

Inventory Control of Steel Bar Materials Using the Economic Order Quantity (EOQ) Method at PT XYZ in Kediri East Java

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DOI : <https://doi.org/10.16796/jgrpd.v3i8.1894>



Sections Info

Article history:

Submitted: June 23, 2026

Final Revised: July 11, 2026

Accepted: August 16, 2026

Published: September 29, 2026

Keywords:

Construction Projects

Economic Order Quantity

Inventory Control

Steel Bar Materials

Total Inventory Cost

ABSTRACT

Objective: Suboptimal material inventory control in construction projects has the potential to trigger cost overruns. PT XYZ currently procures steel bar materials based on field demand without economic order quantity calculations, which potentially increases inventory costs. **Methods:** his study aims to describe steel materials inventory control using the Economic Order Quantity (EOQ) method. This study uses a descriptive qualitative approach. **Results:** the company's conventional method, with an average order quantity of 100.26 tons and an order frequency of 84 times per year, resulted in a total inventory cost of IDR 104,998,800.00. Meanwhile, the application of the EOQ method produced an optimal order quantity of 1,172.03 tons with an order frequency of 7 times per year and a total inventory cost of IDR 8,057,857.04. These findings show that the EOQ method is able to reduce total inventory costs by IDR 96,940,942.96, compared to the method applied by the company. **Novelty:** this study lies in the direct application of the EOQ method to a case study of steel materials procurement in a toll road project, demonstrating the significant cost-efficiency potential compared to the field demand based procurement practice still used by the company. These findings confirm that EOQ can serve as a policy evaluation tool for more efficient inventory control.

INTRODUCTION

Inventory control plays a strategic role in project-based industries such as construction, as it directly affects the timeliness of work completion and project cost control. Inventory functions as a balance between demand uncertainty and supply availability, and its management directly impacts company performance and profitability [1]. A weak material management system can result in delays, increased costs, reduced efficiency, and excessive waste [2], making an effective inventory control system essential to ensure that material procurement runs on time and supports overall project success.

The importance of inventory control is also reinforced within regulatory and quality standard frameworks. Under ISO 9001:2015, the quality management system covers the control of organizational resources, including material inventory, as a key support for production activities, with efficient inventory management considered essential to ensure project success, cost effectiveness, and timeliness [3]. In Indonesia, this is further reinforced by the Regulation of the Minister of Public Works and Housing (PUPR) Number 14/PRT/M/2020, which stipulates that procurement planning must include needs identification, scheduling, and technical and budget specifications that account for material use and implementation time.

Planning and controlling material inventory are essential to ensure project needs are met on time while avoiding cost waste from excess or shortage of materials [4]. Improper inventory management can give rise to operational problems, ranging from schedule delays due to unavailable materials to increased storage costs and physical damage risk from excess inventory [5]. Planned and coordinated inventory management is therefore essential to ensure that available material consistently matches field work needs.

PT XYZ, a construction company carrying out a toll road project, manages several main material types, including steel bar, concrete, and diesel fuel, each with different procurement characteristics. Concrete is ordered according to the casting schedule and has a short storage life, while diesel fuel ordering is relatively stable and follows operational needs. Steel, in contrast, functions as reinforcement and is stored as inventory at the project site, with ordering activities carried out repeatedly according to field needs, making it an important material to analyze in determining the optimal order quantity.

At PT XYZ, steel bar materials procurement is currently carried out through order-by-request without an optimal order quantity calculation method that accounts for inventory costs. Steel demand data for 2025 shows a total demand of 8,421.68 tons with a fluctuating pattern, ranging from 51.46 tons in January to a peak of 1,373.11 tons in August. To meet this demand, the company placed orders 84 times throughout the year with a total inventory cost of IDR 104,998,800.00, without being based on an economical order quantity calculation. This shows that although the company already has a procurement system in place, it has not yet calculated whether the order frequency and inventory cost currently applied have reached a minimum.

Several inventory control methods can address this problem, including Material Requirements Planning (MRP), Just in Time (JIT), Economic Order Quantity (EOQ), and ABC Classification[6]. Among these, EOQ was selected because it simultaneously considers ordering costs and holding costs to determine the optimal and economical order quantity, thereby minimizing total inventory costs[7], in line with PT XYZ's condition, which has not yet applied such a calculation in its steel procurement activities.

Based on the above description, this study aims to describe the inventory control of steel material at PT XYZ using the Economic Order Quantity (EOQ) method, by comparing the order quantity, order frequency, and total inventory cost between the company's conventional method and the EOQ method. This study is expected to provide insight into the potential cost efficiency achievable through the application of EOQ in steel materials procurement in toll road construction projects.

RESEARCH METHOD

This study examines steel bar materials inventory control at PT XYZ, a construction company carrying out a toll road project in East Java, using a descriptive qualitative approach. This approach was selected because the research aims to systematically describe the company's current inventory control practices and the application of the

Economic Order Quantity (EOQ) method, including its safety stock and reorder point components.

Data were obtained from both primary and secondary sources. Primary data were collected through direct observation and interviews, while secondary data consisted of the company's steel material demand records and company profile. Informants were selected using purposive sampling based on their direct involvement in procurement and logistics activities, as they were considered to have direct knowledge of the company's material procurement process, inventory costs, and the constraints encountered in managing steel material inventory. The profile of the informants is presented in Table 1.

Table 1. Research Informants

Code	Position	Role
A-1	Procurement and Logistics Supervisor	Informant
A-2	Procurement and Logistics Administrative Staff	Key Informant
A-3	Procurement Staff	Informant
A-4	Logistics Administrative Staff	Informant

Data were analyzed using the interactive model of Miles and Huberman, comprising data collection, data reduction, data display, and conclusion drawing. Data collection combined the results of interviews, observation, and documentation relevant to the research problem. Data reduction focused the dataset on information directly related to steel material inventory control, namely ordering costs, holding costs, and inventory records. Data were then displayed in tables and charts to provide a structured overview of steel material demand. Conclusions were drawn iteratively and verified against the supporting evidence to ensure that the findings credibly addressed the research problem. To establish data credibility, source triangulation was applied by cross-checking information obtained from the four informants, and time triangulation was applied by conducting interviews in the morning, when informants were considered to provide more reliable responses.

RESULTS AND DISCUSSION

Results

Steel material is one of the primary materials used in the toll road construction project carried out by PT XYZ, alongside concrete and diesel fuel, as it is required throughout the structural and reinforcement stages of construction. Currently, PT XYZ procures steel material on an order-by-request basis, without applying any calculation to determine an optimal order quantity. Purchase order records for the January–December 2025 period show a fluctuating monthly demand pattern, as presented in Table 2, with a total annual demand of 8,421.68 tons.

Table 2. Monthly Steel Bar Material Demand, 2025

Month	Demand (tons)
January	51.46
February	438.92
March	402.01
April	360.32
May	671.35
June	652.77
July	1,185.48
August	1,373.11
September	1,031.75
October	689.48
November	622.83
December	942.20
Total	8,421.68

As shown in Table 1, demand began at 51.46 tons in January and fluctuated sharply throughout the year, peaking at 1,373.11 tons in August before declining to 622.83 tons in November and rising again to 942.20 tons in December. To meet this fluctuating demand, the company placed orders 84 times throughout 2025, resulting in a total inventory cost of IDR 104,998,800.00, based strictly on field demand without any calculation of an economical order quantity. This indicates that although the company already has a procurement system in place, it has not yet determined whether its current order frequency and inventory cost represent the minimum achievable.

Under this conventional approach, the company places an average order of 100.26 tons per order, with an ordering frequency of 84 times per year. The total inventory cost incurred consists of two components: ordering cost and holding cost. The ordering cost includes transportation and administrative expenses, amounting to IDR 560,700.00 per order, or IDR 47,098,800.00 annually. The holding cost includes the cost of tarpaulins, wood, and lighting used to protect stored steel from rust and weather exposure, amounting to IDR 57,900,000.00 annually, or IDR 6,875.11 per ton. The details of these cost components are presented in Table 3, with a total inventory cost components.

Table 3. Inventory Cost Components

Cost Component	Item	Amount (IDR)
Ordering Cost	Transportation Cost	500,000.00
	Administrative Cost	60,700.00
Total Ordering Cost/Order		560,700.00
Total Ordering Cost/Year		47,098,800.00
Holding Cost	Tarpaulin	45,000,000.00
	Wood	10,000,000.00
	Lighting	2,900,000.00
Total Holding Cost/Year		57,900,000.00
Holding Cost/ton		6,875.11
Total Inventory Cost		104,998,000.00

As shown in Table 2, the ordering cost consists of transportation and administrative expenses, while the holding cost consists of tarpaulins, wood, and lighting used to protect stored steel from rust and weather exposure. Combining these two components, the company's total inventory cost for steel material in 2025 reached IDR 104,998,800.00.

The optimal order quantity was calculated using the EOQ formula[8], where D is the annual demand, S is the ordering cost per order, and H is the holding cost per ton per year[9].

$$Q^* = \sqrt{\frac{2DS}{H}}$$

$$Q^* = \sqrt{\frac{2 \times 8.421,68 \times \text{Rp}560.700,00}{\text{Rp}6.875,11}} = \sqrt{\frac{9.444.071.952}{\text{Rp}6.875,11}} = 1,172.03 \text{ ton}$$

The optimal ordering frequency was then determined using[8]:

$$F = \frac{D}{Q^*}$$

$$F = \frac{8.421,68}{1.172,03} = 7,19 = 7 \text{ times}$$

The total inventory cost under EOQ was calculated using[8]:

$$TC = \frac{D}{Q} S + \frac{Q}{2} H$$

$$\begin{aligned} TC &= \left(\frac{8.421,11}{1.172,03} \times \text{Rp}560.700,00 \right) + \left(\frac{1.172,03}{2} \times \text{Rp}6.875,11 \right) \\ &= (7,19 \times \text{Rp}560.700,00) + (586,02 \times \text{Rp}6.875,11) \\ &= \text{Rp}4.028.928,52 + \text{Rp}4.028.928,52 \\ &= \text{Rp}8.057.857,04 \end{aligned}$$

To support the application of EOQ under fluctuating demand conditions, safety stock and reorder point were also calculated, using an average lead time of 14 days. The Safety Stock formula, where Z is the standard normal deviate corresponding to the desired service level, and σ_{LT} is the standard deviation of demand during the lead time[8]. The company using a 95% service level or 1.644.

$$\text{Safety Stock} = z \times \sigma_{LT}$$

$$\begin{aligned}\text{Safety Stock} &= 1,644 \times 257,22 \\ &= 423,08 \text{ ton}\end{aligned}$$

the safety stock for steel material was determined to be 423.08 tons, providing a buffer against demand uncertainty and delivery delays.

The reorder point was then calculated using[8], where d is the average daily demand ($8,421.68 \text{ tons} \div 365 \text{ days} = 23.07 \text{ tons per day}$) and L is the lead time (14 days):

$$\text{Reorder Point} = (d \times L) + \text{Safety Stock}$$

$$\begin{aligned}\text{Reorder Point} &= (23,07 \text{ ton} \times 14) + 423,08 \text{ ton} \\ &= 323,02 \text{ ton} + 423,08 \text{ ton} \\ &= 746,11 \text{ ton}\end{aligned}$$

Substituting these values yields a reorder point of 746.11 tons, indicating the inventory level at which a new order should be placed to maintain material availability without excessive stock accumulation.

Table 4. Comparison of the Company Method and the EOQ

Indicator	Company Method	EOQ Method
Order Quantity/Order (Tons)	100.26	57,900,000.00
Ordering Frequency/Year	84	1,172.03
Total Inventory Cost (IDR)	104,998,800.00	8.057,857.04

As shown in Table 4, both methods are based on the same annual demand of 8,421.68 tons, but differ substantially in order quantity, ordering frequency, and total inventory cost. Under the conventional method, the company places smaller, more frequent orders, averaging 100.26 tons across 84 orders per year. Under EOQ, the optimal order quantity rises to 1,172.03 tons with only 7 orders per year. This shift from frequent, small orders to fewer, larger orders reduces the total inventory cost from IDR 104,998,800.00 to IDR 8,057,857.04, a reduction of IDR 96,940,942.96.

Discussion

The findings show that PT XYZ's current steel procurement practice, which relies solely on field requests without an economic order quantity calculation, results in frequent, small-volume orders and a significantly higher total inventory cost than the EOQ-based approach. This condition reflects a common pattern in construction firms where inventory decisions are driven by immediate project demand rather than by a

calculated balance between ordering and holding costs, despite the fact that inventory control is fundamentally about determining the optimal quantity and the right time to reorder[10]. EOQ addresses this gap by jointly minimizing ordering and holding costs to determine the most economical order quantity[11], and the substantial cost reduction achieved in this study, is consistent with prior findings that EOQ implementation is effective in determining optimal order quantities while reducing total inventory cost[12].

The incorporation of safety stock and reorder point further strengthens the practical applicability of EOQ in this context. Because steel demand at PT XYZ fluctuates considerably across months, applying EOQ alone, without a buffer for demand variability, would risk stockouts during peak periods; safety stock is therefore particularly necessary under such unstable demand conditions[8], and the resulting reorder point marks the inventory level at which the company should initiate a new order to maintain material availability without excessive accumulation. The service level used in the safety stock calculation reflects the level of fulfillment the company is willing to sustain[13], and this is in line with prior findings that pairing EOQ with safety stock and reorder point calculations helps anticipate unpredictable demand surges that could otherwise disrupt material availability[14].

Two practical factors should nonetheless be considered. First, the company's existing pattern of frequent, small-quantity orders is shaped by its purchasing policy, one of the key factors influencing inventory control decisions [15], and tends to increase total inventory cost[16], which is precisely the inefficiency the EOQ calculation corrects, consistent with earlier research showing that EOQ implementation yields more efficient total inventory cost through optimal order quantity and frequency[17]. Second, prolonged storage of steel at the project site carries a risk of corrosion from extended exposure to open-air conditions, reflecting a broader limitation of the standard EOQ model, which assumes inventory can be stored indefinitely, whereas in practice many materials deteriorate over time in ways that can increase inventory costs if unaccounted for[18]. Future research could extend this study by incorporating such operational constraints directly into the inventory model, for instance through a deteriorating-item EOQ variant.

CONCLUSION

Fundamental Finding: this study finds that PT XYZ's current steel inventory control relies solely on field demand, without any calculation of optimal order quantity or inventory cost. Applying the EOQ method to the same data yields an optimal order quantity of 1,172.03 tons with an ordering frequency of 7 times per year, producing a total inventory cost of IDR 8,057,857.04, a reduction of IDR 96,940,942.96 from the company's conventional cost of IDR 104,998,800.00. **Implication:** these findings indicate that EOQ can serve as a practical evaluation tool for PT XYZ in determining a more economical order quantity. The company would benefit from implementing EOQ together with safety stock and reorder point, prioritizing safety stock first to maintain material

availability, and embedding these calculations into a spreadsheet-based tool used in weekly project meetings to support procurement decisions. **Limitation:** this study identifies two practical constraints. First, the company's pattern of frequent, small-quantity orders, shaped by field conditions and workforce capacity, tends to increase ordering costs. Second, prolonged storage of steel at the project site risks corrosion when stockpiled in large quantities. These constraints suggest that realizing EOQ's cost efficiency in practice may require operational adjustments. **Future Research:** future research could incorporate these constraints directly into the inventory model, such as a deteriorating-item EOQ variant or one accounting for supplier minimum-order requirements, and examine the practical implementation of EOQ, safety stock, and reorder point as an integrated decision-support tool in project planning.

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