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Estimation of Material Inventory Using The Economic Order Quantity (EOQ) Method in The PUSKOPCUINA Phase I Pontianak Building Construction Project

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Abstract

Seeing the rapid development of the construction world, as part of the Indonesian economy, we need to support the growth of various facilities and infrastructure. In its growth, it must also improve its quality in all respects. In this case, material management plays an essential role in the construction process. The method chosen for this problem is the Economic Order Quantity (EOQ) method. The most economical amount of inventory can be determined by calculating the Economic Order Quantity (EOQ) method. This economical amount of stock can invest embedded in inventory materials, not excessive, so that it does not experience waste.

1. Introduction

Procurement of building material inventory in a construction project is one of the most critical assets because the material is the most significant cost component in the construction process. The existence of this material management system is expected to direct a project so that later it can run effectively to avoid unwanted things that can cause enormous losses for the company.

Calculating the most economical inventory quantity can determine the exact amount of inventory material. Therefore, it is necessary to optimize the inventory of raw materials, which can be done by the Economic Order Quantity (EOQ) method. This model assumes that the future demand for raw materials can be known with relative certainty and is constant over time.

This research aims to gain knowledge and understanding of the mechanism of procurement of building materials. The result of this research is the minimal cost of material procurement. This research is expected to be an information tool for project material inventory estimation for project planners to select and apply material inventory estimation methods under project characteristics.

2. Material and Methods

Research methods are procedures or steps in obtaining scientific knowledge or knowledge related to the research to be carried out. The process must include interviews, data collection, and analysis to produce excellent and accountable research.

This study conducted interviews by interviewing contractors and consultants involved in the PUSKOPCUINA Pontianak Phase I Office Building Construction project. After conducting interviews, the next step is data collection. The required data was obtained from contractors and consultants in the PUSKOPCUINA Pontianak Phase I Office Building Construction project.

Then the data obtained is processed to get output in the cost of the material that must be ordered, the material reorder point, and the optimal amount of building material inventory without incurring high costs.

2.1 Theoretical Frame Work

Material requirements planning certainly requires various information that supports project activities. This information is used to determine the relationship between the availability and use of materials so that a job can run smoothly according to the order schedule without any delays, and the quantity follows the specifications and needs that have been determined so that this can be minimized the occurrence of additional costs on the project due to delays.

Calculating the most economical inventory quantity can determine the exact amount of inventory material. Therefore, it is necessary to optimize raw material inventory using the Economic Order Quantity (EOQ) method. The goal is that the investment invested in material stock is reasonable to avoid waste.
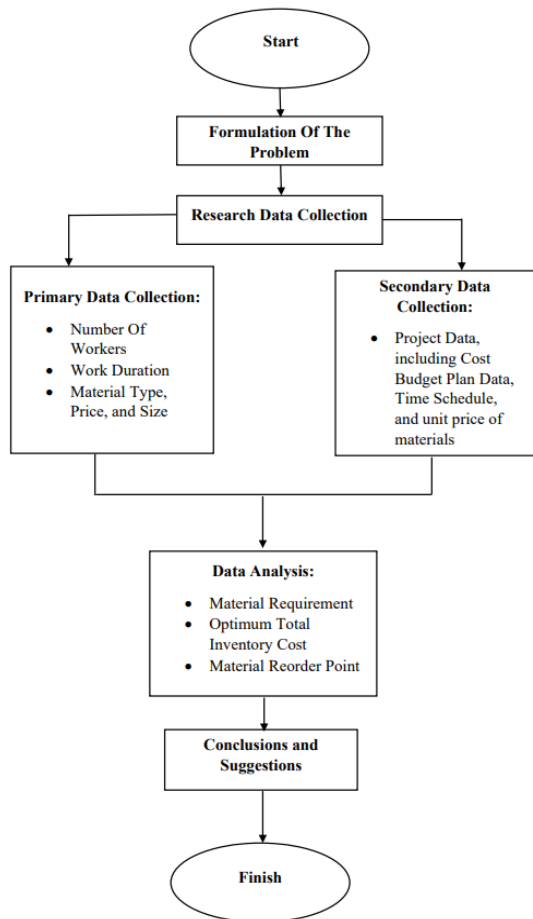

Figure 1. Flowchart

2.2 Research Location

The research location in this final project was carried out on the PUSKOPCUINA Phase I Pontianak building construction project. The building's place is in Gg. H. Mursyid 1 No.7-8, Benua Melayu Laut, Kec. Pontianak Sel., Kota Pontianak, Kalimantan Barat
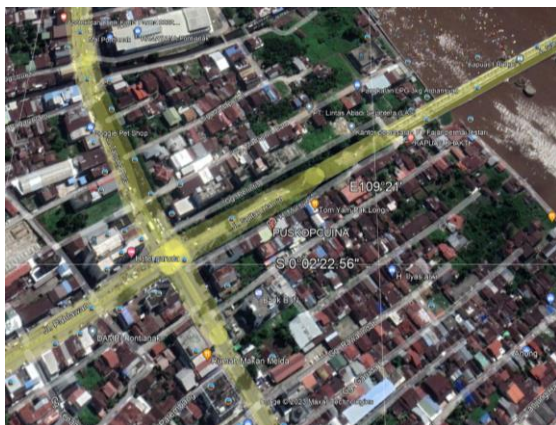

Figure 2. Research Location

2.3 Data

The data are the project schedule, cost budget plan, detail engineering design, and material unit price analysis.

2.4 Analysis Method

Economic Order Quantity (EOQ) is one of the methods in inventory management. This EOQ method will assist the company in determining the proper inventory so that the company can know how many units of stock to order or produce and when inventory orders should be placed or preparations made.

Using this EOQ method will assume that the level of demand for goods is known to be uniformly constant and continuous. That is, the fluctuations in demand for goods are relatively small, the price of the item is the same for all order sizes, the lead time is constant and well-known, and the thing is a single product. It has nothing to do with other products, and the costs taken into account are ordering and storage costs.

Economic Order Quantity is the number of entities that must be ordered when placing an order to minimize expenses related to the supply and purchase of the optimum amount of goods. The formula for EOQ can be determined using the following equation 1.

$$EOQ= \sqrt{\frac{2.S.D}{H}} \qquad (1)$$

S is the cost per order. H is the essential raw material storage cost per kg. D is the estimated demand cost per period. TC's inventory cost is the sum of the order and storage costs. This minimum TC will be reached when the storage cost equals the message cost. When TC is the minimum, the order quantity is said to be the most economical quantity (EOQ).

According to Zulian Yamit (1999: 49) in his book inventory management, it is said that TC is the sum of storage costs and order costs. The total cost of storage is the product of the average number of items $(\frac{q}{2})$ with storage cost (H). Meanwhile, the cost of the message results from multiplying the price of each message (S) by the ordering frequency $(\frac{D}{Q})$. The Q formula is derived from the following derivative of the total cost equation 2.

$$Q = \sqrt{\frac{2SD}{H}} = \sqrt{\frac{2SD}{IP}} \qquad (2)$$

Q is economic order quantity. S is cost per order. D is the estimated demand cost per period. H is the essential raw material storage cost per kg. I is inventory level. P is purchase Price. In the Economic Order Quantity (EOQ) method with Mosel Q, the average inventory level is determined using the formula 3.

$$\bar{I} = SS + \frac{Q}{2} \tag{3}$$

I is average inventory. SS is safety stock. Q is order quantity. The Economic Order Quantity (EOQ) method has a constant or unchanging order quantity. But in its application, this is rarely done perfectly. Usually, this is caused by differences in the rate of demand and differences in determining material requirements. For this reason, it is necessary to have an Economic Order Quantity (EOQ) method with the Q model.

The Economic Order Quantity (EOQ) model Q method can solve problems regarding the assumption that the demand for materials or raw materials is constant or cannot change. The Economic Order Quantity (EOQ) Q model implements that the inventory status is monitored continuously every time a transaction occurs. If, in the end, the inventory status drops to a predetermined point R (ROP), an order of Q will be placed. This method is determined by two values, namely the Q and R (ROP) values.

Reorder Point (ROP) is the inventory level (point) at which action is taken and replenishes the stocked goods. In its application, the Q value will be determined based on a predetermined formula, namely the EOQ formula using the average primary material quantity demand (D). It means that the request is not uncertain, so later, the value will be close to the average value.

Reorder Point, according to Assauri (2008), namely where the reorder level of an inventory is the point or limit of a stock that must be reordered. Reorder point is where a company will place a back order for materials or raw materials to maintain the inventory of these materials or raw materials. If this is not done and the stock is short, the impact is that the development process can be stopped. Therefore, reordering raw materials or building materials is essential for companies to do so that, in the end, the development process will run effectively and efficiently. The formula used to determine reorder point (RoP) is as follows:

$$RoP = (D \times L) + SS \tag{4}$$

L is lead time. D is usage average in a given unit of time. SS is safety stock.

3. Result and Discussion

To fulfill the material, the price of M6 wire mesh material in the PUSKOPCUINA Phase I Pontianak Building Construction project using is IDR 3,800,000 / roll.

- **Determining Total Requirements**

Total requirements of wire mesh is determined by job volume and coefficient of the used wire mesh. The wire mesh requirement is presented in Table 1.

Table 1. Total Wire mesh Requirements

Job Name	Volume (m²)	Coef.	Total Requirement (rol)
Floor Concreting	444	1.02	7.987

Wire mesh is used in 2 layers for floor concreting job. Every layer has 2.1 m × 54 m of dimension with 1.02 of coefficient. The requirement are calculated by this following formula:

Total Requirement (D) $= \frac{2 \times 1.02 \times 444}{113.4}$

$= 7.987 \sim 8$ rolls

So the total wire mesh requirement is 8 rolls.

- **Determining The Ordering Cost (S)**

Ordering costs incurred to obtain M-6 wire mesh material are telephone costs (a) and transportation costs (b). Telephone costs and transportation costs are the results of the author's interview with the project implementer.

S $= a + b$

$= Rp. 15,000 + Rp. 50,000$

$= Rp. 65,000$

- **Storage Costs Analysis**

Storage costs consist of material handling costs, security salaries, logistics staff salaries, and capital costs. From the results of interviews with logistics and accounting staff in the project, the cost of capital embedded due to the material stored is the savings interest rate of 5.5% per year in 2022. (Source: Bank Indonesia accessed on February 5, 2023).

Capital Costs $= 5.5\% \times$ Material Cost

$= 5.5\% \times Rp. 3,800,000$

$= Rp. 209,000$

The interview results show that material handling costs consist of the cost of purchasing tarpaulins. Tarpaulins are used as tents that cover the material on the project. The tarp used is an A12 tarpaulin size 5 × 5 m for Rp. 350,000 the tarp used will be reused to store the following M-6 wire mesh material. The total units from every floor is 31 rolls.

Maintenance Cost $= \frac{Rp. 350,000}{31}$

$= Rp. 11,574$/roll

Security Salary $= 0.5\% \times Rp. 2,000,000$

$= Rp. 10,000$/roll

Logistics Salary $= 0.5\% \times Rp. 3,500,000$

$= Rp. 17,500$/roll

The percentage of storage costs consisting of Security Salaries and Logistics Staff Salaries of 0.5% is obtained from the area used to store the wire mesh. Where the wire mesh storage area is obtained from the size of the wire mesh with

a roll of ± 1 meter multiplied by the length of the roller of 2.1 meters after the storage area is known, then divided by the overall storage area of 420 m^2 or as calculated below:

Storage Area $= 2.1 \times 1$

$= 2.1$ m^2

Coefficient $= \frac{2.1}{420}$

$= 0.005$

$= 0.5 \%$

The illustration of the area of space used for M6 wire mesh is presented in Figure 1. Storage cost every unit (H) is obtained from capital cost, material handling cost, security salary and logistic staff salary.

H = capital cost + material handling cost + security salary + logistic staff salary

= Rp. 209,000 + Rp. 11,574 + Rp. 10,000 + Rp. 17,500
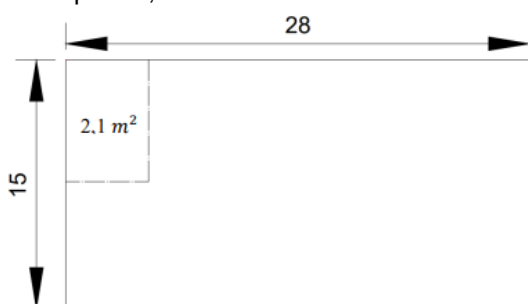
= Rp. 248,074/roll

Figure 3. Sketch of Material Storage Area

• **The Total Inventory Cost (TIC) Analysis**

Total inventory cost is obtained from ordering cost and storage cost. The results will show the most economically optimal order. From Table 2, the most economically optimal order is if the order is placed four times with an order quantity of 2 wire mesh rollers.

Table 2. Total Inventory Cost

n	Q	S	H	TIC
1	8	Rp 65.000,00	Rp992.296,00	Rp1.057.296,00
2	4	Rp130.000,00	Rp496.148,00	Rp 626.148,00
3	2.7	Rp195.000,00	Rp330.765,00	Rp 525.765,00
4	2	Rp260.000,00	Rp249.074,00	Rp 509.074,00
5	1.6	Rp325.000,00	Rp198.459,00	Rp 523.459,00
6	1.3	Rp390.000,00	Rp165.383,00	Rp 555.383,00
7	1.1	Rp455.000,00	Rp141.757,00	Rp 596.757,00
8	1	Rp520.000,00	Rp124.037,00	Rp 644.037,00
9	0.9	Rp585.000,00	Rp110.225,00	Rp 695.225,00
10	0.8	Rp650.000,00	Rp 99.230,00	Rp 749.230,00

• **Reorder Point Analysis**

Reorder point analysis defines a certain amount of inventory that a project should maintain as a necessity to prevent having too much available to waste. The analysis is carried out based on the project's average number of material requirements. With reorder point analysis, the project's M-6 wire mesh material inventory reaches two rolls. The project must place a material order with the supplier so that the project can experience a sufficient amount of material inventory to be used in the construction process.

4. Conclusion

With the Economic Order Quantity (EOQ) method, the optimum number of orders that must be placed can be determined, where the economic order quantity occurs at the lowest total material inventory cost. As the number of orders increases, storage costs will continue to decrease, and ordering costs will continue to rise.

After doing the calculations in this study, it was found that the number of material requirements for wire mesh was eight rollers, while to minimize the total cost of material inventory in this floor forming work, it was necessary to order M6 wire mesh material four times with an entire order of 2 rollers. Material needs to be collected again when the availability of M6 wire mesh material in the warehouse remains two rollers.

5. Acknowledgement

6. Author's Note

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