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Integration of Multi-Item EOQ and EPQ to Minimize Total Inventory Cost of Outsole Raw Materials

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Abstract— This study analyzes the integration of the multi-item Economic Order Quantity (EOQ) and Economic Production Quantity (EPQ) methods to minimize the inventory costs of outsole raw materials at UD. Santoso Mojokerto. The main problem lies in the high storage costs caused by the mismatch between purchasing quantities and the production needs of women's flat sandals in sizes 37–39. Using demand, production, and inventory cost data for the period of August 2024–July 2025, EOQ is applied to determine the optimal order quantity, while EPQ is used to establish the optimal production quantity. The results show that integrating EOQ and EPQ can reduce total inventory costs compared to the company's current method, while also maintaining raw material availability and ensuring smooth production processes.

Keywords— EOQ, EPQ, inventory, inventory cost..

I. INTRODUCTION

Inventory is one of the most important aspects of production activities as it is directly related to the continuity of the process and the company's cost efficiency [1]. Improper inventory management can lead to two main problems: excess inventory, which increases storage costs, and insufficient inventory, which hamper production and May decrease customer satisfaction [2]. Therefore, an effective and efficient inventory control strategy is required.

A manufacturing company engaged in the production of footwear components faces challenges related to the imbalance between the quantity of raw materials purchased and actual production requirements. This situation leads to inefficiencies in inventory management, such US increased storage costs and the risk of production delays caused by raw material shortages [3].

One approach that can be used to address these problems is the application of the Economic Order Quantity (EOQ) and Economic Production Quantity (EPQ) methods [4]. EOQ helps determine the optimal order quantity of raw materials by considering ordering and holding costs, while EPQ is used to determine the optimal production quantity by taking production capacity and demand into account [5]. Integrating these two methods is expected to reduce total inventory costs while ensuring the availability of raw materials according to production requirements [6]. Based on this background, this study aims to analyze the implementation of the integrated EOQ and multi-item EPQ methods in controlling outsole raw material inventory at UD. Santoso Mojokerto, in order to obtain a more efficient inventory control strategy compared to the conventional method currently used by the company.

II. Related Works

A. Forecasting

Forecasting is an essential component of managerial decision-making, particularly in planning inventory and production requirements [7]. Forecasting is conducted by analyzing historical data, identifying existing patterns, and projecting them into the future using specific methods [8]. The goal is to minimize forecasting errors so that the difference between the actual results and the forecasted values is not significant. The general steps in forecasting include:
(1) analyzing past data to identify trends or patterns,
(2) selecting an appropriate forecasting method, and
(3)projecting data into future periods while considering potential changes [9].

Forecasting can be classified into several types, including economic forecasting, technological forecasting, and demand forecasting [10]. Based on the time horizon, forecasting is divided into short-term (up to one year), medium-term (one to three years), and long-term (more than three years) [11].

In the context of this study, demand forecasting is used to estimate the raw material requirements for outsole production of women's flat sandals in sizes 37–39. The forecasting results serve as the foundation for EOQ and EPQ calculations, ensuring that inventory control strategies are more accurate and aligned with future demand conditions [12].

B. Economic Order Quantity

The Economic Order Quantity (EOQ) method is one of the inventory management techniques used to determine the most economical quantity of raw materials to order [13]. EOQ seeks to balance two main components of inventory cost: the ordering cost and the holding cost [14]. Ordering in small quantities increases the frequency of purchases, thereby raising ordering costs, while ordering in large quantities increases holding costs [15]. Therefore, an optimal point must be determined to minimize the total inventory cost.

EOQ Formula:

$$EOQ = \frac{\sqrt{2.D.s}}{H}$$

- EOQ = Optimal purchase quantity (kg)
- D = Quantity of usage per period (kg/year)
- H = Ordering cost (per kg)

• S = Holding cost per unit (kg)

In addition to determining the order quantity, the EOQ concept is also related to the Reorder Point (ROP), which is the specific time at which a new order must be placed to prevent stockouts [16]. By implementing EOQ, companies can reduce total inventory costs while ensuring the availability of raw materials according to production needs [17].

C. Economic Production Quantity

The Economic Production Quantity (EPQ) method is a development of the EOQ model, used when a company produces goods gradually rather than purchasing them all at once [18]. EPQ takes into account the production rate and the level of demand, making it suitable for manufacturing companies [19].

In the EPQ model, inventory increases gradually during the production process, unlike EOQ, which assumes that inventory is replenished all at once [20]. Therefore, the optimal point is determined by considering both production capacity and the daily consumption rate [21].

III. Method

The research stages include a literature review and field study, problem formulation, variable identification, data collection, and data processing using two approaches: the company's existing method and the proposed methods (EOQ and EPQ). The analysis was carried out through the following steps:

1. Determining the order quantity and inventory costs.
2. Calculating the optimal order quantity using the EOQ method.
3. Determining the optimal production quantity using the multi-item EPQ method.
4. Creating calculation tables that include annual demand, production costs, production capacity, holding costs, and setup costs.
5. Calculating the production cycle and optimal production quantity (Q*) along with the total optimal inventory cost (TC*).
6. Comparing the results of the proposed methods with the company's method to assess cost efficiency effectiveness.

IV. Results and Discussion

A. Results Forecasting

Below are the forecasted purchases of slippers raw materials for the period August 2025 – July 2026, obtained using the Weighted Moving Average method.

Table 1. Results forecasting purchase material standard.

Period	Purchase (Pcs)
August 2025	260
September 2025	260
October 2025	260
November 2025	260
December 2025	260
January 2026	260
February 2026	260
March 2026	260
April 2026	260
May 2026	260
June 2026	260

July 2026	260
Total	**3120**

The following are the predicted sandal demands for the period August 2025 – July 2026, calculated using the Weighted Moving Average method.

Table 2. Results Forecasting Request Slippers Period August 2025 – July 2026

Period	Demand size: 37 (Pcs)	Demand size: 38 (Pcs)	Demand size: 39 (Pcs)	Total Demand (Pcs)
Aug-25	83	84	81	248
Sep- 25	83	84	81	248
Oct- 25	83	84	81	248
Nov-25	83	84	81	248
Dec- 25	83	84	81	248
Jan- 26	83	84	81	248
Feb- 26	83	84	81	248
Mar- 26	83	84	81	248
Apr- 26	83	84	81	248
May- 26	83	84	81	248
Jun- 26	83	84	81	248
Jul- 26	83	84	81	248
Total	**996**	**1008**	**972**	**2976**

B. Control Supply EOQ method

1. Economic Order Quantity (EOQ)

Using this method, the company can minimize total inventory costs while avoiding both overstocking and stockouts. The optimal order quantity is determined using the following formula:

$$EOQ = \frac{\sqrt{2.D.s}}{H}$$

Based on the collected data, the annual demand for outsole raw materials was 3,120 units, with an ordering cost of Rp 60,000 per order and a holding cost of Rp 160.6 per unit per year. By substituting these values into the formula, the optimal order quantity (EOQ) obtained is 121 units.

2. Ordering Frequency

This result indicates that each time the company places an order, it should purchase 121 units of outsole raw materials to achieve the lowest total inventory cost. With this order quantity, the ordering frequency per year is calculated as:

$$F = \frac{D}{EOQ}$$

Which yields approximately 26 orders per year. This means that orders should be placed about twice per month to maintain inventory balance.

3. *Safety Stock*

To ensure that production continues without interruptions, the companies also need to calculate Safety Stock (SS), which acts as a buffer against fluctuations in demand or delivery delays. The formula is:

$$SS = Z \times SD \times \sqrt{LT}$$

where:

- Z = Service level constant (for 90% service level, Z = 1.28)
- Elementary School = Standard deviation of demand
- LT = Lead time (in months or periods)

In this study, the standard deviation of demand (SD) was 0, and the lead time (LT) was 0.5 month. This means no additional safety stock is required because demand is stable and predictable.

4. Reorder Point

Next, the Reorder Point (ROP) the level of inventory at which a new order must be placed is calculated using the following formula:

$$ROP = (T \times LT) + SS$$

Where T is the average demand per period, LT is the lead time, and SS is the safety stock. With an average monthly demand of 260 units, a lead time of 0.5 month, and no safety stock (since demand is relatively stable), the ROP value obtained is 130 units. This means that when the remaining inventory reaches 130 units, a new order should be made to avoid material shortages.

5. Maximum Inventory

Furthermore, the maximum inventory (MI) level, which represents the highest quantity of materials stored after a new order arrives, is determined using the formula:

$$MI = EOQ + SS$$

Since safety stock is zero, the maximum inventory equals 121 units. This indicates that the highest inventory level in storage will be 121 units after each replenishment cycle.

6. Total Inventory Cost

Finally, the total inventory cost (TC) is calculated US:

$$TC = \left[\frac{D}{Q}S\right] + \left[\frac{Q}{2}H\right]$$

By substituting the relevant values, the total inventory cost for the EOQ model is IDR 1,556,824 per year. Compared to the company's previous method, this total cost is lower, proving that the EOQ model provides better efficiency and helps maintain optimal stock levels without causing overstocking or stockouts.

C. Inventory Control Usingg the EPQ Method

In addition to calculating the maximum inventory level, the company also needs to determine the Total Inventory Cost (TIC). This calculation is essential because it represents the overall costs incurred from ordering, holding, and production activities, serving as a reference in making decisions related to production efficiency.

Table 3. Total calculation *inventory cost.*

Production Size	Demand / Year (Ri)	Production Cost / Pcs (Pi)	2n	Setup / Production Cost (Ci)	2n × Ci (Rp)	Ri × Pi (Rp)
Size 37	996	1,606	4	20,000	1,040,000	1,599,576
Size 38	1,008	1,606	4	20,000	1,040,000	1,618,848
Size 39	972	1,606	4	20,000	1,040,000	1,561,032
Total					**3,120,000**	**4,779,456**

Based on the calculation results, the maximum Total Inventory Cost (TIC) obtained is IDR 7,899,456. This value represents the overall inventory cost that the company must bear to meet the slippers production requirements for one production period.

V. Conclusion

The integration of the Economic Order Quantity (EOQ) and Economic Production Quantity (EPQ) methods has been proven to reduce total inventory costs compared to the company's existing method at UD. Santoso Mojokerto. The EOQ calculation results show an optimal raw material order quantity of 121 pcs with a frequency of 26 times per year, resulting in a total inventory cost of Rp. 1,556,824. Meanwhile, the EPQ results for the three sandal sizes (37, 38, and 39) indicate optimal production quantities of 38 pcs, 39 pcs, and 38 pcs, respectively, with a production time of 9 days, a cycle time of 10 days, and a total inventory cost of Rp. 7,899,456.Thus, the integrated application of EOQ and EPQ effectively minimizes inventory costs for both raw materials and finished goods while ensuring that production capacity remains sufficient to meet demand.

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