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Efficiency Analysis of Excavator Nut Inventory Using Economic Order Quantity Method at PT. ABCDE Bekasi-Jawa Barat

Mohammad Fahmi Kurniawan¹, Sugiyono Madelan², Ahmad Badawi Saluy³

¹⁾ Universitas Mercu Buana, Jakarta, Indonesia, fahmi_kurniawan@yahoo.com

²⁾ Universitas Mercu Buana, Jakarta, Indonesia, sugiyono.madelan@gmail.com

³⁾ Universitas Mercu Buana, Jakarta, Indonesia, badawi_saluy@yahoo.co.id

Corresponding Author: Mohammad Fahmi Kurniawan¹

Abstract: Inventory management is one of the keys to the success of the production process in any company, including manufacturing companies. Therefore, determining the optimal amount of inventory is crucial for inventory management. In a production process, sometimes a condition is found where the amount of inventory far exceeds what is needed, so that in the process of implementing the specifications change of an inventory will take quite a long time, this is due to an effort to use up obsolete inventory first, so it is necessary to calculate the optimal value of the company inventory. In this research, using the Economic Order Quantity and Reorder Point analysis method in the POM-QM software, it is expected to determine the optimal value of the purchase amount, Safety Stock, Reorder Point, and the required inventory costs of J950010 nuts. The results showed that although there were differences between the results of the POM-QM calculation and the application in the field, the management of J950010 nut stock is optimal.

Keywords: EOQ, ROP, Management Inventory

INTRODUCTION

Inventory is a necessity for every company, including manufacturing companies that process raw materials so that they can become ready-to-use goods that have selling value. No exception with PT. ABCDE, one of the worldwide heavy equipment manufacturers. One of its main products is a medium class hydraulic excavator. Every single excavator unit consists of thousands of parts that compose it, so a good inventory management is needed to support its production activities. One of the most important parts of an excavator is the nut, especially if the nut is used on all production units. If the nut is stocked out, the whole production process will stop, but if too much stock can cause a burden on the company's finances. Related to this issue, good inventory management is needed to avoid those conditions.

Table 1. The inventory of J950010 nuts which will be examined every month in April 2019 - March 2020 period

| Month | Excavator Production (unit) | Nut Supply (pcs) | Nut Inventory (pcs) | Excess Nut (pcs) |
|--------------|-----------------------------|------------------|---------------------|------------------|
| April | 228 | 10640 | 30931 | 20291 |
| May | 231 | 10968 | 24913 | 13949 |
| June | 156 | 7174 | 30346 | 23172 |
| July | 230 | 12072 | 24477 | 12375 |
| August | 220 | 10962 | 18375 | 7415 |
| September | 208 | 10569 | 22001 | 11443 |
| October | 189 | 9204 | 21943 | 12746 |
| November | 220 | 10658 | 18379 | 8260 |
| December | 235 | 11168 | 15331 | 4163 |
| January | 175 | 9790 | 16783 | 9887 |
| February | 147 | 6906 | 21027 | 11267 |
| March | 169 | 7376 | 18813 | 12969 |
| Total | 2408 | 117487 | 263319 | 145832 |

Source: PT. ABCDE

An example case is shown by the inventory of J950010 nuts at PT. ABCDE. In the 2019 fiscal year, there was a problem in changing the nut specifications. The crux of the problem is that the implementation of changing the old nut specification into the new specification takes months. The reason from the PIC of warehouse regarding this problem is that the replacement must wait for the old specification inventory to be used up first, so as to avoid wasted part (scrap). This is supported by the data related to the supply of J950010 nuts for the period April 2019 - March 2020 which is shown in Table 1.

Based on the information contained in table 1, it can be seen that there was a significant excess supply of nut J950010 which caused the part change time takes a very long time. Therefore, this research is aimed at finding out what the optimal supply of J950010 nuts should be in the 2019 fiscal year in order to shorten the time for changing parts. In addition, optimal inventory is expected to prevent the occurrence of stock out conditions and can minimize the required cost of the inventory.

From the core problems that have been known, in order to achieve the goals and objectives of this research, it is necessary to determine the boundaries of the problem to be solved. Considering the scope of inventory management is very broad, so in this research, to prevent the discussion from being too broad, the researcher will limit the problem to a few issues. The problems that will be solved in this research include the value of Economic Order Quantity, Total Inventory Cost, Safety Stock, and Reorder Point of J950010 nuts inventory.

This research was conducted in a private company, located in Cibitung, Bekasi, Indonesia. The object to be investigated is the J950010 nut. This part is the nut used by all medium class excavator units produced by PT. ABCDE. The data source in this research is inventory and logistic data of nut J950010 from April 2019 until March 2020. These data consist of summary of medium excavator production in 2019 fiscal year, Purchase Order number list of nut J950010, Import Declaration, and Inland Service document.

The purpose of doing this research is as input for PT. ABCDE in order to improve inventory efficiency of J950010 nut. Especially if there have been many problems related to inventory management in the company. With this research, it is hoped that it can be a

reference to improve inventory efficiency for other parts Based on explanation above, there are main problems that must solve in this research, which are:

1. What is the optimal value that should be applied to PT. ABCDE in terms of Economic Order Quantity, Reorder Point, and Safety Stock on J950010 excavator nut?
2. Is inventory planning at PT. The ABCDE currently applied in the case mentioned in the previous point is optimal?

LITERATURE REVIEW

Research Review

In the manufacturing industry, inventory management is the key to the success of the production process. In terms of costs, inventory management also plays an important role in the operational costs of a company. If inventory management is not carried out properly, then operating costs can increase and affect a company's profit margin. Usually, companies try to minimize the costs that arise from all activities related to inventory management.

In general, inventory can be defined as organizational resources that are kept to meet demand. Inventory is one of the most expensive assets of many companies, and represents as much as 50% of the total invested capital (Heizer & Render, 2014:512). An inventory system is a set of policies and controls that monitors inventory levels and determines the level of inventory that must always be there, when inventory should be replenished, and how much of an order should be ordered (Jacobs & Chase 2014: 209).

One of the methods used in inventory management is to use Economic Order Quantity. Heizer and Reinder (2010) explain that Economic Order Quantity is an inventory control technique that minimizes total ordering and storage costs. Meanwhile, according to Bambang Riyanto (2013: 78) is the quantity of goods obtained with minimal costs, or often said to be the optimal number of purchases.

In the article "The EOQ Inventory Formula" written by James M. Cargal, the basic theory of Economic Order Quantity is explained. In his writings, he explains the appropriate way how to use each variables. According to him, EOQ can be found using the following formula:

$$Q = \frac{\sqrt{2 \cdot D \cdot S}}{H} \quad (1)$$

Where:

Q = EOQ, or the variable you want to optimize

D = Demand for goods per year

S = Cost of ordering goods once ordered

H = Inventory cost

According to Heizer and Render (2014: 561) this technique is relatively easy to use, but based on the following assumptions:

- a. The number of demands is known, fairly consistent, and independent
- b. The lead time for receipt of orders is known and is constant.
- c. No shortage is allowed
- d. The number of orders received at once.
- e. The purchase price of the item is constant, and there is no discount.

In addition to the Economic Order Quantity method, the Reorder Point method is also used in inventory management. According to Sofjan Assauri (2008), the reorder point or

reorder level is a point or limit of the amount of inventory that exists at a time where orders must be held again.

The reorder point can be affected by several factors, including:

- a) Lead Time, which is an understanding of the time it takes between ordering the ordered goods to arrive at the company.
- b) The average level of use of supplied raw materials to make a product in a certain time unit.
- c) Safety Stock, namely the minimum amount of raw material inventory that must be available as a precaution against possible delays in the arrival of raw materials.

From three factors that can affect it, the Reorder Point value can be found using the following formula:

$$\text{Reorder Point} = (\text{LT} \times \text{AU}) + \text{SS} \quad (2)$$

Where:

LT = Lead Time

AU = Inventory Supply

SS = Safety Stock

Along with the times, manual calculations can now be done using computer calculations. Computer calculations in this study using the POM-QM module. POM-QM stands for Production and Operations Management/Quantitative Methods, is a computer program used to data process and solve various problems in the field of production and operations management that are quantitative. According to the POM-QM for Windows Ver.3 manual, this program provides modules in the business decision-making area, one of which is inventory. In this inventory module, there are several methods, which in this study were used only the Economic Order Quantity method and the Reorder Point method.

Research Framework

Many studies that discuss the Economic Order Quantity and Reorder Point. However, of the many studies, no one has researched the J950010 nut part at PT. ABCDE. The research that approaches is the overstock analysis of the YA40003084 Engine Cover, one of the components of the middle class excavator. Therefore, in this study, we will first describe the research framework regarding the efficiency of the J950010 nut supply as shown in Fig. 1.

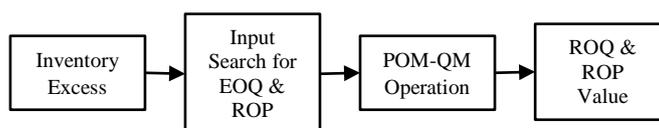


Figure 1. Research Framework

This research started with the discovery of problems related to changing the J950010 nut specifications which took a very long time. From here, the researchers find out why the change took so long. After finding out, this is because parts with old specifications must be spent first.

After knowing the reason, it was concluded that there was a large accumulation of inventory that had to be spent before using the J950010 nuts with the latest specifications. Therefore, it is necessary to analyze what the optimum inventory should be for the J950010 nut. To find out, EOQ and ROP methods are used which are calculated with the help of POM-QM software.

To be able to obtain the results of EOQ and ROP, several input variables are needed in the calculation operation. In the EOQ calculation, input variables are needed in the form of

the number of annual demands for J950010 nuts in Fiscal Year 2019, set up cost each time you place an order for 1 nut, carrying cost of 1 nut for 1 year, and the price of the nut per unit. while the input variables for the ROP are the daily average demand for nuts J95010, service level, lead time, and standard deviation for the daily average demand and lead time.

RESEARCH METHODS

This research was conducted at PT. ABCDE Plan 1 in the Cibitung area, Bekasi Regency, West Java, Indonesia, which produces middle class hydraulic excavators. There are several variables used in this study. these variables are used in the calculation of EOQ and ROP. for more details related to the variables used, can be seen in the Table 2.

Table 2. Variable Measurement

| Variable | Definition | Units | Scale |
|---------------|---|-----------|--------------------|
| Demand | Supplied part for production process | piece | Periodic |
| Daily Demand | Supplied part for production process | piece | Daily |
| Unit Cost | Buying cost per unit part | US Dollar | Average per period |
| Setup Cost | All costs incurred for making a single order per unit part | US Dollar | Every single order |
| Carrying Cost | all costs arising from the activities of holding inventory. | US Dollar | Periodic |
| Lead Time | the time it takes between ordering the ordered goods to arrive at the company | Day | Average per period |

The object of research used in this paper is the general part of the J950010 nut. The part was chosen as the only part in this research because in FY2019, which is in the April 2019 – March 2020 period, the part experienced problems in changing nut from the old specifications to the latest specifications. The problem lies in the time of changing parts which take months. In addition, these parts are used by all finished products produced by PT. ABCDE, so that if there are problems with the inventory of these part, it will interfere with the company's production activities as a whole. From there, the researcher intends to find out whether the nut inventory planning has been carried out correctly.

The research conducted is about the analysis of inventory management at PT. ABCDE using the Economic Order Quantity (EOQ) and Reorder Point methods, which will find out the amount of inventory that needs to be ordered per order, Reorder Point, Safety Stock, and Total Inventory Cost (TIC). Calculation of the variables you want to find out the value is done by POM-QM software.

The data used in this study is secondary data taken from the company's database, especially those contained in the MRP system and from documents in each section at PT. ABCDE. The MRP system that mentioned means the SMAP V3 system used by PT. ABCDE. In addition, data is obtained by directly contacting employees in the relevant department according to the desired data.

The data taken is data regarding the supply of nuts J950010 from April 2019 until March 2020. This period was taken because during that period problems that arose related to changing the J950010 nuts occurred.

To be able to obtain information regarding the number of demands in a year, a data search was carried out to the PPIC section of PT. ABCDE, which then obtained data of

Excavator Production Amounts for one Fiscal Year. The data is processed first to obtain information related to the production of middle class excavators in 1 year. In addition, from this data, other information can be obtained is regarding the daily average number of demands.

To be able to find out information about the price of nut per unit, a data search was conducted to the Procurement section of PT. ABCDE which then obtained data of Purchase Order number list. Apart from obtaining information related to the price of nut per unit, from this data other information was obtained is regarding Lead Time.

To find out the set-up cost, conducted a data search to the Logistics section of PT. ABCDE. From this search, data were obtained in the form of PIB (Import Declaration) as well as Inland Trucking Bills Recap for 2019 and 2020. From these two documents, information related to setup costs can be obtained by adding up all cost items arising in placing an order, such as transportation, insurance, import duty, Value Added Tax, Income Tax and administrative costs.

To find the carrying cost, a simple calculation is carried out on the inventory value of J950010 nuts by dividing the value of the supplied inventory by the average inventory value per year. The result of the calculation is in the form of a percentage.

After all the required inputs are known, the next step is to enter the input values into each column in the POM-QM software. The resulting output is the optimal amount of inventory ordered in each order, the number of orders during the time period studied, as well as the overall inventory cost during the research period.

After the EOQ value is known, the next thing to find out is the Reorder Point value. Reorder Point is a variable that can be time or units of goods, where when it is reached, inventory orders must be made to avoid shortage conditions. To be able to determine the value of the Reorder Point, it takes several inputs in the calculation operation using POM-QM software. The required inputs are daily demand, daily demand standard deviation, Service Level, Lead Time, and Lead Time standard deviation.

To be able to obtain the standard deviation value of daily demand and Lead Time, calculations are carried out on the data contained in Excavator Production Amounts for one Fiscal Year and Purchase Order number list using formulas in Microsoft Excel.

The next step is to enter the input variable in the appropriate column in the Reorder Point calculation menu. The resulting output is Safety Stock, and Reorder Point.

After all the variables you want to know can be solved with POM-QM software, the last step is to draw conclusions by comparing the results of inventory planning calculations with the EOQ method carried out with the help of POM-QM software and those applied by the company today. In addition, several advice and recommendations are also given to help solve the problems that have been formulated previously in this study.

FINDINGS AND DISCUSSION

Determine EOQ

The first step in determining this EOQ is to find information regarding the number of requests for J950010 nut in a year. From the data collection carried out in the PPIC section, documents such as Excavator Production Amounts for one Fiscal Year, can be obtained contains information about the number of demands in a year. The demand value in a year is 115776 pieces.

From the results of the search for data in the procurement section, a document was obtained regarding the list of PO numbers for nuts J950010. From that document, information is obtained about the price of parts per unit. The part price per unit is obtained from finding the average price of the J950010 nut part during the April 2019 - March 2020 period, which is 0.0823 USD.

The next step in determining the EOQ is to find the setup/ordering cost for each order. These costs arise from every activity performed in ordering supplies such as, shipping costs, insurance, administration, taxes and receipts, etc. In this research, setup/ordering costs are divided into 6 categories, namely import duties, Value-Added Tax, Income Tax, insurance, transportation, and administration. from the search and data processing carried out, the ordering cost for 1 unit of J950010 nuts is 0.035 USD.

The final step in determining the EOQ is to find the value of holding/carrying costs. In this study, holding/carrying costs are obtained by comparing the value of the inventory supplied with the existing inventory for one year. from the calculation results obtained a value of 43.82% as the holding/carrying cost.

After all the input variables are known, the EOQ calculation using POM-QM can be done. By entering the input variable in the appropriate column in the POM-QM software, the calculation results can be seen in Fig. 2 as follows:

| Parameter | Value | Parameter | Value |
|---------------------------------|-----------|--|---------|
| Demand rate(D) | 115776 | Optimal order quantity (Q*) | 506.78 |
| Setup/ordering cost(S) | 04 | Maximum Inventory Level (Imax) | 506.78 |
| Holding/carrying cost(H)@43.82% | 0.0360638 | Average inventory | 253.39 |
| Unit cost | 08 | Orders per period/year | 228.45 |
| | | Annual Setup cost | 9.14 |
| | | Annual Holding cost | 9.14 |
| | | Total Inventory (Holding + Setup) Cost | 18.28 |
| | | Unit costs (PD) | 9528.37 |
| | | Total Cost (including units) | 9546.64 |

Figure 2. EOQ calculation with POM-QM

From Fig. 2, it can be seen that the optimal number of orders for J950010 nut is 507 pieces per order. Orders made annually as many as 229 times the order. For inventory costs, the amount is 9547 USD annually. The cost of this inventory can be seen in Fig. 3.

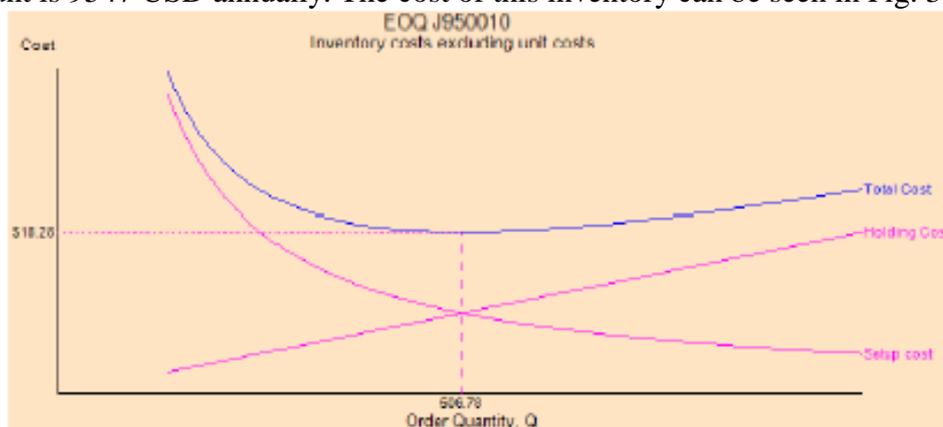


Figure 3. Total Inventory Cost chart (without unit price)

Fig. 3 shows the overall cost of J950010 nut inventory for one year period April 2019 – March 2020 PT. ABCDE. The x-axis on the graph shows the order quantity, while the y-axis shows the cost. The graph shows that the more the order quantity, the less costs to be incurred. However, the more the order quantity, the higher the holding cost, so the point of intersection between the holding cost line and the ordering cost line becomes the optimal order quantity value.

Determine ROP

As mentioned earlier, to calculate ROP input variables are needed such as daily demand, service level, lead time, as well as standard deviation for daily demand and lead time. The data used as daily requests can be obtained from Excavator Production Amounts for one Fiscal Year and Purchase Order number list. The data in these documents are processed first using Microsoft Excel, so that the daily demand value is 483 pieces.

For information related to Lead Time, data processing is carried out in Purchase Order number list. From the Fixed Date and Received Date columns, it can be seen that the average Lead Time for the procurement of J950010 nut is around 66 days. Although the required Lead Time is 66 days, other information is obtained that during FY 2019 PT. ABCDE made 18 deliveries of J950010 nut.

To determine the standard deviation of daily demand and Lead Time, in this study, the researcher used the formula provided in Microsoft Excel software. By using the data in Excavator Production Amounts for one Fiscal Year and Purchase Order number list and using the STDEV.S formula in Microsoft Excel, the standard deviation for daily demand and Lead Time can be determined as follows:

- Daily demand standar deviation = 108.14
- Lead Time standard deviation = 9.56

The last variable that must be known is the service level. in this research, the service level used is 95%. This value is obtained from the inventory grouping based on turnover. Because this J950010 nut is the most widely used part by all excavator hydraulic models produced by PT. ABCDE, then this nut is included in the category of high service level, so the value is 95%. This means that in meeting the need for J950010 nuts in the excavator assembly process per year, only 5% of stock outs are allowed.

After all the input variables needed to perform the ROP calculation are known, the next step is to enter these variables into the appropriate column in the POM-QM software. The method is almost same as the EOQ calculation, but with a different module in the Inventory menu. ROP calculation with POM-QM can be seen in Fig. 4.

The screenshot shows a window titled 'QM for Windows - [Data] Results' with a sub-window '(untitled) Solution'. It displays a table with input parameters and calculated results for a Reorder Point (ROP) calculation.

| Value | Parameter | Value |
|----------------------------------|------------------------------|----------|
| (Daily) Demand (d-bar) | Z value | 1.64 |
| (Daily) Demand std dev (sigma-d) | Expected demand during le... | 31878 |
| Service level % | Safety Stock | 7708.51 |
| Lead time (in days) (L) | Reorder point | 39586.52 |
| Lead time std dev (sigma L) | | |

Figure 4. Reorder Point Calculation with POM-QM

From Figure 4 it can be seen that the safety stock for the J950010 nut is 7709 pieces, and the Reorder Point is 39587 pieces. During the Lead Time period, the number of J950010 nut that are expected to be used is 31878 pieces.

CONCLUSION AND RECOMMENDATION

Conclusions

From the calculation operations with POM-QM software that have been discussed in the previous chapter, the following conclusions can be drawn:

- 1) EOQ value of nut J950010 PT. ABCDE based on data for the period April 2019 – March 2020 are as follows:

The number of nut that should be ordered is 507 pieces per order. The number of orders with this amount for one year is 229 times the order. As for the Reorder Point, the value is

39587 units and the Safety Stock that should be applied based on the calculation results of the software is 7709 units.

- 2) Excavator part control system currently applied at PT. ABCDE is already based on the EOQ value calculated using POM-QM software. This is based on the results of the research previously mentioned that the number of nut that must be ordered each time an order based on calculations using POM-QM software is 507 pieces, while those applied to PT. ABCDE during the research period in question is 500 pieces. Orders that must be made based on software calculations are 229 times, while those made by PT. ABCDE is 222 times. For the Safety Stock value, the calculation result of the software is 7709 pieces, while the actual condition is 7099 pieces. Although there are differences, inventory at PT. ABCDE can be said to have been implemented according to the EOQ and Reorder Point methods.

Recommendation

Based on the conclusions above, even though it has implemented controls based on EOQ, there are several recommendations that can be considered by the company to be able to improve the efficiency of the J95010 nut inventory, which include:

- 1) Due to very long Lead Time and inventory control is carried out automatically by the system, discipline and alertness are needed for the inventory system PIC to immediately stop issuing POs to suppliers after receiving information regarding changes in specifications, so that the stock of existing nut does not increase.
- 2) Discipline is needed in complying with the nut inventory allocation that has been determined by the system, so that the amount of stock in the system and the actual stock in the warehouse there are no significant differences that can affect the production process.
- 3) To speed up the process of changing nut, one of which can be done by increasing sales of the final product so that the use of nut to be replaced will run out faster.
- 4) Improve the communication system which is fast and accurate, especially in terms of distribution of nut from suppliers and shipping parties to the company. All kinds of changes in terms of distribution will affect the existing Lead Time and can also affect the availability of nut in the warehouse. In addition, a fast and accurate communication system between departments must also be implemented, so that all kinds of information can be followed up properly.
- 5) In addition to the four suggestions above, the last one is the company should use the results of these calculations as inventory planning for nuts J950010 that is, by ordering 507 pieces each time you order, do 229 orders for 1 fiscal year, and added safety stock to 7709. Although there is only an insignificant difference, at most no results in this study are more efficient than what has been applied in the company.

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