                     | 39  | 67          | 2              | 62             | IDR 70.000    | IDR 535.465  |
|    |               |                          |     |             |                |                |               | Total IDR 4.490.168 |

3.3 Calculation of Safety Stock
The calculation of safety stock is based on the deviation has occurred from the average over the last several months. The deviation value is the standard deviation. The following is a standard deviation calculation formula [14].

\[ S=\left(\frac{\sum(x-x)^2}{n-1}\right)^{1/2} \]

After the standard deviation results are obtained, the safety stock can be calculated using the following formula [16]:

\[ Safety \ Stock = Sd \times Z \times \sqrt{L} \] (7)

The following is an example of the safety stock calculation of rice by implementing an inventory has met 95% of the needs and a stock inventory of 5%,

\[ S=\left(\frac{\sum (570-450,4)^2+(420-450,4)^2+(440-450,4)^2+...+(445-450,4)^2}{12-1}\right)^{1/2}=56,8 \]

The following is the number of safety stock for each selected type of dried food.

Table 4. Recapitulation of safety stock calculation result

| No | Food Material | Unit | Safety stock |
|----|---------------|------|--------------|
| 1  | Rice          | Kg   | 100          |
| 2  | Cooking Oil   | L    | 20           |
| 3  | Sugar         | Kg   | 11           |
| 4  | Diet Salt     | Pack | 35           |
| 5  | Fried Onions  | Pack | 6            |

3.4 Calculation of Reorder Point
The following is a formula to find reorder points [14].

\[ ROP = Safety \ Stock + (Lead \ Time \times Q) \] (8)

Before determine the reorder point for rice food material, you can find the number of needs per day as an input in the reorder point calculation [14].
\[ Q = \frac{\text{Total of Rice Usage}}{365 \text{ days}} \quad (9) \]

\[ Q = \frac{5405 \text{ Kg}}{365} \]

\[ Q = 14.8 \text{ Kg} \]

After obtaining the number of rice needed per day, the reorder point calculation can be done as follows.

\[ \text{ROP} = \text{Safety Stock} + (\text{Lead Time} \times Q) \quad (10) \]

\[ \text{ROP} = 100 + (1 \times 14.8) \]

\[ \text{ROP} = 114.8 \text{ Kg} \]

### Table 5. Result of reorder point calculation (ROP)

| No | Food Material | Unit | Total Needed | Q | Lead Time | Safety Stock | ROP | ROP Adjustment |
|----|---------------|------|--------------|---|-----------|--------------|-----|----------------|
| 1  | Rice          | Kg   | 5405         | 14.8 | 1         | 100          | 114.8 | 120            |
| 2  | Cooking Oil   | L    | 801          | 2.2  | 1         | 20           | 22.2  | 24             |
| 3  | Sugar         | Kg   | 448          | 1.2  | 1         | 11           | 12.2  | 13             |
| 4  | Diet Salt     | Pack | 154          | 0.4  | 1         | 35           | 35.4  | 36             |
| 5  | Fried Onions  | Pack | 67           | 0.2  | 1         | 6            | 6.2   | 7              |

After calculating the total inventory cost of each selected dried food in the actual condition and the total inventory cost using the EOQ method, the following comparisons are obtained.

### Table 6. Comparison between inventory costs, actual conditions and conditions using the EOQ method

| Description | Actual Condition | EOQ Method |
|-------------|------------------|------------|
| Total of Inventory Cost | IDR 8.050.453 | IDR 4.490.168 |

The minimization of total inventory costs can be seen from the percentage savings calculation. The following is a calculation of the overall cost efficiency of inventory between actual conditions and inventory costs using the EOQ method for a classification of dried food materials in selected hospitals.

\[ \text{Saving} = \frac{(\text{TIC of Company Policy} - \text{TIC of EOQ Model})}{\text{TIC of Company Policy}} \times 100\% \quad (11) \]

\[ = \frac{(IDR 8.050.453 - IDR 4.490.168)}{IDR 8.050.453} \times 100\% \]

\[ = 0.4422 \times 100 \]

\[ = 44.22\% \]

From the above calculations, it is found that using the EOQ method provides savings of 44.22% on inventory cost in the teaching hospital and decreases frequency order at each selected dried food. With this, the use of the EOQ method can be used in minimization and is proven to reduce inventory costs to be more efficient.

### Conclusion

The following is the conclusion from the research on the dried food material in the teaching hospital. Comparisons are made to see the cost efficiency between the actual inventory costs and the inventory costs using the EOQ method and the savings obtain are 44.22% efficiency with a total cost savings of IDR 3,560,285.
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