The Implementation of Economic Order Quantity for Raw Material Planning in SME Producing *Terasi* Crackers

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Abstract. Raw material planning in SME producing crackers is an essential matter since most of its raw materials do not last long and to avoid raw materials shortage or buildup stored in the warehouse. Therefore, the researchers offered a solution by implementing Economic Order Quantity (EOQ) method. From this research, it was concluded that the economic supply of raw materials (wheat flour) is 27.71 Kg with 14-day interval between orders, 6-day waiting time until the products are delivered, 16.47 Kg reorder point, 4.42 Kg safety stock value, and IDR 1,801,064 TIC.

1. Introduction

Raw material planning is something important to be taken into account in a business. It is done to maintain continuity and stability of sales so that the target can be achieved as planned [1]. Especially, business involving raw materials that cannot last long such as culinary in which the company must be able to maximize the optimum number of raw material supplies [2]. Small and Medium Enterprise (SME) of *terasi* (shrimp paste) cracker is a business run by a number of people living in Lamongan, Indonesia, since the raw materials are easy to get from farm community in Gresik consisted of shrimp farmers.

This business can be said to be quite developing. This can be seen from the number of stable demand and even tends to increase dramatically at certain times. However, the problem is that the unstable raw material supply due to high demand at any time. If the stability of raw material availability is not taken seriously, the value owned cannot be optimize to achieve the formulated company objectives [3]. One of the solutions that can be implemented to make optimization plan on raw material supply is Economic Order Quantity (EOQ) [4], so that the company can estimate the optimum quantity of raw material ordering by calculating the total ordering cost, total storage cost, safety stock point, reorder point [5].

2. Data and Method

2.1 Terasi Crackers Production Data

The ingredients used in producing terasi crackers are wheat flour, tapioca flour, *terasi,* salt, sugar, garlic, and stock. The following table presents a comparison sample of each ingredients.

Table 1. Comparison of raw material needs and prices of *terasi* cracker production

Raw materials	Price/Kg	8 kg/production	16 kg/production
Wheat Flour	IDR 12,500	1.25	2.5
Tapioca Flour	IDR 14,000	5	10
Terasi	IDR 160,000	0.5	1
Salt	IDR 15,000	0.5	1
Sugar	IDR 14,000	0.35	0.7
Garlic	IDR 28,000	0.4	0.8
Stock	IDR 6,000	0.1	0.2

Furthermore, ordering and storage costs are what must be taken into account. In this case, the authors only used one raw material as a sample that is wheat flour. The needs of ordering cost are described in table 2, while storage cost is IDR 65,000 per ton/year.

Table 2. Ordering cost of raw materials per one time order

Raw materials	Telephone usage fee	Shipping cost	Total ordering cost
Wheat Flour	IDR 15,000	IDR 20,000	IDR 35,000
Tapioca Flour	IDR 14,000	IDR 20,000	IDR 34,000
Terasi	IDR 19,000	IDR 30,000	IDR 49,000
Salt	IDR 10,000	IDR 10,000	IDR 20,000
Sugar	IDR 20,000	IDR 18,000	IDR 38,000
Garlic	IDR 23,000	IDR 26,000	IDR 49,000
Stock	IDR 5,000	IDR 8,000	IDR 13,000

Optimum raw material inventory planning can be achieved if we understand the data on cracker sales or demands in previous years. From those data, an estimation of raw materials for the following years was made. As for the demand data (sales) of *terasi* crackers during 2017 and data on wheat flour needs (one of the raw materials which is used as the sample for EOQ calculation) are presented in table 3 as follows.

Table 3. Table of *terasi* crackers sales and wheat flour needs in 2017

No	Month	Crackers sales	Wheat Flour (Kg)
1	January	380	57.59
2	February	398	60.32
3	March	406	61.53
4	April	350	53.05
5	May	390	59.11
6	June	417	63.20
7	July	408	61.84
8	August	387	58.65
9	September	400	60.63
10	October	390	59.11
11	November	407	61.69
12	December	416	63.05

2.2 Method

There are several inventory applications in the industry including raw material inventory, in-process inventory, and finished product inventory [6]. Whereas for inventory itself, according to its nature, there are safety stock, anticipation stock, and transit stock [7] with the determining factors of inventory cost, the amount of sales, delivery time or often referred to as lead time, the possibility of storage cost due to production delays, and the possibility of a decrease in product price due to adjustment to the number of purchases [8]. Broadly speaking, EOQ method can be summarized as in Figure 1.

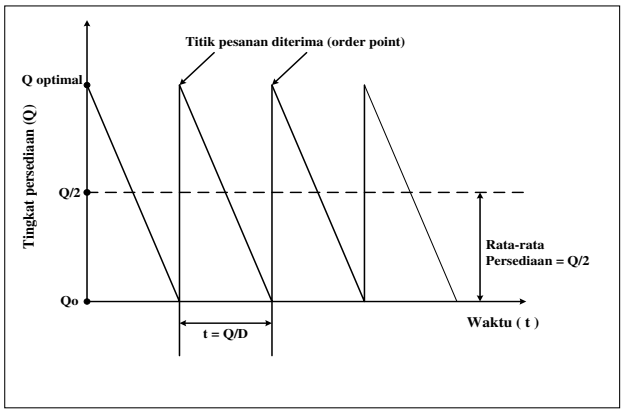

Figure 1. EOQ Model [9]

3. Experiment Result and Discussion

3.1 Production Process

Production process of *terasi* crackers starts from the stage of making the dough from all raw materials mentioned before, followed by the process of producing semi-finished product by steaming the dough and leaving it to be set before being sliced. The third stage is slicing and drying the crackers. The next stage is packing the crackers before being sold.

Crackers that have been produced are marketed to public. From 2017, it has been known that the demand in one year is 4,749 kg or equal to 4.749 ton *terasi* crackers a year. The data were used as a reference for analysing the cracker demand in the next period.

3.2 Economic Order Quantity Process

From the data obtained from initial and follow-up survey, as well as data plotting that has been done, it can be seen that the demand data pattern in *terasi* crackers is a seasonal data pattern. Therefore, the suitable method used to analyze the forecasting is exponential smoothing. The selection of this method depends on the results of data fitting in each method as well as considering Mean Absolute Percentage Error (MAPE) value. After further data fitting, it was obtained that the most suitable method used in the forecasting of raw materials was Single Exponential Smoothing using α 0.9. The result of *terasi* crackers demand forecasting for the next period was 4,703.9 Kg or equivalent to 4.7039 ton per year. From that estimation, the needs of raw materials can be calculated and presented in Table 4.

Table 4. Table of estimated raw material needs for *terasi* crackers in 2018

Raw Materials	Raw Material Needs (Kg)
Wheat Flour	712.93
Tapioca Flour	2939.94
Terasi	293.99
Salt	293.99
Sugar	205.79
Garlic	235.19
Stock	58.79

Thus, the most economical inventory level can be calculated as follows:

$$Q = \sqrt{\frac{2SD}{H}} = \sqrt{\frac{2(712.93)(35000)}{65000}}$$

$$= \sqrt{\frac{49905100}{65000}}$$

$$= \sqrt{767.77}$$

$$= 27.71 \text{ Kg}$$

The result of the calculation above states that the most economical economical inventory level is 27.71 Kg, so that other elements such as the interval between orders is

$$t = \frac{Q}{S} = \frac{27.71}{712.93}$$

$$= 0.04 \text{ year}$$

$$= 0.04 \text{ x } 355 \text{ working day}$$

$$= 14.12$$

$$= 14 \text{ days}$$

While the order frequency (F) can be calculated as follows.

$$F = \frac{S}{Q} = \frac{712.93}{27.71}$$

$$= 25.73$$

$$= 26 \text{ times a year}$$

After the results of other supporting components of EOQ were found, the next step is to find the value of Safety Stock (SS). SS forming components that must be found first is Standard Deviation (SD). From the calculations that have been carried out, it can be seen that the SD value is 4.286718507 with a tolerance limit of 5% valued of 1.65 [10]. While the Safety Stock can be calculated as follows:

$$SS = Sd \text{ x } Z = 4.286718507 \text{ x } 1.6$$

$$= 4.42$$

$$= 4.42 \text{ Kg}$$

Reorder Point (ROP) is calculated using the following equation

$$ROP = SS + (L \text{ x } S) = 4.42 + (6 \text{ x } 712.93 \text{ Kg/year})$$

$$= 4.42 + (6 \text{ x } \frac{712.93}{355})$$

$$= 16.47 \text{ Kg}$$

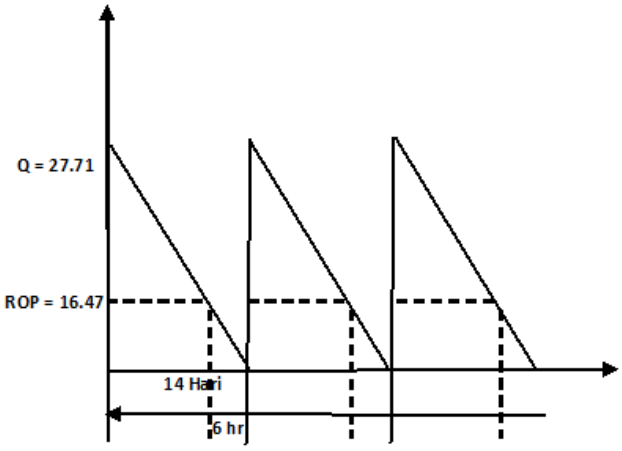

Figure 2. EOQ Graph of Wheat Flour

From that picture can be obtained the information that the economical inventory of raw materials (wheat flour) is 27.71 Kg, with the interval between orders is 14 days, the order waiting time until the products are delivered is 6 days, the reorder point is 16.47 Kg, and safety stock value is 4.42 Kg.

Therefore, the Total Inventory Cost (TIC) for wheat flour is as follows:

$$TIC = \sqrt{2DSH} = \sqrt{2(35000)(712.93)(65000)}$$
$$= \sqrt{3243831500000}$$
$$= 1801064$$
$$= \text{IDR } 1{,}801{,}064$$

From those information, it can be seen that the total inventory cost that must be spent to buy wheat flour in a period of one year using EOQ method is IDR 1,801,064 with order frequency of 26 times/year, and the average cost incurred without using EOQ is as follows:

TIC = (Average use x H) + (D.F) = (59.98 x 65,000) + (35,000 x 12)
= 3,898,700 + 420,000
= 4,318,700
= IDR 4,318,700 with frequency of 12 times/year
= Average of IDR 1,990,184

4. Conclusion

From this research conducted on raw material planning of *terasi* crackers industry using EOQ, it can be concluded that the economical inventory of raw material (wheat flour) is 27.71 Kg, with the interval between orders is 14 days, the order waiting time until the products are delivered is 6 days, the reorder point is 16.47 Kg, the safety stock value is 4.42 Kg, and TIC is IDR 1,801,064.

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