

## Material Management System for the Waste Processing Industry at PT. Pallet with *Economy Order Quantity* (EOQ) Method

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### ABSTRACT

*PT. Pallet is a waste processing company that uses plastic waste as the main material to make plastic pallet products. Based on initial observations, this company experienced problems in material management, thereby reducing cost-effectiveness and efficiency. The purpose of this study is to identify problems in material management and the procurement of raw materials for plastic waste used in the production process of making plastic pallets, as well as to find out some of the causal factors for the occurrence of deficiencies/excesses in the procurement of raw materials for production waste. This research uses a descriptive quantitative approach, and the researcher acts as a research instrument or data collector. The analytical method used is Economy Order Quantity (EOQ), Safety Stock, and Reorder Point (ROP). The EOQ method has a lower total inventory cost. After calculating using the EOQ method, it is clear how much material must be ordered, the time to place the order and the total costs that must be incurred. The number of economic orders in the 3 months was 1,153.57 kg in October, 1,153.02 kg in November and 1,262.22 kg in December. The safety stock needed to expedite the production process is 394,345 kg in October, 376,306 kg in November and 99,652 kg in December. The results of the EOQ calculation produce a lower frequency of reorders, namely 203 times in one month, compared to the frequency of orders without EOQ, namely 378 times in one month.*

**Keywords:** Management Material, Economy Order Quantity (EOQ), Safety Stock, Reorder Point (ROP)

### Introduction

Material is a critical component in determining the cost of production. More than half of the production costs are absorbed by the materials used [1] at the stage of production implementation PT. Pallet International Indonesia, using materials in the field often results in large residual materials, so efforts to minimize the remaining materials are important to implement. This could be due to PT. Pallet processes plastic waste into especially useful items, namely plastic pallets. In addition, PT. Pallet also uses a sewage treatment system (*sewerage system*) in the sense of infrastructure specially built to manage, distribute, and treat waste or rainwater overflow so that it can be returned and accepted by the environment and is not harmful (relatively safe).

Control of the company is needed to be able to measure the company's performance. According to Usry [2], translated by Sirait, defining control or control is a company's systematic effort to achieve goals by comparing work performance with plans and taking appropriate actions to correct important differences. Inventory control systems in companies in Indonesia have the term *Inventory Control*, which is often interpreted as inventory management. Therefore, inventory control can also be interpreted as inventory management. Inventory control is an activity to determine the level and composition of the inventory of assembled components (parts), raw materials and finished goods/products so that the company can protect the smooth production and sales and the company's learning needs effectively and efficiently [3]. An inventory control run by the company, of course, has certain goals.

Inventory is important for companies that carry out the production process. According to Rangkuti [4], "Inventory is one of the most active elements in a company's operations which is continuously acquired, changed, then resold". According to Kusuma [5], "Inventories are defined as goods stored to be used for sale in future periods. Inventory can take the form of raw materials stored for processing, components processed, goods in process in the manufacturing process, and finished goods stored for sale". According to Riyanto [6], "Inventory is defined as some goods stored to support the smooth running of production and distribution activities. Inventory can also be in the form of goods stored in a waiting state or not completed. Based on the definitions above, it can be concluded that inventory is goods in the form of raw materials, semi-finished goods, or finished goods that are stored for the continuity of the production process to meet customer needs.

Planning is part of the management function, including "defining what needs to be done, how it will be done, and who is to do it" [7]. So, in Indonesian, it is interpreted that planning defines what needs to be done, how it can be done, and who will carry it out. Control itself [8] is defined as: "Control is the process of deciding what objectives to pursue during the future and what to do to achieve those objectives." "Control is the process

of deciding what to target in the future and what to do to achieve that goal". Meanwhile, the factors influencing the amount of raw material inventory are [9]: a) Estimated use of raw materials. Determining the amount of material inventory required must be on the needs for using the material in a particular production period. b) Raw material prices: The price of the materials required is another factor influencing the amount of inventory that must be held. c) Inventory costs There are several types of costs for holding raw material inventories, while the types of inventory costs are ordering costs and warehouse material storage costs. d) Order waiting time (lead time).

The cost of running out of inventory (stock cost) is the cost incurred due to not being able to provide products when there is a request from a customer. According to [6], costs related to raw material inventories consist of 1) The invoice price includes transportation costs for each unit (cost per unit) of materials purchased, and 2) Ordering costs or called procurement costs or set up costs or ordering costs. Ordering costs are costs incurred to conduct material ordering activities. Based on the level of variability, ordering costs can be grouped into a. Fixed ordering fees, namely, the ordering costs that remain the same in a certain period, are not influenced by the ordering frequency b. Variable ordering costs, namely ordering costs whose total amount always changes proportionally to the ordering frequency. The higher the order frequency, the higher the total variable order cost. The lower the order frequency, the lower the variable order cost. Which includes variable costs, for example: • Costs of creating and sending purchase requisition documents or purchase orders • Costs of preparing material receipt reports and quantity and quality checks • Costs of receiving ordered materials • Costs of recording accounts payable and preparing payments for purchased materials 3) Storage costs or what are called storage costs or carrying costs Storage costs are costs incurred to carry out storage of materials.

Based on the level of variability, storage costs can be grouped into a) Fixed storage fee. Fixed storage costs are storage costs whose total amount is not influenced by the number or size of materials stored in the warehouse. b) Variable storage fees Variable storage costs are costs for storing materials whose total varies in proportion to the amount or number of materials stored. The greater the material-stored results, the greater the variable storage costs; the smaller the material-stored results, the smaller the variable storage costs. Included in variable storage costs include • Warehouse rental fees, • Material insurance costs • Warehouse administration fees, • The cost of damage or obsolescence of materials. 4) Material shortage costs or stockout costs: Material shortages are an economic consequence of deficiencies from outside or within the company. External shortages occur when orders from consumers cannot be fulfilled. Internal deficiencies occur when a department cannot meet the needs of other departments. External shortage costs can be in the form of backorder costs, lost sales opportunity costs, and lost profit opportunity costs. Internal shortage costs can be in the form of delivery delays or idle capacity.

The EOQ (Economy Order Quantity) method determines the quantity of inventory orders that minimizes the direct costs of storing inventory and the inverse costs of ordering inventory (1999). Reducing the cost of ordering supplies by the EOQ method will optimize inventory for the company. EOQ aims to minimize costs incurred by inventory. The costs important to this model are storage costs, ordering costs, carrying or maintaining inventory, and inventory placement costs. Other costs, such as purchasing the inventory itself, are considered irrelevant for this model because they are constant. Rangkuti [10] states that the EOQ method determines the amount of raw material purchased for each order at the lowest cost. Herlina in [11] also states that the EOQ method is a method for determining the most economical order quantity for one order. Hansen and Mowen [12] in Sakkung and Sinuraya [11] explain the relationship between EOQ as a traditional inventory management method and the associated inventory costs. It is said that if the raw material inventory in the company is raw material purchased from outside and not produced or from within the company, then the costs associated with the inventory are known as ordering costs and carrying costs.

The selection of PT. Pallet became the research site because this company manages plastic waste into a plastic pallet product that other companies can use. In addition, processing plastic waste in the era of globalization is very necessary because it can reduce the threat of plastic waste to the environment. So, this company participates in reducing the impact of plastic waste so that environmental sustainability can be maintained and protected from health problems. Calculations made by the company in procuring purchases of plastic waste raw materials use the company's policy, where sometimes there are advantages or disadvantages of plastic waste raw materials in the production process. Even though it is hoped that in the implementation of the production process, plastic waste raw materials will always be available for the smooth running of the production process, it is necessary to conduct planning and control of more efficient raw materials. Then, an analysis is conducted using the EOQ method to compare the policies implemented in companies with the EOQ method. So that companies can choose which policy is more efficient in terms of spending on inventory costs for purchasing raw materials.

## Research Methods

Data collection techniques aim to ensure that the data obtained follows what is expected to be truly valid; in each study, you must first determine what method will be used to obtain and collect it because it is the

key to success in research. Researchers used data collection techniques in this study, including Observation, Documents, and Interview methods. The types of data used in this research are primary and secondary. The analysis used in this research is descriptive data analysis by collecting, analyzing, and processing data. Research data that has been processed will be compared with previous data. Next, suggestions will be given to improve plastic waste processing to make it more optimal.

The flow of research implementation was carried out in several stages, from the beginning to the end of research implementation. The research steps are illustrated in the research flowchart as follows:

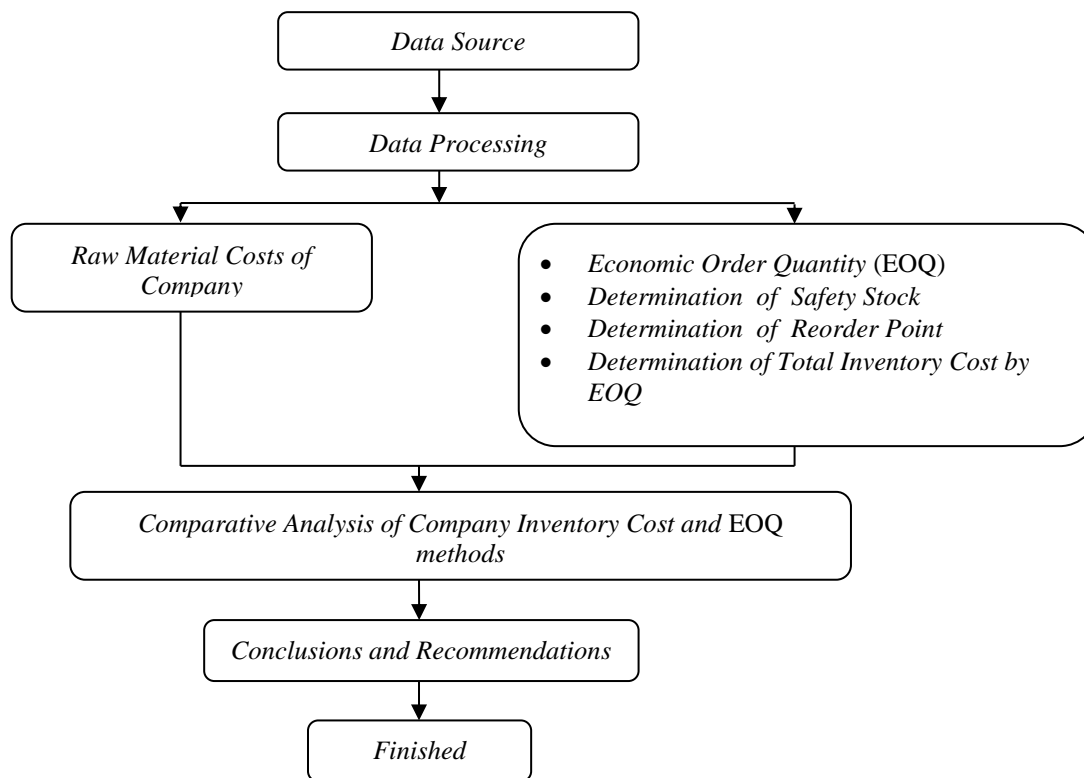


Figure 1. Research Flowchart

## Results and Discussion

The costs incurred by the company in placing an order are :

Table 1. Purchase Schedule of October 2022

No.	Supplier Name	Weight of Plastic Measurement (Kg)	Basic Price (Rp)	Total Invoice (Rp)
1	Mustofa	105,555.00	4,000	422,220,000
2	PT. Wasteforchange	130,835.00	4,000	523,340,000
3	Utfia	99,780.00	4,000	399,120,000
<b>TOTAL</b>		<b>336,170.00</b>		<b>1,344,680,000</b>

Table 2. Purchase Schedule of November 2022

No.	Supplier Name	Weight of Plastic Measurement (Kg)	Basic Price (Rp)	Total Invoice (Rp)
1	Mustofa	76,250.00	4,000	305,000,000
2	PT. Wasteforchange	96,056.00	4,000	384,224,000
3	Utfia	62,104.00	4,000	248,416,000
<b>TOTAL</b>		<b>234,410.00</b>		<b>937,640,000</b>

Table 3. Purchase Schedule of December 2022

No.	Supplier Name	Weight of Plastic Measurement (Kg)	Basic Price (Rp)	Total Invoice (Rp)
1	Mustofa	83,706.00	4,000	334,824,000
2	PT. Wasteforchange	90,282.00	4,000	361,128,000
3	Utfia	82,622.00	4,000	330,488,000
<b>TOTAL</b>		<b>256,610.00</b>		<b>1,026,440,000</b>

Table 4. Total Purchase Schedule of October - December 2022

No.	Supplier Name	Weight of Plastic Measurement (Kg)	Basic Price (Rp)	Total Invoice (Rp)
1	October	336,170.00	4,000	1,344,680,000
2	November	234,410.00	4,000	937,640,000
3	December	256,610.00	4,000	1,026,440,000
<b>TOTAL</b>		<b>827,190.00</b>		<b>3,308,760,000</b>
<b>Mean Total</b>		<b>275,730.00</b>		<b>1,102,920,000</b>

Calculation steps using the Economic Order Quantity (EOQ) method are :

$$Q = \sqrt{\frac{2 \cdot S \cdot D}{H}}$$

D = Total use of raw materials

S = Order fee each time you order (Rp)

H = warehouse storage costs (Rp)

Economical Purchase of Raw Materials using this formula are:

• October 2022 Purchase

Total raw material requirements (D) = 336,170 Kg

One-time order fee per Kg (S) = IDR 1,852

Storage cost per Kg (H) = IDR 455.39

Then, the amount of economical raw material purchases in October can be calculated using the EOQ method of 1,653.57 kg.

• November 2022 Purchase

Total raw material requirements (D) = 234,410 Kg

One-time order fee per Kg (S) = IDR 1,852

Storage cost per Kg (H) = IDR 653.09

Then, the economical purchase of raw materials in November can be calculated by the EOQ method of 1,153.02 Kg.

• December 2022 Purchase

Total raw material requirements (D) = 256,610 Kg

One-time order fee per Kg (S) = IDR 1,852

Storage cost per Kg (H) = IDR 596.59

Then, the economical purchase of raw materials in December can be calculated by the EOQ method of 1,262.22 Kg.

Calculations to calculate the average inventory of plastic waste raw materials in 3 months carried out by PT. Pallet as follows:

$$\text{Average Inventory} = \frac{Q}{2}$$

• Average inventory for October 2022 = 826.79 kg

• Average inventory for October 2022 = 576.51 kg

• Average inventory for October 2022 = 631.11 kg

The calculation for calculating the estimated number of order frequencies in each order according to the EOQ method is:

$$\text{Estimated Order Quantity} = \frac{D}{Q}$$

- Order Frequency in October 2022 = 203.3 times
- Order Frequency in November 2022 = 203.3 times
- Order Frequency in December 2022 = 203.3 times

Based on the results of research conducted at PT. Pallet, the order frequency from the calculation above is 203 times in 1 month. So that PT. Pallets can minimize the frequency of ordering plastic waste raw materials.

The calculation of the order cost using the EOQ method is as follows:

$$\text{Ordering Cost} = \frac{D}{Q} \times S$$

- Order Fee for October 2022 = 376,510.73
- Order Fee for November 2022 = 376,510.73
- Order Fee for December 2022 = 376,510.73

Calculations to calculate storage costs per month with the EOQ method are as follows,

$$\text{Storage Fee} = \frac{Q}{2} \times H$$

- Storage Fee for October 2022 = 376,513.42
- Storage Fee for November 2022 = 376,510.88
- Storage Fee for December 2022 = 376,511.55

The higher the safety stock, the greater the cost of storing raw materials. Therefore, PT. The pallet must be careful and precise in determining that the safety stock can act according to its function. In the production process, apart from the need for raw material supplies, safety stock is also needed so that if there is a shortage of raw material supplies, safety stock can be used to expedite the production process. Subagyo [13] states that "safety stock is a minimum supply of goods to avoid material shortages". Meanwhile, according to Rangkuty [10], "Safety Stock is an additional inventory held to protect or guard against the possibility of material shortages (stock out)". The calculation of safety stock is as follows:

$$\text{Safety Stock} = (\text{maximum usage} - \text{average usage}) \times \text{lead time}$$

- Safety stock for October 2022 = 394,345.00 kg
- Safety stock for November 2022 = 376,306.00 kg
- Safety stock for December 2022 = 99,652.00 kg

Several factors influence the determination of the amount of security provisions that must be made. According to Sofjan Assauri in the journal [14], the factors determining the safety stock amount are • Average raw material usage. One basis for estimating the use of raw materials during a certain period, especially during the ordering period, is the average use of raw materials in the past • Time factor or lead time (Procurement Time) In replenishing inventory, there is a considerable time difference between when placing an order (order) to replace or replenishing inventory and when receiving the ordered goods. A shortage of raw materials occurs because the need for goods during ordering exceeds the average need for goods used. This happens due to uncertain circumstances such as the daily needs being too much compared to usual or the order period being too long. To deal with these uncertain situations, safety stock is needed. With safety stock, problems related to inventory, such as running out of raw material supplies, can be overcome to ensure the smooth running of the production process. Calculations to calculate the average usage:

$$Q = \frac{EOQ}{\text{Order Time}}$$

- Average usage in October 2022 = 78.74 kg
- Average usage in November 2022 = 54.91 kg
- Average use in December 2022 = 60.11 kg

The expected amount is calculated during the grace period, also adding safety stock, which usually refers to the possibility of a stock shortage during the grace period. To calculate ROP, you can use the formula according to A. Wahid [15], the following is the calculation for calculating ROP :

$$ROP = I \times Q$$

- ROP for October 2022 = 1,653.57 kg
- ROP for November 2022 = 1,153.02 kg
- ROP for December 2022 = 1,262.22 kg

Orders must be made before plastic waste raw materials run out. So that PT. Pallet requires a lead time (grace time) of about 1 day from the time of order until the waste material arrives at the warehouse.

The calculation of Total Inventory Cost (TIC) obtained is:

$$TIC = \sqrt{2 \times D \times S \times H}$$

D = Total use of raw materials

S = Ordering cost (Rp)

H = warehouse storage costs (Rp)

- TIC for October 2022 = 753,024.14 kg
- TIC for November 2022 = 387,597.19 kg
- TIC for December 2022 = 427,287.28 kg

## Conclusion

Based on the results of the research and discussion in the previous chapter, the following conclusions can be drawn that the formula approach using the Economic Order Quantity (EOQ) method shows the number of economic orders of 1,153.57 kg in October, 1,153.02 kg in November and 1,262.22 kg in December, which results in costs ordering and storage costs decreased, to minimize costs incurred at PT. Pallet and can maximize the profits obtained. PT. Pallet does not stipulate safety stock or safety stock in its policy. While using the EOQ method, safety stock is needed to expedite the production process, namely 394,345 kg in October, 376,306 kg in November and 99,652 kg in December. The results of the EOQ calculation produce a lower frequency of reorders, namely 203 times in one month, compared to the frequency of orders without EOQ, namely 378 times in one month.

## Acknowledge

Based on the above conclusions, the researcher can provide advice to PT. Pallets that can be used for various considerations include PT. Pallet should review its plastic waste raw material inventory policy because the policy being implemented is inefficient. In addition, PT. A pallet can try to apply the Economic Order Quantity method to calculate economical and efficient order quantities, safety stock, reorder points and Total Inventory Cost. So that PT. Pallet can avoid the risk of running out excess of raw materials and can minimize the purchase of plastic waste raw materials.

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