

Comparison of Optimal Calculation of Inventories

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Abstract — The purpose of this study is to determine and find out the amount of optimal inventories with EOQ approach method (Economic Order Quantity), EOI (Economic Order Interval), Min-Max (Minimum-Maximum Inventory), and other calculations according to company policy. The object of this research is Rajalu Ltd., a private company that engaged in melting aluminum and is located in Gresik city, Surabaya, Indonesia. The raw material used is aluminum scrap, which is obtained from the purchase of foreign imports and local purchases in the country. The research method used was a descriptive study where data collection is collected, analyzed, processed and then interpreted so it can find out what the problem is and can give you an idea of the problem solving while the data types are quantitative and qualitative. The data collected for this research are the data of the needs of raw material (Kg) and supplies (Kg) from 2007 to 2012. The four method calculations, three method of calculations according to EOQ, EOI and Min-Max and the calculations according to company policy, apparently the result is obtained from comparison between 6 item, 2 item is ordering frequency (38 times) and inventory costs (IDR 99.891.213) is the most minimal calculations of EOI method while the other four items is relatively comparable.

Keywords - Economic Order Quantity (EOQ); Economic Order Interval (EOI); Minimum-Maximum Inventory (Min-Max); Company policy; Inventory Control; raw material

I. INTRODUCTION

Basically all companies includes manufacturing and service companies will keep their inventory by holding the planning and control of raw material so that the operational activities of the company run smoothly so the company didn't need to have "Stock out" experience (Running out of material), with the purpose of minimizing the cost and maximize the profit in a certain period. Inventory is one of the most important assets in many companies especially manufacturing companies, because the value of the inventories could reach 40% of the investment capital. Operational manager must be very understanding that the preparation is crucial, on the other one, the company is always trying to reduce the costs by reducing the level of inventories in hand, while on the other hand the customer can be dissatisfied when the number of finished product inventories become scarce. Therefore the company must strive to strike a balance between investment in inventory and minimization of costs is an important factor in creating this balance.

In fact to minimize inventory cost, EOQ analysis method that commonly used can be used in manual calculations. EOQ method is the volume/number of the most economical purchase to be made by a company in every purchase. In the EOQ method will be calculated at a minimum inventory level that will be achieved at a low cost and quality or the same quality. Every manufacturing companies would not necessarily apply in the calculation of EOQ build-up method, one of them is a commitment on the part of suppliers to meet the demand, many suppliers can't meet the demand of the company. One of the EOQ Concept is on time and costs is always constant. So how can it be applied in Indonesia which we all know that the level of uncertainty is quite high. In the application of EOQ method, inventory planning factor to minimize the stock out in the company is very high [1]. So smooth production process is really expected to remain safe and can minimize the cost of the company's inventory.

Rajalu Ltd., is a manufacturing company that engaged in melting aluminum, as well as related to marketing the finished product is aluminum ingots produced with a different composition for each customer. The raw material that used in melting is aluminum scrap which can be obtained from foreign imports or local purchase in the country. As for the type of aluminum scraps, which became the basic material of various forms and types. For example: pots, cans, plates, drums, machine, etc is essentially made from aluminum.

TABLE I. NEEDS OF RAW MATERIAL

Year	Need of raw material (Kg)	Safety of raw material (Kg)
2007	2.474.240	29.755
2008	2.881.581	29.625
2009	1.132.990	20.716
2010	1.815.266	21.923
2011	1.584.014	24.104
2012	2.070.465	21.743

The problem identification of this research are: 1). How is the amount of Rajalu Ltd. raw material according to the calculation of the company policy is already optimal? 2). How much amount of raw material are most optimal for the company? 3). How does a comparison of raw material calculation period 2007 to 2012 between company policy with the approach of the *Economic Order Quantity (EOQ)*, *Economic Order Interval (EOI)*, *Minimum-Maximum Inventory (Min-Max)*?

II. THEORETICAL REVIEW

In inventory management, there is a lot of preparation methods such as Economic Order Quantity (EOQ), Economic Order Interval (EOI), Quantity Discount (QD), Minimum-Maximum Inventory and others. Each model has its advantages and disadvantages [2], but in this study only covered EOQ method, EOI and Min-Max.

1. Basic Model of *Economic Order Quantity* (EOQ): According to Stevenson [3], EOQ is used to identify the optimal order quantity by minimizing the sum of certain annual costs that vary with order size.
2. Basic Model of *Fixed Order Interval System* (EOI): According to Junita and Rhessy [4], fixed order interval system or periodic inventory system, is based on a periodic rather than a continuous review of the inventory stock position. It is a time based inventory system in which orders are placed at equally interval, predetermined points in time, and the order quantity is dependent upon the usage between order review periods.
3. Basic model of *Maximum-Minimum System* (Min-Max): According Soshko, Vjakse and Merkurjev [5] stated that Min Max inventory model has two parameters, such as reorder point s and maximum inventory level S . When inventory level falls down to s , order Q is placed to increase inventory up to maximum level S . When inventory level falls down to s , order Q is placed to increase inventory up to maximum level S . Up to S model requires that order to supplement inventory to a level S is done once in a definite period of time. In this model, the minimum level of inventory is equal to the reorder point.

III. RESULTS AND DISCUSSIONS

The calculations being performed against the 3 inventory method is to be able to analyze and discuss about control and monitoring of raw material and its influence on marketing, by comparing the total cost of the inventory, frequency of order are the most efficient, the most optimal Finish time, safety supplies and determine the point of order again according to company calculations and calculation in theory, so that later the company is expected to improve the marketing of the finished product.

TABLE II. THE COST OF RAW MATERIALS AND SAVE CHARGES IN 2012

Types of Raw Material	%	Quantity (Kg)	Price / Kg (IDR)	Raw Material Cost (IDR)	Q Order (Kg)
Machine, drum, drill (Hard)	40%	828,186	16,000	13,250,976,000	17,254
Frying Pan, plate, elbow (Soft)	40%	828,186	16,000	13,250,976,000	17,254
Cans	5%	103,523	13,500	1,397,563,875	2,157
Abu, Taen, Gram	5%	103,523	10,000	1,035,232,500	2,157
Pure Aluminum	10%	207,047	22,000	4,555,023,000	4,314
Total	100%	2,070,465	-	33,489,771,375	43,135

Save cost per-kg: 10% of the calculated per-kg price of items per-type of goods

- Machine; etc (Hard) = 40% x 1,600 = IDR. 640
- Pan; etc (Soft) = 40% x 1,600 = IDR. 640
- Cans = 5% x 1,350 = IDR. 68
- Abu, taen, Gram = 5% x 1,000 = IDR. 50

$$\begin{aligned} \text{- Pure Aluminum} &= 10\% \times 2,200 = \text{IDR. } \frac{220}{1,618} \\ \text{Total save cost per-kg} &= \text{IDR. } 1,618 \end{aligned}$$

With the cost of supplies, safety stock calculation at least is some 50% of the per order.

- Save Cost = $\frac{1}{2} \times 43,135 \times \text{IDR. } 1,618$
= IDR. 34,896,215
- Order fee = IDR. 30,000,000
- Raw Material Cost = IDR. 33,489,771,375 +
= IDR. 33,554,656,806

1. Calculation of the EOQ in 2012

The Total cost of inventory is based on the calculation of EOQ is done using the following formula [6]:

$$\begin{aligned} \text{EOQ} &= \sqrt{\frac{(2)(2,070)(625,000)}{1,618}} = 39,994.45 \\ \text{F} &= \frac{2,070,465}{39,994.45} = 51.8 \approx 52 \text{ Times} \end{aligned}$$

So the frequency of ordering is 52 Times, then:

$$\text{Q} = \frac{2,070,465}{52} = 39,817 \text{ Kg}$$

Based on the calculation of EOQ above, the frequency of 52 times, the most efficient quantity per-order is 39,817 kg and the total cost of the inventory is IDR. 33,554,473,078, when compared with calculations that have been done so there is a difference in the company amounting to IDR. 183,728.

2. The Calculation by the method of EOI in 2012

D = 2,070,465 kg; Co = IDR. 625,000; Cc = IDR. 1,618/kg; and SS = 21,743 kg

$$\text{T}^* = \sqrt{\frac{2\text{Co}}{\text{CcD}}} = \sqrt{\frac{2(625,000)}{1,618(2,070,465)}} = 0.0193$$

Maximum inventory level:

$$\begin{aligned} \text{E} &= \text{SS} + \text{D} (\text{T}^* + \text{L}) \\ &= 21,743 + 2,070,465 (0.0193 + 0.0167) = 96,280 \end{aligned}$$

$$\begin{aligned} \text{I} &= \text{SS} + \frac{1}{2} (\text{D} \text{T}^*) \\ &= 21,743 + \frac{1}{2} (2,070,465) (0.0193) = 41,723 \end{aligned}$$

$$\text{Q}^* = \text{E} - \text{I} = 96,280 - 41,723 = 54,557$$

$$\text{F} = \frac{2,070,465}{54,557} = 37.95 \approx 38 \text{ times}$$

$$\text{TC}(\text{T}^*) = \frac{\text{Co}}{\text{T}^*} + (\text{SS} + \frac{1}{2} \text{D} \text{T}^*) \text{Cc}$$

$$\begin{aligned} \text{TC}(\text{T}^*) &= \frac{625,000}{0.0193} + \left(21,743 + \frac{1}{2} (2,070,465) (0.0193) \right) 1,618 \\ &= \text{IDR. } 99,891,213 \end{aligned}$$

3. The Calculation by the method of Min-Max in 2012

D = 2,070,465 kg; Co = IDR. 625,000; and

Cc = IDR. 1,618/kg

$$\text{SS} = \frac{2,070,465}{12} = 172,539$$

$$\begin{aligned} \text{Min stock} &= (\text{DL}) + \text{SS} = 2,070,465 (0,0167) + 172,539 \\ &= 207,116 \end{aligned}$$

$$\begin{aligned} \text{Max stock} &= 2(\text{DL}) + \text{SS} = 2[(2,070,465) (0,0167)] + 172,539 \\ &= 241,693 \end{aligned}$$

$$\text{Order (min-max)} = 241,693 - 207,116 = 34,577$$

$$F = \frac{2,070,465}{34,577} = 59.87 = 60 \text{ times}$$

$$TC(\text{min-max}) = \frac{P}{Q^*} C_o + C_c D = \frac{2,070,465}{34,577} (625,000) + 1,618 (2,070,465) = \text{IDR. } 3,387,437,266$$

With the same calculation method, calculation steps were made for 2011, 2010, 2009, 2008 and 2007, and the final results of the calculation above are:

TABLE III. THE COMPARISON OF COMPANY POLICY CALCULATION EOQ, EOI AND MIN-MAX METHOD IN 2007

Description	Company	EOQ	EOI	Min-Max
Raw Material needed	2,474,240 Kg	2,474,240 Kg	2,474,240 Kg	2,474,240 Kg
Frequency of the order	48 times	73 times	39 times	60 times
Inventory costs	IDR. 39,832,553,333	IDR. 39,827,591,167	IDR. 118,883,709	IDR. 4,040,745,296
Time	5 days	7 days	5 days	5 days
Safety stock	0	29,755 Kg	29,755 Kg	29,755 Kg
ROP	41,237 Kg	87,484 Kg	51,652 kg	247,507 kg

TABLE IV. THE COMPARISON OF COMPANY POLICY CALCULATION EOQ, EOI AND MIN-MAX METHOD IN 2008

Description	Company	EOQ	EOI	Min-Max
Raw Material needed	2,881,581 Kg	2,881,581 Kg	2,881,581 Kg	2,881,581 Kg
Frequency of the order	48 times	79 times	41 times	60 times
Inventory costs	IDR. 50,788,337,585	IDR. 50,780,319,161	IDR. 124,275,352	IDR. 4,702,311,806
Finish time	5 days	7 days	5 days	5 days
Safety Stock	0	29,625 Kg	29,625 Kg	29,625 Kg
ROP	48,026 Kg	96,860 Kg	53,110 kg	288,255 kg

TABLE V. THE COMPARISON OF COMPANY POLICY CALCULATION EOQ, EOI AND MIN-MAX METHOD IN 2009

Description	Company	EOQ	EOI	Min-Max
Raw Material needed	1,132,990 Kg	1,132,990 Kg	1,132,990 Kg	1,132,990 Kg
Frequency of the order	48 times	43 times	34 times	60 times
Inventory cost	IDR. 16,935,183,076	IDR. 16,934,951,428	IDR. 81,387,818	IDR. 1,870,602,870
Finish Time	5 days	7 days	5 days	5 days
Safety Stock	0	20,716 kg	20,716 kg	20,716 kg
ROP	18,883 Kg	47,148 Kg	35,502 kg	113,337 kg

TABLE VI. THE COMPARISON OF COMPANY POLICY CALCULATION EOQ, EOI AND MIN-MAX METHOD IN 2010

Description	Company	EOQ	EOI	Min-Max
Raw Material needed	1,815,266 Kg	1,815,266 Kg	1,815,266 Kg	1,815,266 Kg
Frequency of the order	48 times	52 times	38 times	60 times
Inventory cost	IDR. 27,122,652,302	IDR. 27,122,508,219	IDR. 96,092,417	IDR. 2,974,525,466
Finish time	5 days	7 days	5 days	5 days
Safety stock	0	21,923 Kg	21,923 Kg	21,923 Kg
ROP	30,254 Kg	64,273 Kg	40,076 kg	181,588 kg

TABLE VII. THE COMPARISON OF COMPANY POLICY CALCULATION EOQ, EOI AND MIN-MAX METHOD IN 2011

Description	Company	EOQ	EOI	Min-Max
Raw Material needed	1,584,014 Kg	1,584,014 Kg	1,584,014 Kg	1,584,014 Kg
Frequency of the order	48 times	47 times	36 times	60 times
Inventory cost	IDR. 24,684,075,427	IDR. 24,684,058,836	IDR. 95,601,644	IDR. 2,600,359,850
Finish time	5 days	7 days	5 days	5 days
Safety Stock	0	24,104 Kg	24,104 Kg	24,104 Kg
ROP	26,400 kg	61,064 Kg	41,529 kg	158,453 kg

TABLE VIII. THE COMPARISON OF COMPANY POLICY CALCULATION EOQ, EOI AND MIN-MAX METHOD IN 2012

Description	Company	EOQ	EOI	Min-Max
Raw Material Needed	2,070,465 Kg	2,070,465 Kg	2,070,465 Kg	2,070,465 Kg
Frequency of the order	48 times	52 times	38 times	60 times
Inventory cost	IDR. 33,554,656,806	IDR. 33,554,473,078	IDR. 99,891,213	IDR. 3,387,437,266
Finish Time	5 days	7 days	5 days	5 days
Safety stock	0	21,743 Kg	21,743 kg	21,743 kg
ROP	34,508 Kg	70,050 Kg	41,723 kg	207,116 kg

From table VIII, only for the year 2012 can be analyzed as follows:

- The frequency of the most small orders is calculated according to the method of Economic Order Interval (EOI) where in one year made as many as 38 times, so the calculation according to the EOI is considered able to save storage costs and safety supplies with appropriate should be provided by the company.
- The cost of inventories according to the Economic Order Interval (EOI) was IDR. 99,891,213, whereas with the calculation according to the policy of the company amounting to IDR. 33,554,473,078 so there is a saving of about IDR. 33,454,581,865. When compared with the calculation according to the Min-Max is IDR. 3,387,437,266,-, so there is a saving of about IDR. 33,454,765,593,-.
- Finish time according to the discretion of the company was 5 days but when done the calculation by using the EOQ method then the waiting time will be more efficient when the 7 days with the most minimum fee is IDR. 22,809,436.
- According to the discretion of the company there was no safety stock but with the calculation of EOQ then inventory should be known so the seat is 21,743 Kg, it is intended to smooth the company's production and marketing services to the customer can always maintained well.

Reordering point (ROP) according to the discretion of the company was 34,508 Kg while according to the EOQ is 70,050 Kg safety stock calculation due as well as the wearing time of the waiting time.

IV. CONCLUSIONS

From the calculation and analysis above, several conclusions can be drawn:

- Inventories according to the calculation of the company's policy was not optimal because there hasn't been a safety stock calculation, whereas the calculation inventory is a crucial part of the seat in the calculation of independent inventory, while according to other methods (EOQ, EOI and Min-max) safety mains there are approximately 21.743 Kg (in 2012), so the calculation inventory is assumed according to company policy is deemed not optimal.
- The most optimal inventory level (2012) from those four methods used above (based on calculation from the company, EOQ, EOI, and Min-Max) is approximately 43.135 kg that based on the result of Min-Max.

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