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Sales Forecasting and Inventory Control of Turbean Coffee Raw Materials Using the Moving Average and EOQ Methods

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ABSTRACT

Turbean Coffee produces coffee beverages before customers place their orders, so production volumes must be adjusted according to changes in sales and the availability of raw materials. This study aims to select the forecasting method with the lowest error, calculate material requirements, determine ordering policies, and compare inventory costs. Sales data from January–December 2025, recipe compositions, inventory costs, and supplier lead times were used in this case study. Three variations of the Moving Average MA2, MA3, and MA4 as well as the naïve method were tested over the period May–December 2025 using MAD, MSE, and MAPE. Material requirements were calculated based on sales and recipe proportions. Order quantities, safety stock, and reorder points were calculated using Economic Order Quantity (EOQ), Safety Stock, and Reorder Point. MA2 produced the lowest MAPE of 8.44% and a steady projection of 330.50 cups per month, or 3,966 cups in 2026. Actual sales of 3,410 cups in 2025 are equivalent to a demand of 85,250 g of coffee beans, 443.30 L of milk, 17,050 g of creamer, and 34,100 mL of each type of syrup. Based on the 2026 projection, the economic order quantity for coffee beans is 23,349.07 g, with a safety stock of 188 g and a reorder point of 1,752 g. The milk order quantity of 102.91 L is equivalent to approximately 63 days of operations. In a simulation using 2025 demand, inventory costs decreased from Rp20.93 million under monthly ordering to Rp11.25 million under the EOQ scenario, a difference of 46.26%. These results indicate that MA2 can serve as the basis for production planning, and EOQ helps estimate purchase quantities. The contribution of this study is to link sales forecasts with purchasing decisions for each material, including when orders need to be placed.

Keywords: *Inventory Control, Material Requirements Planning, Lot Sizing, Period Order Quantity, Total Inventory Cost.*

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INTRODUCTION

Turbean Coffee is a coffee beverage business that sells Kopi Turbean products using a make-to-stock system, in which products are prepared before customers make a purchase. This system requires careful production planning because coffee stored for too long can lose its quality. According to company data, Turbean Coffee sales from January through December 2025 totaled 3,410 cups, averaging 284 cups per month. Sales were lowest in March at 198 cups, while the highest was in December at 376 cups. These fluctuations indicate that production needs are not always consistent from month to month. Meanwhile, raw material orders are still placed monthly based on estimates, without a precise calculation of order quantities or timing. This situation can lead to the risk of stock shortages or surpluses. However, the amount of wasted materials, instances of stockouts, and losses due to storage have not been fully documented. Therefore, data-driven sales and inventory planning is needed to ensure that production and purchasing decisions are more targeted.

Several studies have used sales data to aid in production and inventory planning. [1] and Matondang and Indriani [2] applied the Moving Average method to forecast sales of coffee and beverages. [3] explained that simple forecasting methods can still produce good forecasts without using complex models. However, [4] showed that additional information, such as promotions and special events, can help improve forecasting accuracy. These

findings indicate that forecasting methods should be selected based on data patterns and availability. For small businesses like Turbean Coffee, simple methods are easier to implement, but their accuracy still needs to be tested before they are used as the basis for production decisions.

Research on inventory control has also been extensively conducted. Pratiwi and Bernik [3] applied the Economic Order Quantity (EOQ), Safety Stock (SS), and Reorder Point (ROP) to help manage the inventory of raw materials for coffee beverages. Meanwhile, Akhtar and Herlina [5] used EOQ, Period Order Quantity (POQ), and ABC analysis to control raw materials in a coffee business. However, the economic order quantity is not necessarily suitable for all types of materials, especially perishable ones. [6] highlighted the importance of timing and order quantities for perishable materials at coffee shops in Thailand. [7] also explained that food inventory planning must account for the risk of material waste. Furthermore, [8] developed an inventory approach that takes into account product availability, order quantities, and waste. The results of their study indicate that inventory costs must be evaluated in conjunction with storage conditions and the shelf life of ingredients.

Based on these issues, this study uses the Moving Average method to forecast sales and the EOQ to calculate the order quantity for raw materials. Forecasting was performed using the MA2, MA3, MA4, and Naïve methods as comparators. The accuracy of each method was measured using Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE) [10]-[14]. Next, raw material requirements were calculated by multiplying actual sales by the recipe composition per cup. The results of the annual requirement calculations were used to determine the EOQ, SS, and ROP for five raw materials: coffee beans, milk, creamer, simple syrup, and magic sugar. The study also compared monthly ordering costs with the EOQ scenario and conducted a sensitivity analysis to determine the effect of changes in demand and costs on order quantities.

Although previous studies have addressed inventory forecasting and control, there are still gaps in their application at Turbean Coffee. First, the forecasting methods used need to be fairly compared to determine which method best fits the sales patterns. Second, raw material requirements need to be calculated based on the quantity of products sold and the recipe composition so that each ingredient has a clear basis for planning. Third, the EOQ calculation must account for the accuracy of ordering and storage costs, as some costs may be shared by more than one ingredient. Fourth, the results of the calculation must be evaluated based on shelf life and storage conditions, especially for perishable ingredients. These gaps indicate that simply calculating order quantities is not sufficient to produce an inventory policy that can be directly implemented.

The novelty of this study lies in the joint evaluation of the accuracy of sales forecasting, recipe-based raw material requirements, and the feasibility of inventory calculations for make-to-stock coffee products. Calculating material requirements based on recipes is not a new method, but it is used in this study to link sales data with the requirements for five raw materials that have different characteristics. Furthermore, this study not only calculates the EOQ, SS, and ROP but also examines cost consistency, compares ordering scenarios, and tests parameter changes through sensitivity analysis. Based on this approach, this study aims to determine the forecasting method with the smallest error, calculate annual raw material requirements based on actual sales, determine order quantities and timing using EOQ, SS, and ROP, and evaluate potential cost differences between a monthly ordering policy and the EOQ scenario. The research results are expected to serve as a foundation for Turbean Coffee in formulating more measured production and purchasing decisions, while still taking into account the limitations of cost data and the shelf life of materials.

METHOD

Research Design

This study employs an applied quantitative approach using a case study of Turbean Coffee. The subject of the study is Turbean Coffee, which is produced using a make-to-stock system. The study aims to forecast sales, determine raw material requirements based on recipe composition, calculate the economic order quantity, and evaluate safety stock, reorder points, and inventory costs.

The analysis was conducted using two approaches. The first approach used the Moving Average method to estimate finished product sales as the basis for production planning. The second approach used actual sales, converted into raw material requirements, to calculate the Economic Order Quantity (EOQ), Safety Stock (SS), and Reorder Point (ROP). Both approaches were analyzed separately because the forecasting results had not yet been used to update

raw material requirements in the EOQ model. The final stage of the study consisted of a cost comparison simulation and a sensitivity analysis to assess the initial feasibility of the inventory policy.

Data Collection

The research data was obtained from Turbean Coffee's internal records and interviews with relevant parties. The primary data includes monthly sales from January through December 2025 totaling 3,410 cups, the composition of five raw ingredients per cup, ordering costs, storage costs, and supplier lead times. Sales data was obtained through the Turbean Cafe POST app, ingredient composition from the head barista, and cost and supplier information from the financial administration department.

The available data was then checked for consistency in units, time periods, and usage in each calculation. Since daily demand records, detailed order transactions, and the shelf life of all materials were not available, several parameters were used as simulation assumptions and were not treated as operational measurement results.

Sales Forecasting and Accuracy Evaluation

Sales forecasting was performed using the Moving Average method with two, three, and four periods (MA2, MA3, MA4), as well as the naïve method for comparison. The MA3 method was the primary focus, in accordance with the initial research design [15], [16]. Forecast values were obtained by calculating the average of actual sales from a number of previous periods using Equation (1).

$$F_t = \frac{1}{k}\sum_{j=1}^{k} X_{t-j} \tag{1}$$

Note: F_t is the sales forecast for period t, X_{t-j} is the actual sales for the previous period, and k is the average number of periods. In the naïve method, the forecast for a given period is equal to the actual sales for the previous period.

The MA3 method was evaluated using one-step-ahead forecasting for April–December 2025. To ensure a fair comparison, the MA2, MA3, MA4, and naïve methods were evaluated over the same period, namely May–December 2025. Forecasting accuracy was measured using the Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE), as shown in Equation (2) [17], [18].

$$MAD = \frac{\sum_{t=1}^{n} |X_t - F_t|}{n} \tag{2}$$

$$MSE = \frac{\sum_{t=1}^{n} (X_t - F_t)^2}{n} \tag{3}$$

$$MAPE = \frac{100\%}{n}\sum_{t=1}^{n} \left|\frac{X_t - F_t}{X_t}\right| \tag{4}$$

Note: n is the number of evaluation periods. The method with the smallest error value is considered to have the best forecasting performance during the testing period. After evaluation, the MA3 is used to generate a forecast for January 2026 based on the last three months of 2025.

Raw Material Requirements

Raw material requirements are calculated based on actual sales and the recipe composition of each cup of Turbean Coffee. The five ingredients analyzed include coffee beans, milk, creamer, simple syrup, and magic sugar. The requirement for each ingredient is calculated by multiplying the actual sales volume by the ingredient measurement per cup, then summing these values to obtain the annual requirement using Equation (5).

$$D_i = \sum_{t=1}^{12} (X_t \times a_i) \tag{5}$$

Note: D_i is the annual requirement for raw material i, X_t is actual sales in month t, and a_i is the amount of material i used to produce one cup.

The results of the calculation are expressed in the units of each material, namely grams, liters, and milliliters. This annual requirement is used as the demand parameter in the EOQ calculation, while the variation in monthly requirements is used to estimate the safety stock [19].

Economic Order Quantity

The EOQ method is used to determine the order quantity for raw materials that balances ordering costs and holding costs. The calculation is performed separately for each material using annual demand, the cost per order, and the holding cost per unit per year. The economic order quantity is calculated using Equation (6).

$$EOQ_i = \sqrt{\frac{2D_iS_i}{H_i}} \tag{6}$$

Notes: EOQ_i is the economic order quantity for material i, D_i is the annual demand, S_i is the cost per order, and H_i is the holding cost per unit per year.

Safety Stock and Reorder Point

Safety stock is used to account for additional inventory during the supplier lead time. Since daily demand data is not available, demand variability is estimated based on monthly raw material requirements converted to equivalent daily usage. The calculation assumes 317 operating days per year, a 95% service level with a Z-score of 1.645, and a supplier lead time that is considered constant. The safety stock is calculated using Equation (7).

$$SS_i = Z \times \sigma_{d_i} \times \sqrt{L_i} \tag{7}$$

Notes: SS_i is the safety stock for item i, Z is the standard normal value based on the service level target, σd_i is the standard deviation of equivalent daily consumption, and L_i is the lead time in days.

Furthermore, the Reorder Point is used to determine the inventory threshold at which a reorder is necessary. The calculation takes into account the average demand during the lead time and the safety stock using Equation (8).

$$ROP_i = (d_i \times L_i) + SS_i \tag{8}$$

Note: ROP_i is the reorder point, d_i is the average daily consumption, and L_i is the supplier lead time. The SS and ROP values are rounded up to the nearest unit of raw material. The calculation results are still estimates because actual daily consumption varies and delivery time uncertainties are not yet known [20], [21].

Inventory Cost Comparison and Sensitivity Analysis

The cost evaluation was conducted by comparing two scenarios: monthly ordering 12 times per year for each material and ordering based on the EOQ. In the EOQ scenario, the order quantity is rounded up, and the final order is adjusted to match the remaining demand. Both scenarios use the same cost parameters and assume that material consumption is uniform. Total inventory costs are calculated using Equation (9).

$$TC_i = n_iS_i + \frac{H_i}{2D_i}\sum_{j=1}^{n_i} q_{ij}^2 \tag{9}$$

Explanation: TC_i is the total cost of ordering and storing item i, n_i is the number of orders per year, and q_{ij} is the quantity of the item in the jth order. This formula allows the final order quantity to be smaller than the EOQ.

RESULTS

Sales Data

Monthly sales of Turbean Coffee from January through December 2025 were used to calculate raw material requirements. The number of cups sold each month was multiplied by the recipe portion per cup to determine the requirements for coffee beans, milk, creamer, simple syrup, and magic sugar.

Table 1. Actual Sales and Raw Material Requirements for Turbean Coffee

Month	Sales (cups)	Coffee Beans (g)	Milk (L)	Creamer (g)	Amount of each type of syrup (mL)
January	217	5,425	28.21	1,085	2,170
February	204	5,100	26.52	1,020	2,040
March	198	4,950	25.74	990	1,980
April	326	8,150	42.38	1,630	3,260
May	278	6,950	36.14	1,390	2,780
June	323	8,075	41.99	1,615	3,230
July	301	7,525	39.13	1,505	3,010
August	278	6,950	36.14	1,390	2,780

September	305	7,625	39.65	1,525	3,050
October	319	7,975	41.47	1,595	3,190
November	285	7,125	37.05	1,425	2,850
December	376	9,400	48.88	1,880	3,760
Total	3,410	85,250	443.3	17,050	34,100

Sales totaled 3,410 cups throughout the year. Demand for raw materials was lowest in March, when sales totaled only 198 cups, and highest in December, when sales reached 376 cups. For example, the demand for coffee beans in December reached 9.40 kg, nearly twice the demand in March. This difference highlights the significant fluctuations in material demand that must be anticipated in monthly purchasing plans.

The MA2, MA3, MA4, and naïve methods were tested using actual sales data from the same eight-month period, namely May–December 2025. Forecast accuracy was assessed using MAD, MSE, and MAPE to determine how far the forecast results deviated from actual sales.

Table 2. Comparison of method accuracy and January sales forecasts.

Method	**MAD (cups)**	**MSE (cups^2)**	**MAPE**	**January 2026 Forecast (cups)**
MA2	26.94	1,131.84	8.44%	330.5
MA3	29.88	1,388.79	9.34%	326.67
MA4	35.53	1,876.57	11.18%	321.25
Naïve	38	1,963.00	12.02%	376

MA2 produced the lowest error across all three metrics. The MAPE for MA2 was 8.44%, which is 0.90 percentage points lower than that of MA3. Based on these test results, MA2 was selected to forecast sales for January 2026. The average sales for November and December 2025 resulted in a forecast of 330.50 cups.

Figure 2 shows the actual sales of Turbean Coffee and the forecast results using a two-period moving average (MA2). The red line begins in March 2025 because the MA2 requires two months of initial data to generate its first forecast. Indices 1–12 represent January–December 2025, while indices 13–24 show the projection for January–December 2026.

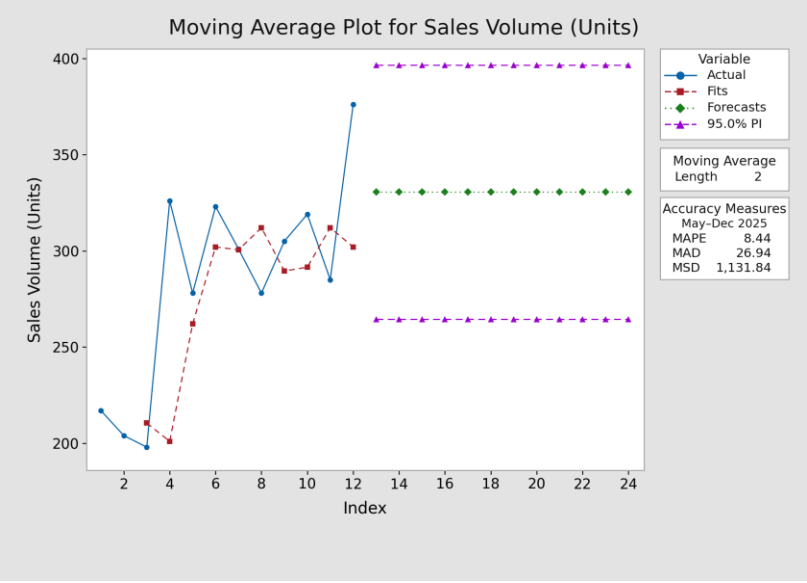

Figure 1. Moving Average MA2

The graph shows that MA2 lags behind when sales rise sharply. In April 2025, for example, sales reached 326 cups, while the forecast was only 201 cups because the calculation was based on the lower sales figures from February and March. The MAPE of 8.44% shown on the graph was calculated for the comparison period of May–December 2025. For 2026, the green line flattens out at 330.50 cups per month because the full-year projection is derived from

the average sales for November and December 2025. The purple line indicates the 95% prediction interval, illustrating the uncertainty surrounding that figure.

The shared shelving cost is calculated once and divided equally between the coffee beans and creamer group and the two types of syrup group. The cost allocation for each ingredient is then determined based on its annual demand within the group. This allocation is used as an assumption because the proportion of shelving space used by each ingredient has not yet been recorded.

Table 3. Allocation of Storage Costs And Cost Parameters Per Raw Material

Raw Material	Storage Cost Allocation (Rp/year)	Storage Cost H (Rp/unit/year)	Unit (H)
Coffee beans	9,997,857.08	117.2769	gram
Milk	13,916,480.00	31,392.92	liters
Creamer	1,999,571.42	117.2769	gram
Simple syrup	6,120,044.25	179.4734	mL
Magic sugar	5,998,714.25	175.9154	mL
Total	38,032,667.00	—	—

The annual storage cost for simple syrup is Rp179.4734 per mL, which is higher than that for magic sugar at Rp175.9154 per mL. Both ingredients have the same annual demand. The cost difference stems from the additional loss cost charged for simple syrup. Consequently, two ingredients with the same demand may have different economic order quantities.

The MA2 projection of 330.50 cups per month was used to estimate the material requirement for 3,966 cups in 2026. This requirement served as the basis for calculating the economic order quantity. The safety stock was estimated based on the variation in demand in 2025 and then added to the estimated consumption during the lead time to determine the reorder point.

Table 4. Simulation Results for EOQ, Safety Stock, and Reorder Point

Parameters	Coffee Beans (g)	Milk (L)	Creamer (g)	Simple syrup (mL)	Magic sugar (mL)
Annual demand (D)	99,150	515.58	19,830	39,660	39,660
Ordering cost (S), IDR/order per material	322,425.33	322,425.33	322,425.33	322,425.33	322,425.33
Storage cost (H), IDR/unit/year	117.2769	31,392.92	117.2769	179.4734	175.9154
EOQ per order	23,349.07	102.91	10,442.02	11,937.29	12,057.41
Waiting time (operational days)	5	3	2	3	3
Service Level Target	95%	95%	95%	95%	95%
Z-score	1.645	1.645	1.645	1.645	1.645
Average daily demand (d)	312.78	1.63	62.56	125.11	125.11
Order frequency (times/year)	5	6	2	4	4
Safety Stock (SS)	188	1	24	59	59
Reorder Point (ROP)	1,752	6	150	435	435
Operating days per year	317	317	317	317	317
Average order interval (operational days)	63.4	52.83	158.5	79.25	79.25

For coffee beans, the economical order quantity is 23,349.07 g, and a reorder is triggered when inventory reaches 1,752 g. This threshold covers estimated consumption over a five-day lead time and a 188 g safety stock. For milk, one economical order of 102.91 L is equivalent to approximately 63 days of operational needs. Therefore, when determining the order quantity for milk, it is necessary to consider its shelf life and refrigeration capacity.

Inventory costs are compared using the 2025 raw material requirements. The monthly ordering scenario assumes 12 orders per material per year. The EOQ scenario uses the economic order quantity and adjusts the final order based on the remaining annual demand. The costs considered include ordering costs and holding costs.

Table 5. Comparison of Annual Inventory Cost Simulations

Raw Materials	Monthly Ordering (Rp/year)	EOQ Ordering (IDR/year)	Simulated Cost Reduction
Coffee beans	4,285,681	2,540,377	40.72%
Milk	4,448,957	3,036,185	31.76%

Creamer	3,952,419	1,153,959	70.80%
Simple syrup	4,124,106	2,259,076	45.22%
Magic sugar	4,119,050	2,257,783	45.19%
Total	20,930,214	11,247,380	46.26%

The total simulation cost decreased from Rp20.93 million under the monthly ordering scenario to Rp11.25 million under the EOQ scenario. The difference amounted to Rp9.68 million, or 46.26%. Less frequent orders reduce ordering costs, while larger quantities of material received per delivery increase holding costs. In this simulation, the reduction in ordering costs outweighed the increase in holding costs.

The sensitivity analysis uses the base EOQ from the 2025 demand forecast. Annual demand, ordering costs, and holding costs were each tested with a 20% change. Each test varied a single parameter to determine its effect on order size.

Table 6. Sensitivity of the EOQ to Changes in Demand and Costs

Raw Materials	**Base EOQ**	**Order Quantity or Cost −20%**	**Order Quantity or Order Cost +20%**	**Holding costs −20%**	**Carrying cost +20%**
Coffee beans (g)	21,650.63	19,364.91	23,717.07	24,206.14	19,764.23
Milk (L)	95.43	85.35	104.53	106.69	87.11
Creamer (g)	9,682.46	8,660.25	10,606.60	10,825.31	8,838.83
Simple syrup (mL)	11,068.96	9,900.38	12,125.43	12,375.47	10,104.53
Magic sugar (mL)	11,180.34	10,000.00	12,247.44	12,500.00	10,206.20

In the tested scenario, a 20% reduction in storage costs resulted in the largest change: an 11.80% increase in the EOQ. For example, the order quantity for coffee beans increased from 21,650.63 g to 24,206.14 g. When holding costs rose by 20%, the order quantity for coffee beans decreased to 19,764.23 g. This pattern indicates that changes in holding costs must be taken into account when determining the quantity of materials to be ordered.

DISCUSSION

Consistent findings. MA2 produced the lowest error among the four methods tested from May to December 2025, with a MAPE of 8.44%. [7] also showed that the Moving Average can be used to forecast short-term beverage sales at Teman Cerita Cafe. The MAPE they reported was 20.59%. Both studies indicate that sales history can serve as a starting point for estimating production needs at coffee shops. From an inventory perspective, Turbean Coffee's simulation based on 2025 demand showed that the Economic Order Quantity (EOQ) reduced costs from 20.93 million IDR to 11.25 million IDR, a decrease of 46.26%. These findings are consistent with those of Pratiwi and Bernik (2025), who reported a 78.22% reduction in costs at another coffee shop after recalculating order size and frequency. The magnitude of the reduction depends on the initial policies and costs included in the calculations of each study. ejournal.marqchainstitute.or.id

Different findings. [18] obtained different results when forecasting daily sales of coffee shop beverages. ARIMA produced lower errors than the Moving Average based on MAE and RMSE. This difference is relevant because the MA2 at Turbean Coffee also lagged behind when sales surged. In April 2025, the MA2 predicted 201 cups, while sales reached 326 cups. Another difference emerged regarding purchasing policy. [10] found that smaller, more frequent orders can reduce simulation costs by 60.74% at a Thai coffee shop after accounting for wasted ingredients and potential lost sales. These findings are important for evaluating Turbean Coffee's milk EOQ result of 102.91 L per order in the 2026 projection. That amount is equivalent to approximately 63 days of operational needs, so its feasibility depends on the milk's shelf life and refrigeration capacity.

References [21] show that the benefits of more accurate forecasts on inventory performance depend on ordering policies and the magnitude of costs when products run out of stock. [23] expand the inventory assessment by taking into account shelf life, package size, product availability, and the amount of waste. Both studies provide a basis for testing the MA2 projection of 3,966 cups and Turbean Coffee's purchasing policy in a 2026 simulation. This test can

compare ordering costs and holding costs while recording stockouts and waste. Using these metrics, the feasibility of the EOQ can be assessed for each ingredient, particularly milk, which has a limited shelf life.

CONCLUSION

The two-period moving average (MA2) method produced the lowest error in the May–December 2025 test, with a MAPE of 8.44%. This method yielded a sales projection of 330.50 cups per month, or 3,966 cups for 2026. Based on actual 2025 sales and recipe measurements, raw material requirements total 85,250 g of coffee beans, 443.30 L of milk, 17,050 g of creamer, and 34,100 mL each of simple syrup and magic sugar. Based on the 2026 demand projections, the economic order quantities for these five ingredients are 23,349.07 g, 102.91 L, 10,442.02 g, 11,937.29 mL, and 12,057.41 mL, respectively. For coffee beans, the safety stock is set at 188 g, and reorders are placed when inventory reaches 1,752 g. In a simulation using 2025 demand, the inventory cost under the EOQ scenario is Rp11.25 million, which is 46.26% lower than the Rp20.93 million under the monthly ordering scenario. This cost difference depends on assumptions regarding ordering and holding costs, while determining the order quantity must take into account shelf life and storage capacity, especially for milk.

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CONFLICT OF INTEREST
The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT
This article presents the monthly sales data and the calculated inventory results. Access to the underlying sales and cost records is subject to approval from Turbean Coffee.

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DECLARATION OF AI TOOL USAGE
The authors used an AI tool solely to improve sentence structure.

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