Economic Order Quantity Method Approach in Raw Material Inventory Control for A Small Medium Enterprise

Andi Erna Mulyana
Business Management Department
Politeknik Negeri Batam
Batam, Indonesia
andierna@polibatam.ac.id

Iin Zuliana
Business Management Department
Politeknik Negeri Batam
Batam, Indonesia
iinzuliana11@gmail.com

Abstract— **This study aims to determine whether the EOQ method can be applied and used in controlling raw material inventories in a small and medium enterprise using the EOQ method. In this study, a case of raw material inventory control in Ananda Bakery is used. Observation, documentation and interview techniques are used to collect data and information needed. Furthermore, the data obtained were analyzed using the EOQ method as well as an analysis data based on the calculation of safety stock and reorder point. The results of calculations and analysis indicate that the EOQ method is good to be applied to the process of controlling raw material inventories in Small and Medium Enterprise businesses such as Ananda Brownis.**

Keywords— *economic order quantity, reorder point, safety stock*

I. INTRODUCTION

Inventory of raw materials is an important factor in the production process. If the process is a shortage of supply of raw materials, it could disrupt the production process. However, if the amount of inventory is too large, it can increase inventory costs. Therefore, the supply of raw materials must always be in optimal condition. To optimize inventory, required a good inventory management.

Inventory management focuses on two basic statements, i.e. how many units of inventory that needs to be booked at one time and when supplies should be ordered [1]. Efficiency in inventory management can reduce production costs, and also drive selling prices for more competitive products [2].

Economic Order Quantity (EOQ) is a method that can be used for inventory efficiency at the lowest cost or economical. The company must also determine the amount of safety stock that must be available and when the inventory must be ordered (reorder point) to anticipate if there is a delay in the delivery of raw materials and so that the inventory level remains in the adequate state.

This research was conducted in a Small and Medium Industry, namely Ananda Brownies. Ananda Brownies produces steamed brownies, grilled brownies, and cakes with various flavors. The main raw material used by this company is wheat flour.

Ananda Brownies fulfills its raw material needs by making continuous purchases to suppliers. Based on the results of interviews with the owner, there are often problems with raw materials being used up before the supplier's delivery schedule of raw materials, thus requiring them to look for other suppliers to meet the necessity. This can hamper ongoing production activities because it takes time to find new suppliers. In addition, finding new suppliers can add to inventory costs such as fees for ordering, administration, delivery of raw materials and so on. These problems can reduce the profits obtained by the company. Therefore, this study aims to determine whether the EOQ method is suitable to be implemented in controlling raw material inventories at Ananda Brownies.

II. LITERATURE REVIEW

Inventory is a stock of goods or other items owned by a firm and held for sale or for processing before being sold, as part of a firm's ordinary operations [3]. In general, inventory consists of three types which are [4]: 1) Raw material; 2) Semi-finished material; 3) Finished material.

For companies, having inventory means infestation in the form of materials or stocks. Therefore, controlling the inventory is needed to prevent losses. The availability of inventory causes inventory costs. Inventory costs are all expenses and losses that must be paid as a result of inventory, which includes purchase prices, ordering costs, unloading costs and storage costs [4].

Small and Medium Enterprise are deemed to be at the forefront of economic development and are actively involved in the resolution of socio-economy problems [5]. In general, Small and Medium Enterprise had an overall failure-rate of between 70% and 80% over the course of 3 to 4 years [6]. The probable reasons for the high Small and Medium Enterprise failure rate is due to inadequate business skill development and training; lack of financial support; unstable business environments as well as inadequate business management [7]. Particularly, the management of inventory is also a critical element that should be taken into account for business in inventory-intensive arenas [8].

In the statement of financial position, inventory is shown as a current asset and is generally utilized to generate a steady stream of income for a business but if ineffectively managed, inventory can become a current liability in the form of potential cash that cannot be converted. Inventory management is a key driver in the stimulation of business development, particularly by becoming more competitive, as

well as attaining operational performance in relation to the effective 'movement' of inventory [9].

It is clear that inventory management is of paramount importance. If inventory is managed effectively, it can help a business become more profitable – decreasing expenditure (e.g. cost of sales, storage costs, shipping fees, etc.).

The total cost of raw material inventory can be known by the accumulation of ordering costs with the cost of maintaining or storing raw materials. The total cost of raw material inventory calculated by the EOQ method can be said to be more efficient if the total cost of inventory is smaller than the total cost of inventory spent by the company if it uses company policy. The total cost of inventory of raw materials can be formulated [10]:

$$TIC = \left(S \times \frac{D}{Q}\right) + \left(H \times \frac{Q}{2}\right) \qquad (1)$$

where
TIC : Total inventory costs (Rp / year)
D : Amount of raw material requirements (Kg /year)
S : Order fee (Rp. / Order)
Q : Amount of order (Kg / order)
H : Storage fee (Rp. / Unit / year)

Use of the conventional EOQ model for inventory controls presents satisfactory solutions from different aspects for the companies. This model makes some assumptions which are encountered in real life while presenting solutions [11]. Some of these assumptions are as follows; order quantity is independent of supply time, demand is stable and continuous, purchasing price is fixed, inventory storage cost is a linear function of inventory quantity, ordering costs are fixed for each order and independent from order quantity and lack of inventory is not allowed [12].

To minimize costs arising from inventory, a method is needed that can calculate the optimal and most economical amount of inventory. The Method of Economic Order Quantity (EOQ) is a mathematical model to determine the number of goods that must be ordered in order to meet projected demand but with inventory costs minimized [1]. The formulas used to calculate EOQ are as follows:

$$EOQ = \sqrt{\frac{2DS}{H}} \qquad (2)$$

where
EOQ : Optimal purchase quantity (Kg)
D : Amount of raw material requirements for one period (Kg / period)
S : One-time booking fee (Rp/Kg)
H : Storage of goods per unit per period (Rp/Kg/ period)

Economic Order Quantity (EOQ) is a tool used to determine the best time to order the most economic quantity of inventory. This is generally done by 'assuming' that there is a fixed ordering cost, the demand of inventory will remain constant, there is no discount available on the purchases of the inventory and only one product is ordered [13]

In controlling inventory, the amount of safety inventory needs to be taken into account to protect the company from

the risk of running out of raw materials and to avoid any delay in receiving raw materials ordered. Safety inventory is the company's ability to create conditions so that inventories are always safe in the hope that the company will never experience shortages of inventory [14]. To determine the amount of safety stock by comparing the use of raw materials and finding standard deviations using the following formula:

$$Sd = \sqrt{\frac{\sum(X-\bar{X})^2}{n}} \qquad (3)$$

where
Sd : Standard deviation
$\bar{X}$: Average use of raw materials (Kg)
X : Amount of actual raw material usage (Kg/ period)
N : Number of periods for ordering raw materials

After the standard deviation is known, then to calculate the safety inventory can be done by multiplying the standard deviation with the Security factor that is formed on the ability of the company:

$$Safety\ Stock = Sd\ x\ Z \qquad (4)$$

where
Sd : Standard Deviation
Z : Security factor that is formed on the ability of the company

The management of the company determines how far the analysis of irregularities is still acceptable. Analysis of deviations can be determined after knowing the size of the standard deviation. Tolerance limits used in deviation analysis in general are 5% above estimates and 5% below estimates with a value of 1.65 [10].

In addition, to maintain the level of inventory the company needs to determine the point of reordering. The point of reordering is the point where a company must order goods or materials in order to create an inventory condition that is constantly under control [1]. Control of inventory will be more effective by determining safety stocks and reorder points [15]. To determine the point of reordering, you can find out with the following formula:

$$ROP = Safety\ Stock + (Lead\ Time\ x\ Q) \qquad (5)$$

where
ROP : Reorder point
Safety Stock : Safety Inventory (Kg)
Lead Time : Waiting time (days)
Q : Average use of raw materials per day (Kg/ day)

III. RESEARCH METHODS

A. Population and Sample

The population used in this study is raw material inventory data at Ananda Brownies Batam. The sample used is data relating to the supply of raw materials for wheat flour in making brownies at Ananda Brownies in 2017.

B. Research Methodologies and Data Analysis

The research was conducted by observing the inventory activities and interviewing the owner of Ananda Brownies as well as collecting data related to the supply of raw materials at Ananda Brownies Batam.

Collected information is about raw material and frequency of ordering the raw material, as well as lead time. Furthermore, the data and information collected were calculated and analyzed with the EOQ method, Reorder Point, and Safety Stock.

IV. FINDINGS AND DISCUSSIONS

A. Ananda Brownies's Actual Raw Material Inventory Control

The quantity of raw material for wheat flour purchases in one order is 1,375 kg. The average monthly usage for raw materials for wheat flour is 1,323 kg.

Order fee of raw material for every order is Rp 15.000 and the storage cost of raw materials is 10% of the price of raw materials, which is Rp 636.

TABLE I.   ORDERED QUANTITY AND CONSUMPTION DATA OF RAW MATERIAL FOR WHEAT FLOUR

Month	Initial Inventory (Kg)	Purchase (Kg)	Total Initial Inventory (Kg)	Consumption (Kg)	End Inventory (Kg)
Jan	150	1375	1525	1154	371
Feb	371	1375	1746	1237	509
March	509	1375	1884	1462	422
April	422	1375	1797	1453	344
May	344	1375	1719	1245	474
June	474	1375	1849	1464	385
July	385	1375	1760	1114	646
August	646	1375	2021	1551	470
Sept	470	1375	1845	1234	611
Oct	611	1375	1986	1391	595
Nov	595	1375	1970	1181	789
Dec	789	1375	2164	1389	775
Total	5766	16500	22266	15875	6391
Average / Month	480.50	1375	1855.50	1323	532.58
Average / day				44.10	

According to the described data above, total inventory costs can be calculated as a following:

TIC = (Average Use) (C) + (P) (F)

= (1,323) (636) + (15,000) (12)

= Rp 1,021,428

where
TIC   : Total Inventory Cost
C   : Inventory Cost
P   : Fee per order
F   : Purchasing frequency

B. Raw Material Inventory Analysis with EOQ Method

$$\text{EOQ} = \sqrt{\frac{2DS}{H}}$$

$$= \sqrt{\frac{2 \times 15,875 \times Rp\ 15,000}{363}}$$

$$= 865,34$$

The optimal amount of raw material purchase of wheat flour using the EOQ method is 865.34 kilograms. The amount of raw material purchases is fulfilled to 875 Kg because the raw material is bought for the container with a quantity of 25 Kg.

According to the optimal amount of raw material purchase of wheat flour using the EOQ method, total inventory costs can be calculated as a following:

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

$$= \left(Rp\ 15,000 \times \frac{15,875}{875}\right) + \left(Rp\ 636 \times \frac{875}{2}\right)$$

$$= Rp\ 550,393$$

C. Determining Safety Stock

Statistical analysis is used to determine the size of the safety inventory by calculating the deviations that occur between the estimated usage and actual use of raw materials. In general, the tolerance limit used is 5% above the estimate and 5% below the estimate with the Z value used is 1.65.

TABLE II.   CALCULATION OF STANDARD DEVIATION

Month	x	$\bar{x}$	(x - $\bar{x}$)	(x - $\bar{x}$)²
January	1154	1323	-169	28561
February	1237	1323	-86	7396
March	1462	1323	139	19321
April	1453	1323	130	16900
May	1245	1323	-78	6084
June	1464	1323	141	19881
July	1114	1323	-209	43681
August	1551	1323	228	51984
September	1234	1323	-89	7921
October	1391	1323	68	4624
November	1181	1323	-142	20164
December	1389	1323	66	4356
Total	**15.875**			**230.873**

$$Sd = \sqrt{\frac{\sum(X-\bar{X})^2}{n}}$$

$$= \sqrt{\frac{230.873}{12}}$$

$$= 138{,}71$$

After the standard deviation is known, the safety stock of the raw material can be calculated as a following:

Safety Stock = Sd x Z

= 138, 71 x 1, 65

= 229 kg

The amount of safety inventory that must be reserved for the raw material for flour is 229 kg. The amount of safety inventory must be maintained to prevent the company from the risk of running out of raw materials.

D. Determining Reorder Point

There are grace period or lead time from the time of order until raw materials was received. The time required by Ananda Brownies to order until receipt of raw materials in the warehouse is 1 day. Calculation of the point of re-ordering for raw materials for flour is described in the following Table III.
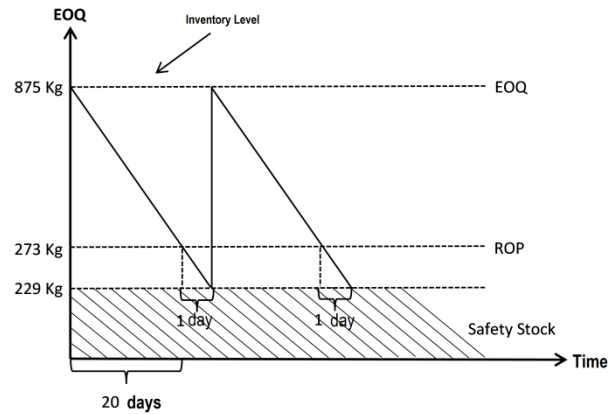
TABLE III.   REORDER POINT

Raw Material	Lead Time	Average used/day (Q)	Q X Lead Time (dL)	Safety Stock (SS)	ROP dL + SS
Wheat Flour	1 day	44 Kg	44	229 Kg	273 Kg

E. Discussion

According to the EOQ calculation, a smaller total inventory cost is obtained compared to the total inventory cost that has been calculated by Ananda Brownies. The calculation of the total inventory cost of wheat flour raw material using the EOQ method is Rp 550,393 which means there is a difference of Rp 471,035 when compared to the total inventory cost of wheat flour raw material according to Ananda Brownies policy of Rp 1,021,428.

Fig. 1. EOQ for wheat flour.

The amount of raw material that must be purchased each time an order using the EOQ method is smaller than the number of purchases made by Ananda Brownies. The optimal amount of wheat flour raw material purchases using the EOQ method is 875 kilograms with a frequency of 18 times, this amount is less than the average raw material purchases made by Ananda Brownies which is 1375 kilograms with a frequency of 12 times the purchase. The time interval between orders for raw materials of flour is 20 days. The smaller amount of raw material purchases will reduce the storage costs that Ananda Brownies must incur and maximize profits.

In addition, inventory control will be more effective with the determination of safety inventory and reorder points [7]. Determination of safety supplies can overcome the shortage of raw materials.

V. CONCLUSIONS

Control of the raw material inventory of wheat flour is done by buying raw materials to fixed suppliers in Batam. Raw materials for wheat flour are purchased once a month with a fixed amount of 1,375 Kg. The excess of raw materials in one month will be used for the following month with the first order of raw material usage into the warehouse that will be used first.

The raw material inventory control carried out   by Ananda Brownies has not been efficient compared to the EOQ method. This can be evidenced by the accumulation of raw material supplies of wheat flour as much as 775 kg at the end of the period, namely in December 2017. In addition, there is also a shortage of supplies for raw materials for sugar in April, June, August and October. The amount of ordering of raw flour that is efficient using the EOQ method is as much as 875 kilograms with an order frequency of 18 times in one year period with a time interval between orders is 20 days.

The amount of the total cost of raw material for wheat flour in 2017 in accordance with Ananda Brownies' policy is Rp. 1,021,428 and if the company applies the EOQ method the total cost of inventory is Rp 550,393. This shows the existence of inventory cost savings of Rp. 471,035 if Ananda Brownies applies the EOQ method.

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