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Optimizing Inventory Control in Rural MSME an Integrated Application of EOQ, Reorder Point and Safety Stock

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Abstract—
Micro, Small, and Medium Enterprises (MSMEs) play a pivotal role in Indonesia's economy; however, many rural MSMEs continue to rely on intuitive and informal inventory practices, resulting in inefficiencies, elevated costs, and production disruptions. This paper presents an integrated framework for optimizing inventory management in rural MSMEs through the combined application of Economic Order Quantity (EOQ), Reorder Point (ROP), and Safety Stock methods. Employing a descriptive quantitative design, the study was conducted at the Sri Tanjung Cracker Factory in Indramayu using primary data from interviews and direct observations, complemented by secondary data from purchase and inventory records. The empirical findings reveal that implementing EOQ reduced total annual inventory costs from Rp 91,689,449 to Rp 43,360,000 (a 52.7% reduction), while the calculation of ROP and Safety Stock ensured more reliable and consistent raw material availability. This integrated approach demonstrates significant potential to enhance cost efficiency, improve operational stability, and support evidence-based decision-making, thereby establishing a scalable model for sustainable inventory management in rural MSMEs.

Keywords— Inventory Control; Economic Order Quantity; Reorder Point; Safety Stock; Rural MSMEs

I. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are widely recognized as the backbone of Indonesia's economy. According to data from the Ministry of Economic Affairs of the Republic of Indonesia (2023), they contribute 61.9% to the national GDP and employ 97% of the total workforce. This substantial contribution underscores their critical role in driving economic growth, reducing unemployment, and fostering equitable development across the archipelago.

Given their extensive reach, particularly in rural areas, operational efficiency within these businesses is a crucial issue for the national economy.

Despite their vital economic role, many MSMEs face significant challenges in inventory management, which substantially hinder their stability and growth. Two common and critical issues are excess inventory and raw material shortages. Excess inventory can severely complicate financial management by tying up working capital that could otherwise be used for critical activities such as marketing and product development. Moreover, excess inventory also increases storage costs, including insurance and the risk of obsolescence, thereby reducing profitability due to resource wastage (Muksin, 2023; Chung & Wee, 2008). Conversely, raw material shortages can disrupt production lines, delay order fulfillment, and affect overall customer satisfaction, leading to lost sales and damaging the company's reputation (Ahmad et al., 2023). Insufficient inventory can disrupt production, while excess inventory inflates storage costs and results in resource waste (Panjaitan et al., 2024).

Although inventory management models such as Economic Order Quantity (EOQ), Reorder Point (ROP), and Safety Stock are widely adopted in various industries, their implementation among MSMEs in rural areas remains limited. These models, grounded in operations research and supply chain management theory, offer a systematic, data-driven framework for inventory decision-making. The limited application of these modern management models is a significant barrier for MSMEs in rural areas, negatively affecting their cost efficiency and operational stability compared to larger companies. This is primarily due to limited access to technology and a lack of adequate training programs (Triwahyono et al., 2023). Additionally, the lack of formal training in new management practices exacerbates the issue, as many entrepreneurs do not possess the necessary expertise to optimize operations effectively (Gunawan & Winarto, 2024). The family-based structure commonly found in informal businesses often maintains traditional practices, further hindering the adoption of modern inventory management techniques that have proven effective in larger firms (Kartiwi & MacGregor, 2007).

A major factor contributing to poor inventory management in rural MSMEs is the heavy reliance on intuitive and informal methods. Many business owners make inventory decisions based on personal experience or simple rules of thumb, rather than data-driven analysis. While this approach may seem practical, it is often inefficient and prone to errors. For example, a rural MSME like Pabrik Kerupuk Sri Tanjung may find its warehouse full of raw materials that are slowly expiring or, conversely, may be forced to halt production due to a shortage of essential raw materials. This intuitive approach leads to high operational costs, missed business opportunities, and a recurring inventory crisis cycle.

To address this challenge, this study proposes the integrated application of EOQ, ROP, and Safety Stock models, specifically tailored for rural MSMEs. The primary goal is to facilitate the transition from an intuition-based approach to a data-driven approach, enabling businesses to make optimal inventory decisions. This integrated framework will assist MSMEs in determining the most cost-effective order quantities, the optimal timing for reordering, and the necessary buffer stocks to mitigate risks. By implementing these models, rural MSMEs are expected to significantly reduce inventory costs, improve operational efficiency, and ultimately enhance their competitiveness and long-term sustainability in the market.

II. METHOD

This study employed a descriptive quantitative research design, which aimed to provide a snapshot of a phenomenon at a specific point in time using statistical analysis to describe its characteristics (Creswell, 2014). This approach was applied to analyze and design a raw material inventory control system at Sri Tanjung Krupuk Factory for the 2024 period. The research collected numerical data on current inventory management and raw material usage, and subsequently applied inventory control models, including Economic Order Quantity (EOQ), Reorder Point (ROP), and Safety Stock, to optimize the inventory system. This quantitative method ensured objective and measurable findings, facilitating data-driven solutions.

The research used purposive sampling, a technique in which samples are intentionally selected based on specific criteria (Schindler, 2021). Sri Tanjung Krupuk Factory was chosen as the unit of analysis because it represents rural MSMEs that rely on traditional and intuitive inventory management. This selection was made based on the consideration that the case study was relevant and suitable for the application and evaluation of an integrated EOQ, ROP, and Safety Stock model. Furthermore, the factory provided accessible primary and secondary data, enabling an in-depth analysis and practical application.

Data were collected from two main sources: primary and secondary. Primary data, collected directly from research subjects (Schindler, 2021), included information gathered through interviews with factory management and direct observation of current inventory practices. Secondary data provided supporting information and contextual background (Saunders et al., 2019), obtained from factory documentation, specifically records of raw material purchases and inventory costs for the 2024 period.

Data analysis was conducted using three main inventory management techniques to develop a more efficient and cost-effective system.

- **Economic Order Quantity (EOQ)** is an inventory control technique designed to minimize the total costs associated with ordering and holding inventory (Heizer et al., 2016). ROP is calculated with the formula:

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

Whereas, the Total Cost Formula (TC) uses the following formula:

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

where Q = Number of units per order
Q* = Optimum number of units per order (EOQ)
D = Annual demand in units for the inventory item
S = Setup or ordering cost for each order
H = Holding or carrying cost per unit per year

- **ROP (Reorder Point)** is the inventory level at which an action is taken to replenish the stocked item (Haizer, 2016). ROP is calculated with the formula:

ROP = Expected demand during lead time + Safety stock

- **Safety Stock** is the extra stock to allow for uneven demand, acting as a buffer (Heizer et al., 2016). Safety stock is calculated based on standard deviation and a Z-value.

$$\text{Standard Deviation} = \sqrt{\frac{\sum(x-\bar{x})^2}{n}}$$

Safety Stock = Standard Deviation×Z

where x = Each individual data value in the set
$\bar{x}$ = The arithmetic mean (average) of the data
n = The total number of data points
∑ = The summation symbol, which means "to sum up" or "to total"
Z (Z-score) = This is a statistical factor that corresponds to a desired service level

III. RESULTS AND DISCUSSION

Before the implementation of the Economic Order Quantity (EOQ), inventory management at the Sri Tanjung Cracker Industry in Indramayu still relied on a conventional ordering system. This system followed the availability of raw materials in the market, warehouse capacity, and daily production requirements, without considering the most economical order size. The annual demand data for the main raw materials were obtained through interviews with management, while unit prices, transportation costs, and actual order quantities were collected from purchase receipt documents. Based on these data, the total annual inventory cost was calculated using the conventional approach. The results are presented in Table 1.

Table 1. Total Inventory Cost Before EOQ

Raw Material	Total Requirement (D)	Average Purchase (Q)	Ordering Cost (S)	Holding Cost (H)	Total Cost (TC)
Tapioca flour	912,500 Kg	2,000 Kg	Rp 100,000	Rp 2,000	Rp 47,625,000
Remang fish	300,000 Kg	2,000 Kg	Rp 150,000	Rp 3,000	Rp 25,500,000
Salt	18,250 Kg	4,000 Kg	Rp 100,000	Rp 1,200	Rp 2,856,250
Sugar	36,500 Kg	2,000 Kg	Rp 50,000	Rp 2,000	Rp 2,912,500
MSG	2,504 Kg	24 Kg	Rp 40,000	Rp 7,500	Rp 4,263,333
Whitening agent	1,565 Kg	15 Kg	Rp 40,000	Rp 5,000	Rp 4,210,833
Leavening agent	2,504 Kg	24 Kg	Rp 40.000	Rp 12,350	Rp 4,321,533
Total					Rp 91,689,449

Data processed, 2025

The calculation results presented in Table 1 indicate that the total inventory cost before the implementation of the EOQ method reached IDR 91,689,449 per year. The largest cost component was tapioca flour at IDR 47,625,000 (51.9% of the total), followed by remang fish at IDR 25,500,000 (27.8%). These two raw materials dominated the inventory cost because of their large volume and the need for continuous availability to meet sustained market demand. This finding is consistent with interview results, which emphasized that flour and fish constitute the core materials in the production process.

In contrast, supplementary materials such as MSG, whitening agents, and leavening agents, although required in relatively small quantities, still contributed significantly to the total cost, accounting for approximately 14%. This contribution was mainly due to their higher unit prices and the ordering pattern in small lots, which led to higher per-unit holding costs. Meanwhile, sugar and salt accounted for only about 6% of the total cost, in line with the stability of their supply in the market and the ease of procuring them in larger quantities.

These findings suggest that the conventional ordering pattern remains inefficient. The high holding costs of primary materials combined with the elevated ordering costs of supplementary materials caused the total annual inventory cost to remain considerably high. This condition highlights the need for optimization through the EOQ method to balance ordering and holding costs in order to achieve a more economical total inventory cost.

This result is consistent with prior studies showing that essential raw materials, including flour, often represent the largest portion of inventory costs due to their high daily usage and significant procurement needs (Sadohara et al., 2022). Furthermore, fluctuations in demand and lead time for perishable raw materials may increase inventory costs (Sihotang & Damiyati, 2023). High-value materials may also disproportionately affect total inventory costs due to their relatively high per-unit holding costs (Hidayatuloh et al., 2023). Overall, Table 1 serves as an important basis for evaluating the effectiveness of EOQ implementation in the subsequent stage.

Table 2. Total Inventory Cost After EOQ

Raw Material	Total Requirement (D)	Average Purchase (Q)	Ordering Cost (S)	Holding Cost (H)	Total Cost (TC)
Tapioca flour	912,500 Kg	9,552 Kg	Rp 100,000	Rp 2,000	Rp 19,105,000
Remang fish	300,000 Kg	5,477 Kg	Rp 150,000	Rp 3,000	Rp 16,433,000
Salt	18,250 Kg	1,744 Kg	Rp 100,000	Rp 1,200	Rp 2,093,000
Sugar	36,500 Kg	1,349 Kg	Rp 50,000	Rp 2,000	Rp 2,701,000
MSG	2,504 Kg	163 Kg	Rp 40,000	Rp 7,500	Rp 1,226,000
Whitening agent	1,565 Kg	112 Kg	Rp 40,000	Rp 5,000	Rp 839,000
Leavening agent	2,504 Kg	79 Kg	Rp 40,000	Rp 12,350	Rp 963,000
Total					Rp 43,360,000

Data processed, 2025

The calculation results in Table 2 show that the total inventory cost after the implementation of the EOQ method decreased significantly to approximately IDR 43.36 million per year, compared to the previous condition of IDR 91.69 million. Thus, the application of EOQ has the potential to generate savings of IDR 48.33 million, or about 52.7%.

In detail, the largest cost reductions occurred in tapioca flour (from IDR 47.6 million to IDR 19.1 million) and remang fish (from IDR 25.5 million to IDR 16.4 million). These two materials were the main contributors to inventory costs before EOQ implementation; therefore, optimizing order sizes provided the most significant impact on cost efficiency.

Additionally, supplementary materials such as MSG, whitening agents, and leavening agents also experienced substantial cost reductions. This was primarily due to the reduced frequency of small-lot orders, which had previously generated high ordering costs. However, since their required volume was relatively small, their contribution to total savings was not as substantial as that of flour and fish.

The cost reduction shown in Table 2 is consistent with previous research findings regarding the benefits of EOQ implementation in SMEs, particularly in the food sector. Ghiffari (2024) notes that effective inventory control through the EOQ method can improve both efficiency and profitability. Similarly, Ikrom (2025) emphasizes that EOQ implementation can reduce holding costs while minimizing the risks of overstocking and stockouts, thereby demonstrating its holistic benefits. In the context of Sri Tanjung, cost savings reached 52.7% because previous ordering practices were carried out in less-than-optimal quantities, especially for high-volume raw materials.

From a managerial perspective, the implementation of EOQ at Sri Tanjung not only increased cost efficiency but also supported the development of more measurable inventory planning. Nevertheless, the practical implementation of EOQ must also consider warehouse capacity, the risk of spoilage in perishable materials such as fish, and seasonal supply patterns. Therefore, combining EOQ with Reorder Point (ROP) and Safety Stock policies becomes essential, which will be discussed in the subsequent section.

Table 3. Reorder Point (ROP) and Safety Stock

Raw Material	Total Requirement (D)	Average Daily Usage (Q)	Lead Time	Safety Stok	ROP
Tapioca flour	912,500 Kg	2,534.72 Kg	3	1,448.79 Kg	9,052.95 Kg
Remang fish	300,000 Kg	833.333 Kg	3	476.31 Kg	2,976.31 Kg
Salt	18,250 Kg	50.694 Kg	3	28.98 Kg	181.06 Kg
Sugar	36,500 Kg	101.389 Kg	3	57.95 Kg	362.12 Kg
MSG	2,504 Kg	6.9556 Kg	3	3.98 Kg	24.84 Kg
Whitening agent	1,565 Kg	4.3472 Kg	3	2.48 Kg	15.53 Kg
Leavening agent	2,504 Kg	6.9556 Kg	3	3.98 Kg	24.84 Kg
Total					

Data processed, 2025

The results in Table 3 indicate that each raw material has a distinct reorder point (ROP) and safety stock, which are determined by daily demand levels and the characteristics of each material. Tapioca flour, as the main ingredient with an average daily requirement of more than 2.5 tons, has the largest ROP of approximately 9,053 kg and a safety stock of 1,449 kg. This reflects the crucial role of tapioca flour in ensuring smooth production, thereby requiring the company to reorder once inventory approaches this threshold.

For remang fish, the ROP is set at 2,976 kg with a safety stock of 476 kg. This figure is relatively high given that fish is perishable and its availability is influenced by seasonal factors. Therefore, although the theoretical ROP already accounts for lead time requirements and demand variation, in practice, the company must also adjust based on storage capacity and supply availability from fishermen.

Meanwhile, supplementary materials such as sugar and salt have relatively smaller ROPs—362 kg and 181 kg, respectively—reflecting their lower daily requirements. Conversely, materials with low volume but high value, such as MSG, whitening agents, and leavening agents, have very small ROPs of around 16–25 kg. Nevertheless, these items still require safety stock due to fluctuations in supply and price, which can affect production continuity.

These findings are consistent with previous research. Saripudin and Wahyudin (2023) emphasized that setting appropriate safety stock values and reorder points is critical for avoiding overstock situations while adequately responding to market needs. Similarly, Christyani (2025) concluded that effective inventory management through the implementation of safety stock and ROP can significantly improve operational efficiency. The integration of these methods enables companies to navigate demand uncertainty, ultimately reducing the risk of stockouts.

In conclusion, the implementation of ROP and safety stock at Sri Tanjung not only provides a quantitative guideline for determining reorder timing but also serves as a foundation for more adaptive inventory management strategies. The combination of calculated results with practical measures—such as rounding to packaging sizes, utilizing cold storage facilities, and maintaining intensive coordination with suppliers—will make the company's inventory system more effective and efficient.

IV. CONCLUSIONS

In rural MSMEs, effective inventory management is crucial for success. Based on the case of the Sri Tanjung Cracker Factory, it can be concluded that the integrated application of Economic Order Quantity (EOQ), reorder points, and safety stock offers a robust solution to challenges posed by ineffective management. The implementation of this strategy significantly reduces inventory costs, while ensuring optimal stock availability to prevent stockouts and maintain production continuity. Consequently, this approach not only enhances operational efficiency but also establishes a solid foundation for sustainable business growth. However, a key limitation of this study is its reliance on a single-case study using only one-year of data. For future research, it is recommended to expand the study to include more MSMEs across different sectors to improve the generalization of the findings. Additionally, utilizing multi-year data is crucial to effectively analyze trends and fluctuations, which can further refine the inventory management models.

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