



Optimizing Raw Material Inventory Using Economic Order Quantity (EOQ) Method in Bombay Bakery

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ABSTRACT

The development of population increases every year causing food needs to increase, to meet food needs by increasing food crop productivity so that food availability can be sufficient. Food crops consist of rice, corn, green beans, peanuts, cassava, and sweet potatoes. Productivity in each region has different characteristics and therefore it is necessary to group the regions so that solution can be implemented in accordance with each of the characteristics of the region. The purpose of this study is to group districts/cities in North Sumatera Province based on food crop productivity using the k-means clustering method. Clustering k-means is method of grouping non-hierarchical data that attempts to partition existing data into one or more cluster or groups so that data that has the same characteristics are grouped into one same characterstics are grouped into other groups. The result of this study are the formation of 3 city district clusters namely, cluster 1 amounting to 1 regency/city, cluster 2 totaling 7 districts/cities, and cluster 3 totaling 25 districts/cities.

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1. INTRODUCTION

In the current era of globalization and technological advances, many companies have established themselves in big cities in Indonesia, especially in city centers, causing competition between companies in the market to become increasingly tight and difficult, all competition is caused by consumers who are increasingly demanding so that they are not limited to a product. quality and price alone, the level of good service must be improved and paid attention to. The relevant service is the provision of products that buyers need efficiently and effectively in terms of quality and quantity of materials according to needs [1]. Fulfilling consumer needs in the culinary business industry means having superior quality products that are safe regarding the smoothness and availability of production. For a company to achieve needs and keep production running smoothly, the company must get large profits and profits so that the production process runs well so that it covers everything. Production runs smoothly with the influence of several factors, one of which is the supply of raw materials for processing in the production process. The agency believes that by storing and purchasing raw materials in large quantities, the production process can run without shortages of raw materials. If a company purchases raw materials in large quantities, then the company must invest a lot of capital for storing raw materials and purchasing raw materials.

Operations in an inventory company is a much needed role. Inventory is available material or finished goods in the production process within a company, and products available to fulfill consumer or customer needs [2].

Every company must carry out inventory control of raw materials in order to maintain its position or be able to increase its business in market competition. Having appropriate inventory control can also help companies in the efficient use of material components. However, management of material components cannot 100 percent reduce the risk if the supply of material components is too large or too small. With company control, companies can reduce or minimize losses. Inventory at each company is different, depending on the type of factory, production volume and production process [3].

Bombay Bakery is a privately owned business venture in the culinary sector that was founded in 2000. A business that serves consumer demand with a wide variety of bread and donut flavors to choose from. Apart from that, Bombay Bakery was also taken over by distributors to be remarketed, in fact almost all the stalls in the city of Padangsidimpuan Bombay Bakery were marketed.

The problem with Bombay Bakery and other culinary companies is the problem of supply of ingredient components. Problems that often arise are inadequate supply of raw materials so that the production process stops. Apart from that, ordering material components that are not planned well will increase production costs. So there is a buildup of raw materials in the warehouse which can reduce the quality of the raw materials, causing the company to experience losses.

So, to prevent the company from experiencing losses and undesirable things happening in the production process, it is necessary to control the company's raw material inventory. Controlling raw material inventory helps companies produce according to scheduled plans and by applying the Economic Order Quantity (EOQ) method so that requirements are met.

raw materials are met precisely at the optimal cost possible. EOQ is the number of purchases at each purchase that has the greatest economic value low. By using the EOQ method the company is able to minimize the occurrence of out of stock so that the company does not experience losses because the production process is running well. The EOQ method is a comparison between policies in terms of spending less inventory costs or total inventory costs [4].

Previous researcher [5] Analysis of Inventory Control by Using Economic Order Quantity Model-A case study in PT Semen Padang [6], The Implementation of Economic Order Quantity for Raw Material Planning in SME Producing Terasi Crackers [7], Analysis of PT's raw material inventory. BS with the Economic order Quantity (EOQ) and also Economic order Quantity (EOQ) methods have been widely used in the supply of production materials, including Wilton Kuala Simpang Bread Production [8], Inventory Management with EOQ Method at "Nitra Jaya" Fashion-Making Company In Bandung [9], raw material supply for veils at RAR Azkia Padalarang [10], optimization of the granulated sugar raw material supply system using the Economic Order Quantity (EOQ) method in the thesis (11).

Based on the description above, the author would like to propose the title "Optimizing Raw Material Inventory Using the Economic Order Quantity (EOQ) Method in Bombay Bakery".

2. RESEARCH METHODE

Inventory is one of the things that is really needed by service agencies, trading agencies and manufacturing agencies. According to [2] inventory is an activity which includes goods owned by the agency with the aim of being sold within a certain time, or inventory of components of goods which are in the procedural stage. production process, or inventory of material components waiting in a production process. According to [12] inventory is a component of goods that is stored for the future by selling and using or needing it. Meanwhile [12] believes that item component planning is used to show goods owned for resale and Inventory Inventory is a general term for fulfilling desires to show everything that is stored in anticipation [13].

3. RESULT AND ANALYSIS

2.1. Inventory Functions

Handoko's opinion in the journal [13] is that the inventory function is:

1. Decoupling Function

The special function of inventory is the independence of external and internal agency processes. This decoupling inventory in agencies has the possibility of fulfilling consumer desires without depending on suppliers.

2. Economic Lot Sizing Function

With inventory storage, agencies can create and choose sellers of goods in quantities that can save on unit costs.

3. Anticipation Function

In terms of business functions it can predict seasonal inventory levels

4. Inventory costs

5. The mandatory costs are considered as follows:

- a. Costs for storing goods. The costs for storing goods
- b. Ordering costs
- c. Production Costs Production costs exist if the company makes its own materials in the factory
- d. Material shortage costs are costs that occur if there is a shortage of raw materials in inventory
- e. Systemic costs of planning for personal training to run the system and provide equipment are also called costs.

6. Inventory Planning

Inventory planning is an activity that maintains and stores all inventory to determine the amount of inventory. Consider the costs incurred and the inventory stored.

7. Raw Material Inventory Control

Understanding Raw Material Inventory Control Control of the material components in each agency is definitely needed to facilitate activities within the related company. Control is ensuring that oneself as management manages all activities carried out by each employee in accordance with company policies.

8. Inventory Control Objectives

9. The fundamental objective of material control is the ability to send orders to suppliers of goods at the best time in order to obtain the right quantity, fixed price and quality.

2.2. Economic Order Quantity (EOQ)

Economic Order Quantity (EOQ) is a model for determining order quantity in a continuous system. The function of the Economic Order Quantity (EOQ) model is to determine the number of orders that can minimize total inventory costs. The aim of the Economic Order Quantity (EOQ) method is to reduce total inventory costs by determining the order quantity. Apart from that, the aim of the EOQ method is to optimize the quantity and frequency of purchases.

$$Q^* = \sqrt{\frac{2DS}{H}} \quad (1)$$

Description :

Q* = Optimal value

S = Ordering cost (rupiah/order)

H = Storage costs (rupiah/unit/year)

2.3. Purchase Frequency

Every order using the Economic Order Quantity Method is related to the number of orders. So, the number of purchases per year is inget from one year's demand for materials divided by the optimal number of buyers per order. According to [3], the purchase frequency is formulated as follows:

$$N = \frac{D}{Q} \quad (2)$$

Description:

N = Number of purchases

D = Number of requests for goods per year

Q = Number of goods ordered

2.4. Safety Inventory (Safety stock)

Opinion [14] safety stock is inventory that companies must have to anticipate fluctuations in demand and avoid running out of stock. To calculate safety stock, it is necessary to pay attention to maintaining service levels in the face of uncertain demand, by showing the service level that the company is able to provide [15]. What [16] explained in calculating the size of the Safety Stock. It can be formulated as follows:

$$\text{Safety Stock} = (\text{Maximum Usage} - \text{Average Usage}) \text{Leadtime} \quad (3)$$

2.5. Reorder Point

According to (G.Taharapry 2016) the four main variables for determining safety stock are: lead time, safety stock, material requirements at any time, and the amount needed per day. Opinion (A.Slamet 2007), reordering is formulated as follows:

$$\text{Reorder point} = (LT \times AU) + SS \quad (4)$$

Description :

LT = Lead time

AU = Average units

SS = Safety stock

2.6. Total Inventory Cost (Total Inventory Cost)

According to Fadly, total inventory costs are all expenses arising from each agency's inventory. Meanwhile, total inventory costs according to Sumayang, (2003) are the number of orders with a balanced inventory level. The Total Inventory Cost explained by Buffa can be formulated as follows:

$$TIC = \frac{D}{Q} \times S + \frac{Q}{2} \times H \quad (5)$$

Information:

D = Number of goods requested in units

S = Ordering costs or ordering costs for each order

H = Storage cost per unit

Q = Number of orders in units

TIC = Total inventory cost the function of total inventory cost can be seen.

2.7. METHODS

This The data collection technique in this research is carried out by collecting data directly from the object to be studied by taking the data needed in the case of this research. This research will be carried out at Bombay Bakery, Jalan Sutan Maujalo, Sidangkal sub-district, Padangsimpunan city, North Sumatra. And the time required to complete this research is approximately two months.

2.8. Research procedure

The research procedures carried out in this research are:

1. Collect theories about inventory that support using the EOQ method.
2. Take data or collect data regarding control of raw materials including data on the amount of raw material production usage at Bombay Bakery in 2020, ordering costs and storage costs for raw materials and the number of purchases of raw materials in 2020 at Bombay Bakery.
3. Formulate problems regarding research questions that require answers by collecting data related to material control
4. Identify raw material control using company management.
5. Carry out calculation analysis using the EOQ method
6. Drawing conclusions

4. RESULT AND ANALYSIS

Like most companies, the Bombay Bakery company does not use the EOQ method to control raw inventory. Secondary data was obtained through company records and interviews according to the needs in solving problems. Based on research conducted at the Bombay Bakery bakery company, to optimize the supply of raw materials in order to expedite the production process, data on the amount of raw materials used for wheat flour, butter, sugar, bread improver and eggs is needed.

Table 1: Total Use of Raw Materials in 2020

Bulan	Wheat flour (Kg)	Butter (Kg)	Sugar (Kg)	Bread Improver (Kg)	Egg
January	2360	188	525	6,5	38
February	2060	160	460	5,8	33
March	2150	165	473	6,1	34
April	1540	148	418	4,3	26
Mey	1630	154	424	4,8	27
June	1700	157	432	5,1	28
July	1460	135	403	3,7	25
August	1650	156	428	5,1	26
September	1800	159	437	5,3	28
October	2100	171	465	5,9	32
November	2250	179	488	6,2	36
December	2300	185	530	6,4	37
Total	23000	1957	5483	65,2	370

So far, Bombay Bakery has been purchasing raw materials based on previous sales by purchasing raw materials every month.

3.1. Quantity and Frequency of Raw Material Orders

The quantity and frequency of ordering raw materials is also needed optimizing raw material inventory.

Table 2. Quantity and Frequency of Raw Material Orders

No	Rows	Order Quantity	Intensity	Order Total
1	Wheat flour	1916,67 Kg	12	23000 kg
2	Butter	163,08 Kg	12	1957 Kg
3	Sugar	456,91 Kg	12	5483 Kg
4	Bread improver	27,25 Kg	12	65,2 Kg
5	Egg	31	12	370

3.2. Raw Material Ordering Costs

The Bombay Bakery Company also incurs ordering costs in ordering raw materials. Company ordering costs include telephone costs, as well as wages for unloading goods. The amount of raw material ordering expenditure can be seen in the following table:

Table 3. Raw Material Ordering Costs

No	Rows	Telephone costs and wages (Rp)
1	Wheat Flour	780.000, -
2	Mentega	300.000, -
3	Sugar	420.000, -
4	bread improver	60.000, -
5	Egg	60.000, -

3.3. Raw Material Storage Costs

Storage costs are also required for calculation in the form of a percentage of inventory value. Raw material storage costs arise due to the costs of maintaining raw materials in the warehouse. The amount of raw material storage costs at Bombay Bakery is in the following table:

Table 4: Raw Material Storage Costs

No	Type Of Fee	Details (Rp)
1	Warehouse Maintenance	1.200.000, -
2	Electricity costs	2.100.000, -
Total (Rp)		3.300.000, -

Raw material storage costs for each type have not been determined by the company, so it is necessary to have storage costs for each raw material calculated in the form of a percentage of the total raw material storage costs. So the storage costs for each raw material are as follows following:

Table 5. Percent of Raw Material Storage Costs in 2020

Raw	Cost (%)	Total Storage Costs (Rp)	Storage Costs (Rp)
Wheat Flour	75	3.300.000, -	2.475.000, -
Butter	5	3.300.000, -	165.000, -
Sugar	1	3.300.000, -	594.000, -
Bread Improver	0,5	3.300.000, -	16.500, -
Egg	1,5	3.300.000, -	49.500, -

Table 6. Storage Costs per Raw Material (H) in 2020

Raw	Storage Costs	Usage	Storage Cost Unit
Wheat flour	2.475.000, -	23000 kg	Rp.1.291,32 /Kg
Butter	165.000, -	1957 Kg	Rp.1.011,72 /Kg
Sugar	594.000, -	5483 Kg	Rp.1.299,96 /Kg
Bread Improver	16.500, -	65,2 Kg	Rp.3.036,72 /Kg
Egg	49.500, -	370 Board	Rp.1.605/Board

3.4. Data processing

a. Total Company Inventory Costs

Total Company Inventory Costs using conventional methods or calculating the company's total inventory costs.

1. Total cost of raw material inventory for wheat flour

$$\begin{aligned}
 TIC &= (\bar{D} \times H) + (n \times S) \\
 &= 1916,67 \times 1291,32 + (12 \times 780.000) \\
 &= 11.835.034
 \end{aligned}$$

2. Total cost of raw material inventory for Butter

$$TIC = (\bar{D} \times H) + (n \times S)$$

$$= 163.08 \times 1011,72 + (12 \times 300.000)$$

$$= 3.764.991$$

3. Total cost of raw material inventory for Sugar

$$\text{TIC} = (\bar{D} \times H) + (n \times S)$$

$$= (456,91 \times 1299,96) + (12 \times 420.000)$$

$$= 5.633.96428$$

4. Total cost of raw material inventory for Bread Improver

$$\text{TIC} = (\bar{D} \times H) + (n \times S)$$

$$= (5,43 \times 3036,72) + (12 \times 60.000)$$

$$= 736.489$$

5. Total cost of raw material inventory for Egg

$$\text{TIC} = (\bar{D} \times H) + (n \times S)$$

$$= (31 \times 49.755) + (12 \times 60.000)$$

$$= 769.755$$

3.5. Economic Order Quantity (EOQ)

- a. Supplies of raw materials for wheat flour

$$Q^* = \sqrt{\frac{2 \times 23000 \times 780.000}{1291,32}}$$

$$= 5.271,19 \text{ or } 5.271 \text{ Kg}$$

$$F = \frac{D}{Q} = \frac{23000}{5271} = 4,36 = 4 \text{ time}$$

- b. Supplies of raw materials for Butter

$$Q^* = \sqrt{\frac{2 \times 1957 \times 300.000}{1022,72}}$$

$$= 1077,2 \text{ or } 1077 \text{ Kg}$$

$$F = \frac{D}{Q} = \frac{1957}{1077} = 1,8 = 2 \text{ time}$$

- c. Supplies of raw materials for Sugar

$$Q^* = \sqrt{\frac{2 \times 5483 \times 420.000}{1299,96}}$$

$$= 1822,27 \text{ or } 1882 \text{ Kg}$$

$$F = \frac{D}{Q} = \frac{5483}{1882} = 2,9 = 3 \text{ time}$$

- d. Supplies of raw materials for Bread Improver

$$Q^* = \sqrt{\frac{2 \times 65,2 \times 60.000}{3036,72}}$$

$$= 50,75 \text{ or } 51 \text{ Kg}$$

$$F = \frac{D}{Q} = \frac{65,2}{51} = 1,3 = 1 \text{ time}$$

e. Supplies of raw materials for Egg

$$Q^* = \sqrt{\frac{2 \times 370 \times 60.000}{1605}}$$

$$= 166 \text{ papan}$$

$$F = \frac{D}{Q} = \frac{370}{166} = 2,2 = 2 \text{ time}$$

3.6. Safety Stock

Safety stock is used to find out how much a company reserves raw material supplies to ensure the continuity of the production process. Companies also anticipate shortages of raw material supplies and also avoid delays in receiving raw material supplies, so companies must prepare safety supplies.

Table 7. Standard Deviation of Raw Materials

No	Raw	Standar Deviasi (σ)
1	Wheat Flour	306,52 Kg
2	Butter	14,81 Kg
3	Sugar	39,41 Kg
4	Bread Improver	0,83 Kg
5	Egg	5 Board

1. Safety Stock Wheat Flour
 $SS = (1,65 \times 306,52) = 505,75 \text{ Kg}$
2. Safety Stock Butter
 $SS = (\sigma \times Z) = (1,65 \times 14,81) = 24,43 \text{ Kg}$
3. Safety Stock Sugar
 $SS = (\sigma \times Z) = (1,65 \times 39,41) = 65,02 \text{ Kg}$
4. Safety Stock Bread Improver
 $SS = (\sigma \times Z) = (1,65 \times 0,83) = 1,36 \text{ Kg}$
5. Safety Stock Egg
 $SS = (\sigma \times Z) = (1,65 \times 5) = 8,25 \text{ Board}$

3.7. Reorder Point (ROP)

Companies require reordering for purchasing raw materials using EOQ so as not to disrupt the smooth production. In because suppliers do not always fulfill raw materials or cannot fulfill them immediately. So

a lead time or grace period of 2 days is required in companies where the company's operating time in one year is 300 days. The company's Reorder Point calculation is as follows:

1. Reorder Point Wheat Flour

$$\frac{D}{300} = \frac{23000}{300} = 76,75$$

$$ROP = (Lt \times d) + SS = (2 \times 76,67) + 505,75 = 659,09 \text{ Kg}$$

2. Reorder Point Butter

$$\frac{D}{300} = \frac{1957}{300} = 6,52$$

$$ROP = (Lt \times d) + SS = (2 \times 6,52) + 24,43 = 37,47$$

3. Reorder Point Sugar

$$\frac{D}{300} = \frac{5483}{300} = 18,28$$

$$ROP = (Lt \times d) + SS = (2 \times 18,28) + 65,02 = 101,58$$

4. Reorder Point Bread Improver

$$\frac{D}{300} = \frac{65,2}{300} = 0,652$$

$$ROP = (Lt \times d) + SS = (2 \times 0,652) + 1,36 = 2,664$$

5. Reorder Point Egg

$$\frac{D}{300} = \frac{370}{300} = 1,23$$

$$ROP = (Lt \times d) + SS = (2 \times 1,23) + 8,25 = 10,71$$

The total cost of inventory is used to prove that with using the EOQ method there is an optimal amount of raw material purchases and the total cost of raw material inventory will be achieved.

1. Total inventory cost of wheat flour EOQ model

$$TIC = \frac{23000}{5127,19} \times 780.000 + \frac{5127,19}{2} \times 375 = 6.806.802$$

2. Total inventory cost of Butter EOQ model

$$TIC = \frac{1957}{1077,3} \times 300.000 + \frac{1077,3}{2} \times 1011,72 = 1.089.935$$

3. Total inventory cost of Sugar EOQ model

$$TIC = \frac{5483}{1882,27} \times 420.000 + \frac{1882,27}{2} \times 1299,96 = 2.444.062$$

4. Total inventory cost of Bread Improver EOQ model

$$TIC = \frac{65,2}{50,75} \times 60.000 + \frac{50,75}{2} \times 3036,7 = 154.139$$

5. Total inventory cost of Egg EOQ model

$$TIC = \frac{370}{166} \times 60.000 + \frac{166}{2} \times 1605 = 266.950$$

3.8. Comparison of Total Company Inventory Costs with Total Economic Order Quantity (EOQ) Inventory Costs

The total cost of raw material inventory to analyze differences or comparisons between company policies and calculations using the Economic Order Quantity (EOQ) method.

Table 8. Comparison of Total Inventory Costs

Rows	TIC Company (Rp)	TIC EOQ (Rp)	Difference (Rp)
Wheat Flour	11.835.034, -	8.806.802, -	3.028.232, -
Butter	3.764.991, -	1.089.935, -	2.675.056, -
Sugar	5.633.964, -	2.444.064, -	3.189.902, -
Bread Improver	736.489, -	154.139, -	582.350, -
Egg	769.755, -	266.950, -	502.805, -

5. CONCLUSION

Based on the research results, the following conclusions are obtained:

1. The optimal order quantity for wheat flour raw materials using the Economic Order Quantity (EOQ) method is 5271 kg, with a purchase frequency of 4 times. Safety stock to expedite the production process is 501 kg. The company reordered (reorder point) wheat flour raw materials at a quantity level of 659 kg. The total inventory cost of wheat flour raw materials using company policy is IDR 11,835,034.00, while using the EOQ method is IDR 8,806,802.00 and can save inventory costs of IDR 3,028,232.00
2. The optimal order quantity for butter raw materials using the Economic Order Quantity (EOQ) method is 1077 kg, with a purchase frequency of 2 times. Safety stock to streamline the production process is the amount of 24 Kg. The company reordered (reorder point) butter raw materials at a quantity level of 37 kg. The total inventory cost of butter raw materials using company policy is IDR 3,764,991.00 while using the EOQ method is IDR 1,089,945 and can save inventory costs of IDR 2,675,056
3. The optimal order quantity for sugar raw materials using the Economic Order Quantity (EOQ) method is 1882 kg, with a purchase frequency of 3 times. Safety stock to expedite the production process is 65 kg. The company reordered (reorder point) sugar raw materials at a quantity level of 102 kg. The total inventory cost of sugar raw materials using company policy is IDR 5,633,964.00, while using the EOQ method is IDR 2,444,062.00 and can save inventory costs of IDR 3,189,902.00.
4. The optimal order quantity for bread making raw materials using the Economic Order Quantity (EOQ) method is 51 kg, with a purchase frequency of 1 time. Safety stock to expedite the production process is 1 kg. Company reorder (reorder point) raw materials for bread improvement at a quantity level of 3 Kg. The total inventory cost of raw materials for baking bread using company policy is IDR 736,489.00, while using the EOQ method is IDR 154,139.00 and can save inventory costs of IDR 582,809.00
5. The optimal number of orders for egg raw materials using the Economic Order Quantity (EOQ) method is 166 boards, with a purchase frequency of 2 times. Safety stock to expedite the production process is 8 boards. The company reordered (reorder point) egg raw materials at a quantity level of 11 boards. Total cost of egg raw material inventory with using company policy amounting to IDR 769,755.00 while using the EOQ method it is IDR 266,950.00 and can save inventory costs amounted to Rp. 502,805.00.

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