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Digital-Based Soybean Raw Material Inventory Optimization Using Economic Order Quantity, Safety Stock, and Reorder Point Methods at Tofu MSME CV XYZ

Nuriyanti Arifiyah [a], Emon Rifa'i [a], Cristina Beatrice Mallari [b]

[a]Department of Industrial Engineering, University of KH. Bahaudin mudhary Madura, Sumenep, Indonesia
[b]Faculty of Industrial and Systems Engineering, De La Salle University, Manila, Philippines

A B S T R A C T

Raw material inventory control that ignores actual demand patterns may cause overstocking, stockouts, emergency purchases, and higher operating costs. This study aims to determine the economic order quantity, ordering frequency, safety stock, dynamic reorder point, and relevant soybean inventory costs, and to design a digital inventory control system for Tofu MSME CV XYZ. A quantitative descriptive case-study approach was applied using annual demand of 166,320 kg, an ordering cost of IDR 100,000 per order, a holding cost of IDR 1,600 per kg per year, a two-day lead time, 324 production days, daily demand observations, and monthly and seasonal demand patterns. The results show an EOQ of 4,559.61 kg, rounded to 4,560 kg per order, with 36–37 orders per year and an average interval of 8.88 production days. At a 95% service level, safety stock is 50 kg. The baseline reorder point is 1,077 kg, while the dynamic monthly reorder point ranges from 1,010 to 1,190 kg and reaches 1,210 kg under peak holiday demand. The total relevant inventory cost is IDR 7,375,368 per year. The proposed digital inventory system integrates transaction records, automatic balance updates, monthly reorder points, and safe, reorder, and critical stock alerts. The integrated policy is more economical, measurable, and responsive to seasonal demand variation.

Keywords: Digital inventory, Economic order quantity, Reorder point, Safety stock, Soybean.

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1. Introduction

Raw material inventory plays a strategic role in maintaining production continuity. Adequate material availability enables a company to follow its production schedule and meet customer demand. However, excessive inventory increases holding costs, ties up working capital, and raises the risk of deterioration, whereas insufficient inventory can lead to stockouts, emergency purchases, and production interruptions. This issue is particularly important for micro, small, and medium enterprises (MSMEs), where raw material purchasing decisions are often based on the owner's experience, demand estimates, and physical stock checks. An unstructured control system makes it difficult to determine order quantity, ordering time, minimum stock, and inventory costs. Prior studies indicate that MSME inventory policies are frequently influenced by estimates and industry practice, highlighting the need for a more data-driven system [1].

Tofu MSME CV XYZ uses soybeans as its primary raw material. Annual soybean demand reaches 166,320 kg, with an average of 13,860 kg per month. At a purchase price of IDR 8,000 per kg, annual soybean purchases amount to IDR 1,330,560,000. This value indicates that improper inventory decisions may have substantial financial consequences for the enterprise.

The receipt, usage, and balance of soybean inventory at CV XYZ are still recorded manually. Consequently, stock information is not always available promptly, and the system is prone to delayed entries, calculation errors, missing records, and discrepancies between physical and recorded stock. The manual system also does not provide an automatic alert when inventory reaches a reorder threshold. Soybean demand at CV XYZ is not constant. Data from 27 production days show daily usage ranging from 460 to 540 kg, with an average of 500 kg and a standard deviation of 21.21 kg. On a monthly scale, demand ranges from 12,960 to 15,390 kg, while quarterly demand ranges from 39,690 to 43,200 kg. Demand increases during busy weekends, celebration seasons, and major holidays.

Demand uncertainty affects service levels and inventory cost efficiency [2]. Economic Order Quantity (EOQ) can determine the order size that balances ordering and holding costs. Previous studies in tofu and soybean-processing businesses have shown that EOQ can provide a more economical and systematic purchasing policy [3-6].

* *Corresponding author.* Phone :
E-mail address: nuriyanti@unibamadura.ac.id.

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EOQ alone does not directly address demand variation during lead time. Therefore, safety stock and a reorder point (ROP) are required. Safety stock protects the company from short-term demand uncertainty, while ROP determines when a replenishment order should be placed [7-10].

Using one fixed ROP throughout the year is less appropriate when demand changes seasonally. An ROP based on annual average demand may be unnecessarily high during low-demand periods and too low during peak periods. Therefore, this study develops a dynamic ROP based on the average daily demand of each month.

Digitalization provides an opportunity to connect inventory calculations with daily operations. A simple digital system can record receipts and usage, update stock balances, track outstanding orders, and issue alerts when the inventory position reaches the active ROP. Digital technology has been associated with improved inventory efficiency, particularly among small and medium-sized firms [11].

The research gap lies in the limited number of soybean inventory studies that simultaneously incorporate daily, monthly, quarterly, and seasonal demand variation; apply a dynamic ROP; and translate EOQ, safety stock, and ROP values into operational parameters for a digital inventory system. This study aims to determine the EOQ, ordering frequency and interval, safety stock, baseline and dynamic ROP, relevant inventory costs, and a digital inventory control design for Tofu MSME CV XYZ.

2. Literature Review

2.1. Inventory management

Inventory management includes planning, procurement, storage, utilization, and control of materials so that they are available in the required quantity and at the right time. Its main objective is to maintain production continuity while controlling total inventory costs.

2.2. Economic order quantity

EOQ is the order quantity that minimizes the combined annual ordering cost and cycle-stock holding cost. The basic model assumes known annual demand, constant ordering and holding costs, instantaneous replenishment, and no quantity discounts.

$$Q^* = \sqrt{\frac{2DS}{H}} \quad (1)$$

Q* denotes the economic order quantity, D annual demand, S ordering cost per order, and H annual holding cost per kilogram.

2.3. Safety stock and reorder point

With a constant lead time and uncertainty originating from daily demand, safety stock is calculated from the standard deviation of demand during lead time. At a 95% service level, this study uses Z = 1.645.

$$SS = Z_s d\sqrt{L} \quad (2)$$

$$ROP = (d.L) + SS \quad (3)$$

For seasonal demand, the dynamic ROP is calculated using the average daily demand of each month. ROP is applied to the inventory position, defined as on-hand stock plus outstanding orders minus backorders.

2.4. Digital inventory

A digital inventory system records transactions, updates balances, stores usage history, and provides an alert when the inventory position reaches a specified threshold. In this study, the digital design integrates EOQ, safety stock, monthly ROP, and inventory-status notifications.

3. 3. Research method

3.1. Research design and data

This study applies a quantitative descriptive approach with a case-study design at Tofu MSME CV XYZ. Data were obtained through documentation, observation, interviews, and records of daily, monthly, and seasonal soybean requirements. The analysis used annual demand of 166,320 kg, an ordering cost of IDR 100,000 per order, a holding cost of IDR 1,600 per kg per year, a two-day lead time, 324 production days per year, and a 95% service level.

Table 1. Inventory Parameter.

Parameter	Value
Annual demand	166,320 kg
Average monthly demand	13,860 kg
Production days	324 days/year
Soybean price	IDR 8,000/kg
Ordering cost	IDR 100,000/order
Holding cost	IDR 1,600/kg/year
Lead time	2 days
Service level	95%
Recording system	Manual

3.2. Analysis procedure

The analysis consisted of: (1) validating annual demand and seasonal patterns; (2) calculating the mean and standard deviation of daily demand; (3) calculating EOQ, ordering frequency, and ordering interval; (4) determining safety stock; (5) calculating the baseline and monthly dynamic ROP; (6) calculating relevant inventory costs; and (7) designing a digital inventory control system.

Monthly variation was used to determine lead-time demand for each month, whereas the standard deviation of daily demand was used to calculate safety stock. This separation avoids double-counting seasonal variation in both the monthly ROP and safety stock.

3.3. Monthly and seasonal demand

Table 2. Monthly soybean requirement.

Month	Daily	Monthly
January	480 kg	12,960 kg
February	490 kg	13,230 kg
March	520 kg	14,040 kg
April	560 kg	15,120 kg
May	510 kg	13,770 kg
June	530 kg	14,310 kg
July	500 kg	13,500 kg
August	490 kg	13,230 kg
September	480 kg	12,960 kg
October	510 kg	13,770 kg
November	520 kg	14,040 kg
December	570 kg	15,390 kg

Table 3. Demand by operating condition.

Condition	Daily demand
Normal day	500 kg
Busy weekend	530 kg
Celebration season	550 kg
Before major holiday	560 kg
Holiday peak	580 kg

4. Result and Discussion

4.1. Demand Pattern

Annual soybean demand totals 166,320 kg, equivalent to an average of 513.33 kg per production day. The lowest monthly requirement is 12,960 kg and the highest is 15,390 kg, a difference of 2,430 kg or 18.75%. Quarterly demand is lowest in Quarter III at 39,690 kg and highest in Quarters II and IV at 43,200 kg.

4.2. EOQ, frequency, and interval

The EOQ resulted by using equation 1 is 4,559.61 kg. The operational order quantity is rounded to 4,560 kg per order. Ordering frequency is 166,320/4,559.61 = 36.48 orders per year, or approximately 36–37 orders. The average interval is 324/36.48 = 8.88 production days, or about nine days.

4.3. Safety stock and reorder point

The result of the SS calculation using formula (2) is 49.35 kg, approximate to 50. Meanwhile, the result of the ROP base calculation using formula (3) is 1,076.66 or 1,077 kg. The dynamic ROP is calculated using the daily demand of each month. The lowest value is 1,010 kg in January and September, while the highest is 1,190 kg in December. Under peak major-holiday demand of 580 kg per day, the situational ROP rises to 1,210 kg.

Table 4. Dynamic monthly reorder points 2024.

Month	Daily demand	ROP
January	480 kg	1,010 kg
February	490 kg	1,030 kg
March	520 kg	1,090 kg
April	560 kg	1,170 kg
May	510 kg	1,070 kg
June	530 kg	1,110 kg
July	500 kg	1,050 kg
August	490 kg	1,030 kg
September	480 kg	1,010 kg
October	510 kg	1,070 kg
November	520 kg	1,090 kg
December	570 kg	1,190 kg

4.4. Inventory costs

Annual ordering cost is IDR 3,647,684, and cycle-stock holding cost is also IDR 3,647,684. Safety-stock holding cost is IDR 80,000. Therefore, the total relevant inventory cost is IDR 7,375,368 per year. Including annual soybean purchases of IDR 1,330,560,000, total soybean-related expenditure is IDR 1,337,935,368 per year.

Table 5. Proposed inventory policy.

Indicator	Result
EOQ	4,560 kg/order
Order frequency	36–37 orders/year
Average interval	8.88 days
Safety stock	50 kg
Base ROP	1,077 kg
Dynamic ROP	1,010–1,190 kg
Peak-condition ROP	1,210 kg
Maximum inventory	4,609.61 kg
Average inventory	2,329.81 kg
Relevant inventory cost	IDR 7,375,368/year

4.5. Digital inventory system design

The digital system is designed to replace manual bookkeeping and connect the analytical results with daily operations. Key data fields include date, transaction number, transaction type, opening stock, receipts, usage, closing stock, outstanding orders, inventory position, active ROP, supplier, order date, receipt date, actual lead time, and stock status.

Status is classified as safe when the inventory position exceeds the active ROP; reorder when the inventory position is above safety stock but not

higher than the active ROP; and critical when the inventory position is at or below 50 kg.

The proposed workflow is: enter opening stock, record daily usage, update the balance, identify the month or special demand condition, activate the appropriate ROP, check the inventory position, issue a reorder alert, place an order of approximately 4,560 kg, record the outstanding order, receive the material, and update the stock balance and actual lead time.

Table 6. Digital inventory status logistic.

Inventory position	Status	Action
IP > active ROP	Safe	Normal operation
50 kg < IP ⩽ active ROP	Reorder	Order approximately 4,560 kg
IP ⩽ 50 kg	Critical	Expedite delivery or emergency purchase

Similar study identifies an annual soybean requirement of 166,320 kg with significant monthly variability, ranging from 1,010 to 1,190 kg and reaching 1,210 kg during peak holiday periods. By applying the Economic Order Quantity (EOQ) method, the optimal order quantity is set at 4,560 kg per order, resulting in an ordering frequency of approximately 3,637 times per year or every 8.88 days. To anticipate demand uncertainty, a safety stock of 50 kg with a 95% service level has been calculated, complemented by a dynamic Reorder Point (ROP) system to accommodate monthly demand fluctuations. The total relevant annual inventory cost is estimated at IDR 7,375,368, highlighting the importance of efficiency. These findings are consistent with various similar studies demonstrating the effectiveness of EOQ, ROP, and safety stock methods in reducing inventory costs and preventing stockouts or overstocking in MSMEs [16-20] achieved inventory cost savings of up to IDR 13,422,389.18 through the application of these methods. This research's approach to handling dynamic demand and its proposed digital inventory control system also align with modern trends in supply chain management, as shown by the integration of EOQ with ARIMA forecasting in a web-based system that successfully reduced inventory costs by 22.73% 8. Furthermore, the focus on specific raw materials like soybeans, chicken/shrimp [21], or soybeans in a tofu factory [22] emphasizes the relevance of this model across various agro-industrial and food processing sectors, including tempeh and tofu production [23-25]. Thus, the implementation of this systematic inventory management protocol not only enhances the operational efficiency of CV XYZ but also provides practical contributions to the management of volatile raw material inventories.

4.6. Implications of demand variability

The increase in monthly demand from 12,960 to 15,390 kg indicates that one ROP value is insufficient for the entire year. The annual baseline ROP of 1,077 kg may trigger ordering too early in low-demand months and too late during high-demand months. A dynamic ROP therefore provides a more appropriate replenishment trigger.

4.7. Economic order quantity and cost balance

The EOQ of 4,559.61 kg is equivalent to approximately 8.88 days of average demand and is consistent with the calculated ordering interval. At this quantity, annual ordering cost and cycle-stock holding cost are balanced at IDR 3,647,684 each. Differences between this result and previous studies arise from differences in annual demand, ordering cost, and holding cost [26-29].

4.8. Safety stock and dynamic ROP

Safety stock of 50 kg is derived from short-term daily variation, while seasonal variation is incorporated through monthly average demand in the dynamic ROP. This separation prevents seasonal risk from being counted twice. The safety-stock value remains valid only when the two-day lead time is stable; if lead time varies, its variability should also be included in the calculation [30].

4.9. Digital contribution

Digitalization is not merely a recording medium but a mechanism to ensure that monthly ROP values are applied consistently. The system can automatically change the active ROP according to the month and can switch to a special-demand mode during celebrations or major holidays. Digital records also provide historical data for evaluating service levels, supplier lead-time performance, emergency purchases, and future parameter updates.

4.10. Managerial implications and limitations

CV XYZ is advised to set a standard order quantity of approximately 4,560 kg, use ROP as the primary replenishment trigger, maintain safety stock of 50 kg, provide warehouse capacity of at least 4,610 kg, record outstanding orders, and review all parameters at least annually.

This study is limited by the use of 27 daily observations, the assumption of a constant lead time, and a digital system that has not yet been evaluated through a before-and-after implementation study. Future research should use at least 12 months of daily data, incorporate lead-time variability and stockout costs, and test the digital prototype operationally.

5. Conclusion

Soybean demand at CV XYZ totals 166,320 kg per year and fluctuates on both daily and seasonal bases. With an ordering cost of IDR 100,000 per order and a holding cost of IDR 1,600 per kg per year, the EOQ is 4,559.61 kg, operationally rounded to 4,560 kg per order. The recommended ordering frequency is approximately 36–37 times per year, with an average interval of 8.88 production days. At a 95% service level and a two-day lead time, safety stock is 50 kg. The baseline ROP is 1,077 kg, while the dynamic monthly ROP ranges from 1,010 to 1,190 kg and reaches 1,210 kg under peak major-holiday demand. The total relevant inventory cost is IDR 7,375,368 per year.

The proposed digital system integrates material transactions, inventory position, monthly ROP, and automatic status alerts. Integrating EOQ, safety stock, dynamic ROP, and digital recording produces a more economical, measurable, and seasonally adaptive soybean inventory policy for CV XYZ.

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