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Inventory Control Analysis of Raw Materials using the Min–Max Stock Method in LPG Cap Seal Production at XYZ Company

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Abstract

Raw material inventory control plays a crucial role in supporting the smooth production process while simultaneously increasing operational cost efficiency. XYZ Company, a manufacturing company producing LPG cap seals, still faces inventory management challenges, as indicated by the high frequency of orders and the high total inventory costs. This study aims to improve the inventory control system by implementing the min-max stock method. The research process begins with forecasting raw material needs using several methods, then selecting the method with the lowest error rate as the basis for the calculation. The forecast results are then used in the application of the min-max stock method to determine a more optimal inventory policy. Evaluation is carried out by comparing the performance of the proposed method with the method used by the company based on the frequency of orders and total inventory costs. The results show that the application of the min-max stock method is able to reduce the frequency of orders and inventory costs for all raw materials. For LDPE plastic, the ordering frequency decreased from 40 times to 30 times, with cost savings of Rp3,850,000, or 15%. For HDPE plastic, the ordering frequency decreased from 40 times to 30 times, with cost savings of Rp3,600,000, or 15%. For dye raw materials, the ordering frequency decreased from 26 times to 19 times, with cost savings of Rp1,641,177 or 13%. Overall, the proposed method resulted in total cost savings of Rp 9,091,177, or approximately 15% compared with the company's existing method. These results indicate that the min-max stock method can reduce ordering frequency and inventory costs while maintaining raw material availability to support smooth production processes.

Keywords: Forecasting; inventory costs; inventory control; min-max stock

1. Introduction

As time goes by, the number of manufacturing companies in Indonesia continues to increase, leading to competition in the business world that encourages each entrepreneur to improve efficiency in their operational activities. One of the most important aspects in this effort is production management [1]. Efficient inventory management plays a crucial role in maintaining optimal inventory levels, thereby minimizing the risk of stock shortages or excesses that can disrupt company operations [2]. Inventory control is an activity to determine the level and composition of inventory, replacement components, raw materials, and finished goods [3]. Without inventory, the company risks being unable to produce adequately, failing to meet consumer needs or desires, and potentially incurring losses [4]. The lack of adequate inventory can hinder the production process, reduce the company's ability to meet consumer demand, and increase the risk of losses [5], [6].

XYZ Company is a manufacturing company specializing in the production of plastic products such as landkrone, ovalet caps and bodies, reflector brackets, wire guides, and LPG cap seals. The company focuses on producing LPG cap seals, which act as safety covers for LPG gas cylinders. The company was founded to meet the growing needs of the plastics industry in Indonesia. XYZ Company faces challenges in managing the inventory of raw materials for LPG cap seal production. Fluctuating consumer demand makes it difficult for XYZ Company to accurately determine the amount of raw material inventory needed for LPG cap seals to ensure smooth production. This situation can lead to the risk of overstocking or stockouts, which can result in losses for the company.

Based on data from Company XYZ, it can be seen that demand for products at UD. Kema Sejahtera for the period May 2025–April 2026 shows that demand for cap seals is significantly higher than for other products, totaling 416,655,200 pieces. Demand for other products, such as

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landkrone, stands at 50,000 pieces; ovalet at 325,000 pieces; bracket reflectors at 46,841 pieces; and wire guides at 252,000 pieces. This difference in scale indicates that cap seals are the most frequently ordered product.

Based on the company's historical data, it can be seen that raw material inventory levels are unstable, as there are frequent instances of overstock and stockouts. This indicates that the company's inventory control system is not yet stable. This situation poses a risk of disrupting the production process; therefore, an effective and appropriate inventory control system is needed to ensure the smooth operation of the production process while optimizing the company's operating costs. Essentially, these fluctuations are caused by an imbalance between the amount of inventory available and the amount of demand required in the production process and by consumers [7]. This condition suggests that the company's existing inventory control system has not been fully optimized to accommodate demand variability. If not properly addressed, these issues can lead to increased inventory costs, disrupted production processes, and reduced operational efficiency.

Based on several existing studies, research on Analysis of Inventory Control Using EOQ and the Min-Max Method at the XYZ Drinking Water Depot shows a focus on quantitative aspects such as inventory costs, ordering frequency, safety stock, and reorder points [8]. Other research that discusses the control of raw material inventory of skipjack tuna using the min-max stock method focuses more on managing the amount of inventory so that production continues, but has not yet linked the quality of raw materials to the technical production process [9]. Meanwhile, studies related to inventory control to reduce costs and avoid excess and shortage of stock with the assumption of stable demand have not yet discussed the operational risks that may occur [1].

Based on these findings, a research gap is identified in the limited integration of inventory control methods with forecasting approaches that consider real demand fluctuations. In practice, demand patterns are dynamic, requiring adaptive inventory policies that can respond effectively to such variability. Therefore, this study proposes the application of the min-max stock method integrated with demand forecasting to determine more accurate minimum and maximum inventory levels based on actual company conditions.

This study aims to analyze and optimize raw material inventory control at XYZ Company by implementing the min-max stock method supported by demand forecasting. This approach is expected to determine optimal inventory policies, reduce total inventory costs, optimize ordering frequency, and ensure material availability to support uninterrupted production processes. Furthermore, this research is expected to provide practical contributions to improving operational efficiency and theoretical contributions to the development of adaptive inventory control models under fluctuating demand conditions.

2. Method

2.1. Research location and time

The research was conducted at XYZ Company, one of the manufacturing companies. The research was carried out starting from September 2025 until all required data for the study were obtained.

2.2. Data collection technique

In this study, data collection was conducted using various techniques to obtain accurate information related to raw material stock control in the company. Data processing is the process of converting unprocessed data into relevant and usable information.

This is called data processing [10]. Initial data were collected through direct observation of the ordering, storage, and utilization of raw materials in the production process, as well as through interviews with related parties, such as the owner and employees involved in stock management. In addition, secondary data were obtained through document studies that included company records regarding raw material usage, ordering frequency, and inventory costs. All collected information was then used as the basis for inventory control analysis and calculations using predetermined methods.

2.3. Data analysis method

In the initial stage, the total inventory cost is calculated using the method currently used by the company. This calculation aims to determine the initial costs incurred and thus serve as a basis for comparison when evaluating proposed inventory control methods. The following is the equation for total inventory cost.

In the next step is to calculate inventory control using the min-max stock method. The min-max method is one of the raw material control methods used. This method assumes that raw material stock is divided into two levels, namely minimum and maximum. The min-max stock method is a method used to control inventory when it reaches the safety stock limit or has reached the minimum reorder level and maximum stock level, which are the company's maximum limits for meeting raw material needs in the production process. This way, waste and excess inventory can be avoided [11]. From the results of this calculation, the total inventory cost is recalculated and then compared with the total inventory cost using the company's method. If the total inventory cost using the min-max stock method is smaller than the company's method, then this method is considered more efficient and suitable for application in raw material inventory control. The following are the stages and equations of the min-max stock method [12].

$$Safety\ Stock = (Maximum\ usage\ - T) \times LT \quad (1)$$

$$Minimum\ Inventory = (T \times LT) + SS \quad (2)$$

$$Maximum\ Inventory = 2 \times (T \times LT) + SS \quad (3)$$

$$Order\ Quantity = 2 \times T \times LT \quad (4)$$

$$Reorder\ Point = (T \times LT)\ +\ SS \quad (5)$$

$$Order\ Frequency = \frac{D}{Q} \quad (6)$$

where:
T : average raw material usage
LT : lead time
SS : safety stock
D : demand
F : frequency
Q : inventory order quantity

Once a more efficient inventory control method is determined, the next step is to estimate raw material requirements as a basis for planning for the next period using the time series forecasting method. The time series forecasting method is a forecasting approach that uses time based historical data to analyze patterns, trends, and fluctuations in a phenomenon. By utilizing systematically arranged past data, this method is used to estimate future conditions. The level of forecasting accuracy is greatly influenced by the quality and consistency of the data, so the results can be used as a basis for planning raw material requirements, production, and distribution. The forecasting process is carried out using POM-QM software for Windows, utilizing available historical data. The forecasting methods used include moving averages, weighted moving averages, and single exponential smoothing [13]. POM for Windows is a computer program used to help solve quantitative problems in production and operations. Its user-friendly interface aids decision-making, such as determining production mixes, order quantities, and optimal work assignments [14].

The forecasting results processed using historical raw material demand data using the single exponential smoothing, weighted moving average, and moving average methods are then evaluated by calculating the error rate using the Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD), and Mean Squared Error (MSE) methods. MAPE is the average absolute error over a certain period multiplied by 100% to obtain a percentage result and is used if the size of the forecasted variable greatly determines the forecast accuracy. The ability of the forecasting model can be stated as good if the MAPE value is low. The MAPE value can be used as a measuring tool to determine the accuracy of errors in the forecasting model. MAD is the main measurement of the overall forecasting error of the forecasting model. The error value is calculated by dividing the sum of the absolute values or exact values of the forecast errors by the number of periods. This method is useful when wanting to measure errors in forecasting in the same units as the original series, while MSE is the method used to evaluate the forecasting method described previously. The value of each error is squared and will be divided by the number of observations. The weakness of this method is that it tends to highlight large deviations because the values are squared [13].

After analyzing the forecasting results using the time series method, the forecast data with the lowest error is selected. These results can then be used to plan future production [15]. Based on the evaluation, the method with the lowest MAPE value is selected as the best, allowing the estimation results to guide more accurate raw material requirements and support optimal inventory management.

3. Results and Discussion

3.1. Min-max stock method

The initial stage in data processing is carried out by calculating inventory control using the min-max stock method. The following is an inventory control calculation using the min-max stock method for LPG cap seal raw materials.

- Calculations on LDPE plastic raw materials

a. Safety Stock
$\text{Safety Stock} = (26{,}733 - 21{,}247) \times 0.20$
$\text{Safety Stock} = 1{,}097.20 \approx 1{,}097 \text{ kg}$

b. Minimum Inventory
$\text{Min. Inventory} = (21{,}247 \times 0.20) + 1{,}097$
$\text{Min. Inventory} = 5{,}346.6 \approx 5{,}347 \text{ kg}$

c. Maximum Inventory
$\text{Max. Inventory} = 2 \times (21{,}247 \times 0.20) + 1{,}097$
$\text{Max. Inventory} = 9{,}596 \text{ kg}$

d. Order Quantity
$\text{Order Quantity} = 2 \times 21{,}247 \times 0.20$
$\text{Order Quantity} = 8{,}498.8 \approx 8{,}499 \text{ kg}$

e. Reorder Point
$\text{Reorder Point} = (21{,}247 \times 0.20) + 1{,}097$
$\text{Reorder Point} = 5{,}346.6 \approx 5{,}347$

f. Order Frequency
$\text{Order Frequency} = \frac{254.964}{8{,}499}$
$\text{Order Frequency} = 30 \text{ times}$

After calculating inventory control using the min-max stock method, the next step is to calculate the total inventory cost resulting from the application of this method. This cost calculation is performed using the same components as the company's method, so the results can be directly compared. The following is a summary of the comparison between the company method and the min max stock method.

Table 1. Comparative recapitulation of raw material inventory calculation for LPG cap seal using the company's method with the min-max stock method

Raw Material	Company Method	Min-Max Stock Method
LDPE Plastic	Rp. 25,690,000	Rp. 21,840,000
HDPE Plastic	Rp. 24,190,000	Rp. 20,590,000
Dye	Rp. 12,630,733	Rp. 10,989,556
Total	Rp. 62,510,733	Rp. 53,419,556

Based on Table 1, the results show that the min-max method produces lower total costs compared to the company's current method.

After it has been proven that the min-max stock method is more effective in managing raw material inventory, the next stage is to calculate the amount of cost savings obtained from implementing this method, so that it can be seen to what extent the resulting efficiency increase is compared to the method used previously.

Cost saving $= \text{Rp.}\,62{,}510{,}733 - \text{Rp.}\,53{,}419{,}556$

Cost saving $= \text{Rp.}\,9{,}091{,}177$ or equivalent to 15%

3.2. Raw material requirements forecasting analysis

Based on the LPG cap seal raw material inventory data for May 2025 - April 2026, the data pattern is as follows:

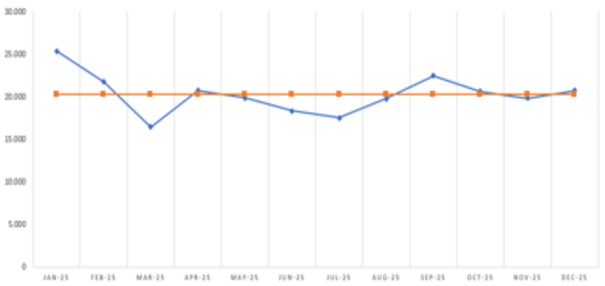

Figure 1. Plotting LDPE raw material usage data for May 2025-April 2026

Figure 1 shows that raw material usage fluctuates modestly and tends to hover around the average value without showing any significant upward or downward trends. This indicates that the raw material usage pattern is uncertain and fluctuates over time, thus categorizing it as a probabilistic pattern influenced by variations in demand and other operational factors.

3.3. Forecasting using the single exponential smoothing (SES) method

Table 2. Output of the single exponential smoothing method on LDPE plastic raw materials using POM-QM software

Measure	Value
Bias (Mean Error)	506.155
MAD (Mean Absolute Deviation)	1,711.612
MSE (Mean Squared Error)	5,864,498
Standard Error (denom=n-2=9)	2677.26
MAPE (Mean Absolute Percent Error)	7.706%
Forecast Next Period	20646.63

Based on Table 2, the results of forecasting LDPE plastic raw materials using the Single Exponential Smoothing method with a weight (n) of 0.47, the MAD value was 1,711.612; the MSE value was 5,864,498.0; and the MAPE value was 7.706% or 0.077.

3.4. Forecasting using the weighted moving average (WMA) method

Table 3. Output of the weighted moving average method on LDPE plastic raw materials using POM-QM software

Measure	Value
Bias (Mean Error)	985.45
MAD (Mean Absolute Deviation)	1,880.05
MSE (Mean Squared Error)	7,427,278
Standard Error (denom=n-2=9)	3,146.909
MAPE (Mean Absolute Percent Error)	7.956%
Forecast Next Period	23,189.9

Based on Table 3, the results of forecasting LDPE plastic raw materials using the Weighted Moving Average method with weights (n) of 0.4; 0.3; 0.2; and 0.1, the MAD value was 1,880.05; the MSE value was 7,427,278; and the MAPE value was 7.956% or 0.08.

3.5. Forecasting using moving average (MA) method

Table 4. Output of the moving average method on LDPE plastic raw materials using POM-QM software

Measure	Value
Bias (Mean Error)	1,365.938
MAD (Mean Absolute Deviation)	2,023.375
MSE (Mean Squared Error)	7,220,052
Standard Error (denom=n-2=9)	3,102.698
MAPE (Mean Absolute Percent Error)	8.543%
Forecast Next Period	23947.75

Based on Table 4, the results of forecasting LDPE plastic raw materials using the Moving Average method with a weight (n) of 4, the MAD value was 2,023.375; the MSE value was 7,220,052; and the MAPE value was 8.543% or 0.09.

Based on the forecasting calculations performed using each method, an error value was obtained for each forecasting method. This value is used to evaluate the accuracy of the resulting forecast. The error values for each forecasting method can be seen in Table 5.

Table 5. Recapitulation of error value calculation

Method	Raw Material	Error Value		
		MAD	MSE	MAPE
SES	LDPE Plastic	1,711.612	5,864,498	0.07
	HDPE Plastic	1,635.13	4,687,530	0.08
	Dye	35.69	2,272.01	0.09
WMA	LDPE Plastic	1,880.05	7,427,278	0.08
	HDPE Plastic	1,576.35	4,849,168	0.06
	Dye	34.65	2,378.314	0.07
MA	LDPE Plastic	2,023.375	7,220,052	0.09
	HDPE Plastic	1,841.594	5,381,197	0.08
	Dye	38.094	2,452,945	0.08

After calculating the error value, the smallest error value can be selected. For the three raw materials, the smallest error value is found in the Weighted Moving Average method. For LDPE plastic raw materials, the MAD value is 1,880.05; the MSE is 7,427,278; and the MAPE is 7.606% or 0.08. For HDPE plastic raw materials, the MAD value is 1,576.35; the MSE is 4,849,168; and the MAPE is 6.48% or 0.06. For dye raw materials, the MAD value is 34.65; the MSE is 2,378.314; and the MAPE is 7.21% or 0.07. Therefore, it can be seen that the most appropriate forecasting method used by the company is the Weighted Moving Average.

Once the smallest error value is known, the next step is to forecast LPG cap seal raw material inventory for the May 2026-April 2027 period using the Weighted Moving Average forecasting method. The results of the forecast calculations for each raw material can be seen in Table 6.

Based on Table 6, the forecasted demand for LDPE plastic is 172,803 kg, with an average demand of 21,600 kg. HDPE plastic is 179,010 kg, with an average demand of 22,376 kg. For dyes, the forecasted demand for dyes is 3,530 kg, with an average demand of 441 kg.

Table 6. Recapitulation of cap seal raw material forecasting results using the weighted moving average method

Month	Forecast		
	LDPE	HDPE	Dye
May 26	0	0	0
Jun 26	0	0	0
Jul 26	0	0	0
Aug 26	0	0	0
Sep 26	18,716	19,511	383
Oct 26	20,439	20,587	412
Nov 26	21,017	21,448	426
Dec 26	20,666	21,412	423
Jan 27	20,438	21,862	424
Feb 27	23,172	24,220	475
Mar 27	23,902	24,731	488
Apr 27	24,454	25,239	499
Total	172,803	179,010	3,530
Average	21,600	22,376	441

3.6. Forecasting LPG cap seal raw material inventory using the min-max method in the next period

This is the final stage of the data processing process. It involves calculating inventory control using the min-max stock method based on forecasting results for the next period. These calculations are expected to provide more effective alternative solutions for companies in managing raw material inventory. The following is the calculation process for each type of raw material.

- Calculations on LDPE plastic raw materials

a. Safety Stock
$\text{Safety Stock} = (24{,}454 - 21{,}600) \times 0.20$
$\text{Safety Stock} = 570{,}7 \approx 571 \text{ kg}$

b. Minimum Inventory
$\text{Min. Inventory} = (21.600 \times 0.20) + 571$
$\text{Min. Inventory} = 4{,}890{,}78 \approx 4{,}891 \text{ kg}$

c. Maximum Inventory
$\text{Max. Inventory} = 2 \times (21{,}600 \times 0.20) + 571$
$\text{Max. Inventory} = 9{,}210{,}86 \approx 9{,}211 \text{ kg}$

d. Order Quantity
$\text{Order Quantity} = 2 \times 21{,}600 \times 0.20$
$\text{Order Quantity} = 8{,}640{,}16 \approx 8{,}640 \text{ kg}$

e. Reorder Point
$\text{Reorder Point} = (21{,}600 \times 0.20) + 571$
$\text{Reorder Point} = 4{,}890.78 \approx 4{,}891$

f. Order Frequency
$\text{Order Frequency} = \frac{172{,}803}{8{,}640}$
$\text{Order Frequency} = 20 \text{ times}$

Table 7. Recapitulation results of min-max stock calculations in the next period

Variables	Raw Materials for LPG Cap Seal Production at XYZ Company		
	LDPE	HDPE	Dye
Average Usage	21,600 kg	22,376 kg	441 kg
Total Usage	172,803 kg	179,010 kg	3,530
Lead Time	0.20 month	0.20 month	0.30 month
Safety Stock	571 kg	573 kg	17 kg
Min. Inventory	4,891 kg	5,048 kg	150 kg
Max Inventory	9,211 kg	10,668 kg	282 kg
Order Quantity	8,640 kg	10,096 kg	265 kg
Reorder Point	4,891 kg	5,048 kg	150 kg
Order Frequency	20 times	18 times	13 times

4. Conclusion

Based on the calculation results, the implementation of the min-max stock method provides quite clear changes to the inventory control pattern for each raw material. For LDPE plastic raw materials, the ordering frequency decreased from 40 times to 30 times after implementing the min-max stock method. In addition, the total inventory cost also decreased, from initially Rp. 25,690,000 to Rp. 21,840,000. This shows that the company has saved costs of Rp. 3,850,000 or 15%. For HDPE plastic raw materials, the order frequency decreased from 40 to 30 after implementing the min-max stock method. Furthermore, total inventory costs also decreased, from Rp 24,190,000 to Rp 20,590,000. This indicates a cost savings of Rp 3,600,000, or 15%, for the company. For dye raw materials, the order frequency decreased from 26 to 19 after implementing the min-max stock method. Furthermore, total inventory costs also decreased, from Rp 12,630,733 to Rp 10,989,556. This indicates aor 13% for the company. These cost reductions indicate that the min-max stock method is able to reduce order frequency while simultaneously reducing total inventory costs across all raw materials. Thus, the company achieved cost savings of Rp 9,091,177, or approximately 15%. This cost reduction occurs because the min-max stock method can control inventory levels by setting minimum and maximum limits, thus preventing unnecessary stock buildup without disrupting raw material availability. This method not only helps reduce inventory costs but also improves orderliness in the ordering process and maintains stable raw material availability to support smooth production activities. After using the min-max stock method in calculating raw material inventory, you can continue to forecast inventory in the next period.

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