

ANALYSIS OF CONTROL OF TEMPE RAW MATERIAL INVENTORY AT TEMPE SOJA AGROINDUSTRY IN NORTH ACEH REGENCY

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Abstract

This examination seeks to evaluate how soybean raw material inventories are handled at Agroindustri Tempe Soja, situated in North Aceh Regency, by employing the Economic Order Quantity (EOQ) method. The research took place in Paloh Lada Village, within the Dewantara District of North Aceh Regency. The data gathered was primary, collected through direct discussions with the owners and staff of the agroindustry, encompassing details on soybean needs, ordering expenses, and storage fees. The EOQ technique was utilized to find the optimal order quantity, frequency of orders, extra stock, and the overall inventory and supplementary storage expenses. Implementing the EOQ method greatly decreased total inventory costs from IDR 250,579,296 to IDR 17,597.065, leading to a financial saving of IDR 250,561,669. Thus, the EOQ approach has demonstrated effectiveness in raw material management. Consequently, it is advised that the soybean tempe agroindustry persist in using the EOQ method in a sustainable manner to maintain raw material availability and optimize production costs.

INTRODUCTION

Soybean is a strategically important food commodity in Indonesia because domestic demand continues to exceed national production. An official agricultural report citing Statistics Indonesia data reported that Indonesia's soybean production was about 555,000 tons in December 2023, whereas national demand reached approximately 2.7 million tons, indicating a persistent structural supply gap (Balai Besar Penerapan Modernisasi Pertanian Jawa Timur, 2024). The Ministry of Agriculture has also identified soybean as an important commodity in the national food system and highlighted the continuing growth in demand for soybean-based products, particularly tofu and tempeh (Kementerian Pertanian, 2020). This issue is especially important because tempe remains one of the most widely consumed soybean-based foods in Indonesia and functions as an affordable protein source with strong cultural and nutritional relevance (Romulo & Surya, 2021).

In this context, inventory planning becomes a critical operational issue for soybean-processing MSMEs. Agroindustri Tempe Soja, a home-based tempe producer in North Aceh Regency, relies on soybeans as its main raw material and procures them through weekly orders from long-term suppliers, including an imported soybean distributor. However, the order quantity is still determined manually on the basis of estimation rather than through a systematic and data-based inventory approach. For small firms, such practice is risky because inventory decisions directly affect stock availability, storage burden, cash flow, and production continuity. Recent literature has emphasized that inventory management is particularly crucial for SMEs because they operate under tighter constraints in working capital, storage capacity, and exposure to stockout risk (Panigrahi et al., 2024).

Despite the importance of soybean availability for tempe production, empirical studies that specifically examine raw-material inventory planning in household-scale tempe agroindustries remain limited, particularly under routine weekly procurement and supplier-dependent sourcing arrangements. Existing studies have more strongly emphasized tempe as a traditional fermented

food with nutritional and cultural value (Romulo & Surya, 2021), while inventory-management studies have largely discussed SMEs at a broader level (Panigrahi et al., 2024). This suggests a gap between the practical need for analytical inventory planning in small tempe enterprises and the limited empirical attention given to this specific operational setting. Accordingly, this study addresses that gap by focusing on a home-industry tempe producer whose production sustainability depends on recurring soybean procurement decisions. The novelty of this study lies in linking the macro-level problem of Indonesia's soybean supply dependence with the micro-level challenge of inventory decision-making in a small-scale tempe enterprise, thereby providing a more grounded basis for improving production continuity and cost efficiency in soybean-processing MSMEs.

METHODS

This study was conducted at Agroindustri Tempe Soja, located in Gampong Paloh Lada, Dewantara District, North Aceh Regency, Indonesia. The study employed a quantitative case-study approach because the enterprise represents a household-scale tempe agroindustry whose production continuity depends heavily on the availability of soybean as the main raw material. This approach was considered appropriate for examining actual inventory practices and for formulating a more efficient raw-material planning basis under routine procurement conditions.

The study used primary data collected through direct interviews with the business owner and employees involved in procurement and production activities. The main data required for the analysis included soybean demand, ordering cost, and holding cost. Supporting data related to procurement frequency, lead time, and inventory conditions were also collected to calculate safety stock, reorder point, and maximum inventory. Because Agroindustri Tempe Soja procures soybeans on a weekly basis, actual usage data were first identified from operational records and then converted into annual demand to fit the requirements of the EOQ model.

To address the research objective, this study applied the Economic Order Quantity (EOQ) method. EOQ is a classical inventory-control model used to determine the optimal order quantity by minimizing the trade-off between ordering cost and holding cost (Harris, 1913; Herjanto, 2015). This method was selected because the main problem faced by Agroindustri Tempe Soja lies in determining soybean order quantities that are still based on estimation rather than systematic calculation. In the context of SMEs and agroindustries, inventory management is particularly important because it directly affects cost efficiency, storage burden, and production continuity (Panigrahi et al., 2024). Previous studies on food and soybean-based agroindustries have also shown that EOQ can be applied to determine optimal order quantity, safety stock, reorder point, and total inventory cost more efficiently (Dania et al., 2005; Efendi et al., 2019).

The optimal order quantity was calculated using the following formula:

EOQ formula:

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Description:

- D = Annual Demand
- S = Ordering Cost Per Order
- H = Storage Cost Per Unit Per Year

To estimate the total inventory cost under the EOQ policy, the following formula was used:

$$TIC = \left(\frac{D}{Q}\right) S + \left(\frac{Q}{2}\right) H$$

where:

TIC = total inventory cost

Q = order quantity

where D denotes annual soybean demand, S denotes ordering cost per order, and H denotes holding cost per unit per year.

Furthermore, the study calculated safety stock, reorder point, and maximum inventory level to complement the EOQ results. Safety stock was estimated to protect the enterprise against uncertainty in consumption and delivery time. Reorder point indicated the inventory threshold at which a new soybean order should be placed, whereas maximum inventory represented the sum of EOQ and safety stock after replenishment. These indicators were used to develop a more reliable raw-material inventory policy capable of supporting production continuity and improving cost efficiency in Agroindustri Tempe Soja.

RESULTS AND DISCUSSION

Result

Based on interviews with the owner of Agroindustri Tempe Soja, it is known that during the period January 2025-December 2025, Agroindustri Tempe Soja ordered raw materials four times each month with an average monthly quantity of 4,128.33 kilograms (kg) of soybeans. The data obtained from Agroindustri Tempe Soja can be seen in the following table.

Table 1. Total Frequency of Raw Material Orders for Tempe Soja Agroindustry

Number	Month	Ordering Frequency	OderQuantity (Kg)
1.	Januari	4	3.000
2.	Febuary	4	4.500
3.	March	4	3.900
4.	April	4	4.050
5.	May	4	3.300
6.	Juni	4	4.200
7.	July	4	3.600
8.	Agust	4	4.350
9.	September	4	4.500
10.	October	4	4.760
11.	November	4	4.580
12.	December	4	4.800
Total		48	49.540
Average		4	4.128,33

Source: Tempe Soja Agroindustry 2025

Based on Table 1 above, it is known that the number of soybean orders placed by Agroindustri Tempe Soja for the period January 2025-December 2025 is 48 times per year. Meanwhile, the total order is 49,540 kg per year, with an average order per month of 4,128.33 kg.

In the interview, phone credit and SMS (Short Message Service) are elements of the ordering costs for communicating with suppliers. Shipping and transportation costs are borne by the supplier, so Agroindustri Tempe Soja does not incur any costs. The following ordering costs at Agroindustri Tempe Soja can be seen in Table 2 below.

Table 2. Types of Costs for Ordering Raw Materials for Tempe Soja Agroindustry

No	Cost Type	Total
1.	Telephone cost	Rp.600.000
Total		Rp.600.000

Source: Tempe Soja Agroindustry 2025

Based on Table 2, it is known that the cost of soybean orders made by Agroindustri Tempe Soja for one year is Rp. 600,000.

Table 3. Raw Material Order Costs for Agroindustri Tempe Soja per Order.

No	Ordering Cost	Ordering Frequensy Pemesanan	Ordering Cost per Order
1.	Rp.600.000	48	12.500

Source: Tempe Soja Agroindustry 2025

Based on Table 3, it is known that the ordering cost per order at Agroindustri Tempe Soja is Rp. 12,500. This result is obtained from dividing the ordering cost by the frequency of orders during 12 months.

Table 4. Total Storage Costs for Tempe Soja Agroindustry Raw Materials

No	Cost Type	Total
1.	Electricit cost	Rp.3.000.000
Total		Rp.3.000.000

Source: Tempe Soja Agroindustry 2025

Based on Table 4, it can be seen that the total cost of storing soybean raw materials is Rp. 3,000,000, which is used for electricity costs at Agroindustri Tempe Soja.

Table 5. Storage Cost Data per Kg of Soybeans in 2025

No	Soybean Usage (Kg)	Ordering Cost	Holding Cost per Kg
1.	49.540	Rp.600.000	60,557

Source: Tempe Soja Agroindustry 2025

Based on Table 5, it can be seen that the storage cost per kg of soybean raw material at the Tempe Soja Agroindustry from January 2025 to December 2025 is Rp.60,557. This result is obtained by dividing the total storage cost by the total soybean raw material usage for one year.

Inventory Analysis using Economic Order Quantity (EOQ) Technique

Table 6. Soybean Consumption, Ordering Cost per Kg, and Storage Cost per Kg for Agroindustri Tempe Soja

No	Soybean Usage	Ordering Cost per Order	Holding Cost / Kg
1.	49.540	Rp. 12.500	Rp.60,557

Source: Tempe Soja Agroindustry 2025

Based on Table 6, it is known that from January 2025 to December 2025, the amount of soybean raw material used by Agroindustri Tempe Soja is 49,540 kg, the ordering cost is Rp. 12,500, and the storage cost per kg is Rp. 60,557. After obtaining the data, the next step is to calculate the order quantity using the EOQ technique and the appropriate frequency calculation. The calculation is as follows:

$$\begin{aligned}
 EOQ &= \sqrt{\frac{2 \cdot D \cdot S}{H}} \\
 &= \sqrt{\frac{2 \cdot 49.540 \cdot 12.500}{60,557}} \\
 &= \sqrt{1.238.500.000} \\
 &= 35.192,328
 \end{aligned}$$

Based on Table 6, it is known that from January 2025 to December 2025, the amount of soybean raw material used by Agroindustri Tempe Soja is 49,540 kg, the ordering cost is Rp. 12,500, and the storage cost per kg is Rp. 60,557. After obtaining the data, the next step is to calculate the order quantity using the EOQ technique and the appropriate frequency calculation. The calculation is as follows:

From the calculation results, the optimal order quantity for January 2025-December 2025 is 35,192.328 kg for each order. Meanwhile, the required order frequency can be calculated as

follows.

$$\begin{aligned} \text{Order frequency} &= \frac{\text{Pemakaian Kedelai per tahun}}{\text{EOQ}} \\ &= \frac{49.540}{35.192,328} \\ &= 1,407 \end{aligned}$$

Based on the above calculations, the number of soybean orders for each order is 35,192.328 kg with an order frequency of 1 time. The following is a table of analysis results at Agroindustri Tempe Soja.

Table. 7 Optimal Order Quantity and Frequency According to the Economic Order Quantity (EOQ) Method

No	Tahun	Kuantitas Per Pesanan (Kg)	Frekuensi (Kali)
1.	2025	35.192,328	1

Source: Tempe Soja Agroindustry 2025

Based on the data in Table 7, it is known that the optimal soybean order for Agroindustri Tempe Soja from January 2025 to December 2025 is 35,192.328 kg, while the purchase frequency is calculated using the EOQ technique from January 2025 to December 2025 as 1 time.

Safety Stock

No.	Mount	X	Y	(X-Y)	(X-Y) ²
1.	Januari	3.000		-1.128,33	1.273.128,588
2.	Febuari	4.500		371,67	138.138,588
3.	Maret	3.900		-227,33	51.678,928
4.	April	4.050		-78,33	6.135,588
5.	Mei	3.300		-828,33	686.130,588
6.	Juni	4.200		71,67	5.136,588
7.	Juli	3.600	4.128,33	-528,33	279.132,588
8.	Agustus	4.350		221,67	49.137,588
9.	September	4.500		371,67	138.138,588
10.	Oktober	4.760		631,67	399.006,988
11.	November	4.580		451,67	204.005,788
12.	Desember	4.800		671,67	451.140,588
Total		49.540		1,04	3.274.910,99

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Source: Tempe Soja Agroindustry 2025

Explanation:

X = Monthly usage

Y = Average monthly usage

Based on the standard deviation table with the amount of data obtained, the standard deviation for that year can be calculated and found using the following calculation:

$$\begin{aligned}\sigma &= \sqrt{\frac{\sum (x-y)^2}{n}} \\ &= \sqrt{\frac{3.274.910,996}{12}} \\ &= \sqrt{272.909} \\ &= 522,4\end{aligned}$$

After obtaining the standard deviation value, the safety stock value can then be calculated.

Where the Z value or standard normal deviation is 5% with the following calculation:

$$\begin{aligned}SS &= Z \times \sigma \\ &= 1,65 \times 522,4 \\ &= 861,96\end{aligned}$$

From the above calculation, it is known that the optimal safety stock for soybeans in tempeh at Agroindustri Tempe Soja in North Aceh Regency is 861.96.

Total Inventory Cost

The main purpose of calculating total inventory cost using the Economic Order Quantity (EOQ) method is to determine the amount of raw materials to order that will result in the lowest inventory cost. The formula used to calculate total inventory cost is as follows:

a) Total Inventory Cost Economic Order Quantity (EOQ)

$$\begin{aligned}TIC &= \frac{D}{Q^*}S + \frac{Q^*}{2}H \\ &= \frac{49.540}{35.192,328^*}12.500 + \frac{35.192,328^*}{2}60,557 \\ &= \text{RP. } 17.596 + 1.065,570 \\ &= \text{RP. } 17.597,065\end{aligned}$$

Meanwhile, the calculation of total inventory costs used by agroindustry is as follows:

b) Total Inventory Cost according to agroindustry

$$\begin{aligned}TIC &= (\text{Order Frequency} \times \text{Cost per Order}) + (\text{Average Inventory} \times \text{Storage Cost per Kg}) \\ &= (48 \times 12.500) + (4.128 \times 60.557) \\ &= \text{Rp } 250.579.296\end{aligned}$$

Discussion

The findings indicate that the existing soybean procurement practice at Agroindustri Tempe Soja was operationally convenient but economically inefficient. Before the EOQ model was applied, soybean purchasing was carried out 48 times per year under a weekly ordering pattern. After EOQ was introduced, the optimal policy pointed to a much lower ordering frequency, indicating that the firm had previously relied on excessive order repetition rather than cost-based planning. This result is important because inventory management in SMEs is not merely an administrative routine; it directly affects cash flow, storage pressure, and exposure to stockout risk. Prior studies have similarly shown that EOQ-based inventory control can improve ordering efficiency and support better decisions on safety stock, reorder point, and total inventory cost in food-processing businesses (Hidayat et al., 2019; Panigrahi et al., 2024; Wahyuni et al., 2024; Amri et al., 2024; Robbani et al., 2025; Safa'at & Zebua, 2024).

The practical weakness of the previous system lies in the fact that Agroindustri Tempe Soja reordered soybean only after the existing stock had been exhausted, while no formal safety stock

and reorder point were maintained. Such a policy may function under stable conditions, but it becomes highly vulnerable when demand fluctuates or when procurement lead time changes unexpectedly. For a tempe-producing enterprise, this risk is particularly critical because soybean is the core raw material of a staple fermented food that is widely consumed in Indonesia (Romulo & Surya, 2021). From an inventory-management perspective, buffer inventory is not simply an additional stock burden; it is a protective mechanism against supply-side and demand-side uncertainty (Guo et al., 2025). Recent SME studies also suggest that the benefits of lean inventory are contingent rather than absolute: inventory reduction can improve performance, but overly lean systems may become fragile when firms face shocks, operational volatility, or limited managerial capability (Liu et al., 2024; Lefebvre, 2025). Therefore, the estimated safety stock of 861.96 kg should be interpreted as a managerial safeguard that increases production reliability rather than as idle inventory. In this sense, the contribution of EOQ in the present study is not limited to identifying an optimal order size; it also establishes a more disciplined inventory policy through the simultaneous use of safety stock and reorder point. cost implications are even more decisive. The total inventory cost under the firm's existing policy reached Rp 250,579,296, whereas the EOQ-based policy reduced this amount to Rp 17,597,065. Based on these figures, the potential cost saving is Rp 232,982,231. This substantial gap confirms that the former procurement system imposed an unnecessarily high inventory burden, most likely because of frequent small-lot purchases and the absence of a cost-minimizing decision rule. Nevertheless, the finding that EOQ reduces purchasing frequency to once per year should be interpreted with caution. A mathematically optimal EOQ does not automatically translate into a fully feasible operational policy, particularly for a household-scale agroindustry facing limitations in warehouse capacity, working capital, and raw-material quality preservation. Recent evidence further indicates that inventory performance depends not only on order-size optimization but also on the firm's broader managerial and organizational capabilities, including its ability to align inventory practices with lean operations and digital decision support (Fang et al., 2024; Liu et al., 2024; Lefebvre, 2025). Thus, the EOQ result in this study should be viewed as a strategic benchmark for improving procurement efficiency, while its implementation may still need adjustment to the actual capabilities of the enterprise. In all, this study demonstrates that EOQ is valuable not only as a cost-reduction tool but also as a decision-support mechanism for strengthening inventory governance in small-scale agroindustries. The managerial implication is clear: Agroindustri Tempe Soja should move away from intuition-based weekly purchasing and adopt a structured inventory policy that integrates optimal order quantity, safety stock, and reorder point. By doing so, the firm can reduce avoidable inventory costs while simultaneously improving production continuity. More broadly, the study contributes to the discussion on SME inventory management by showing how a classical inventory model remains highly relevant when applied to a resource-constrained tempe enterprise operating under raw-material dependence and procurement uncertainty. This implication is reinforced by recent work showing that SME inventory outcomes improve when quantitative control is combined with stronger operational discipline, context-sensitive lean practices, and more systematic managerial routines (Panigrahi et al., 2024; Fang et al., 2024; Liu et al., 2024).

CONCLUSION

This study demonstrates that soybean inventory management at Agroindustri Tempe Soja was previously handled through a routine ordering practice that was operationally simple but economically inefficient. The application of the Economic Order Quantity (EOQ) method provided a more rational basis for raw-material planning by identifying an optimal order quantity, establishing a safety stock level, and determining the reorder point required to maintain production

continuity. The results show that the existing procurement policy, which relied on frequent weekly purchases and did not apply formal safety stock, exposed the enterprise to unnecessary inventory costs and a higher risk of stock shortages. The EOQ analysis indicates that soybean procurement can be managed more efficiently through a lower ordering frequency and a more structured inventory policy. The estimated safety stock of 861.96 kg further suggests that Agroindustri Tempe Soja needs a buffer inventory to protect production against uncertainty in demand and lead time. In addition, the total inventory cost under the firm's existing policy was substantially higher than under the EOQ-based policy, confirming that the current procurement system had not yet achieved cost efficiency. These findings imply that the adoption of EOQ can improve not only cost control but also the overall reliability of raw-material management in household-scale tempe agroindustries. From a managerial perspective, this study suggests that Agroindustri Tempe Soja should move away from intuition-based weekly ordering and adopt a more systematic inventory-planning approach that integrates optimal order quantity, safety stock, and reorder point. However, the practical implementation of the EOQ recommendation should still consider the enterprise's actual constraints, particularly storage capacity, working capital, and soybean quality preservation during longer holding periods. Therefore, the EOQ result should be interpreted as a strategic benchmark for improving procurement efficiency rather than as a rigid operational rule.

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