JOURNAL LA MULTIAPP

VOL. 06, ISSUE 03 (618-630), 2025
DOI: 10.37899/journallamultiapp.v6i3.2011

Analysis of Spare Parts Inventory Control Using the Min-Max Stock Method and Continuous Review

Wardatul Lailiyah[1], Farida Pulansari[1], Sinta Dewi[1]

[1]Department of Industrial Engineering, Faculty of Engineering and Science, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya, Jawa Timur, Indonesia 60294

**Corresponding Author: Wardatul Lailiyah*
Email: wardatul047@gmail.com

Article Info

Article history:
Received 08 February 2025
Received in revised form 04 March 2025
Accepted 30 June 2025

Keywords:
Inventory
Inventory Cost
Min - Max Stock
Continuous Review

Abstract

Inventory is one component that has an important role in a company. The smooth production process and demand fulfillment will be greatly influenced by how to manage this component properly. PT XYZ, as one of the strategic power generation units in Indonesia, is responsible for providing a stable supply of electricity. As a company that relies on the reliability of machines and spare parts, good inventory management is essential. The problems faced include the inaccuracy in the procurement of spare parts which causes overstock or stockout with a range of around 10% to 20% which can disrupt the operation of the plant. improvements in inventory control are made using the Min-Max Stock and Continuous Review methods, both of which maintain a balance between inventory costs and spare parts availability to compare the smallest total inventory cost including ordering costs and storage costs. In addition, this research has novelty by providing recommendations for mitigating downtime risks to optimize spare parts inventory control in the power generation industry. Based on the results of the calculation of total inventory costs, the min max stock method is proven to be able to produce lower inventory costs and get savings of Rp 159.961.310 or around 25%. This efficiency proves that the application of Min-Max Stock can optimize spare parts inventory costs.

Introduction

Technological advances in the industrial era in Indonesia have brought major changes in various sectors. In modern industry, operational speed and efficiency are the main factors in maintaining company competitiveness. Inventory management has a crucial role in smooth operations and is an important element for the company (Ledy Vanesa & Helma, 2023; Alam & Tandra, 2021; Mor et al., 2021). Therefore, companies need to determine the amount of inventory carefully so as not to incur unnecessary costs (Marpaung & Marzolina, 2024). While inventory optimization can help reduce costs, the risk of stock-outs remains a challenge (Amrina & Dewi, 2021). Inaccuracies in inventory management can lead to losses due to unnecessary expenses (Almadany, 2021). Therefore, inventory planning and control are carried out to minimize costs and maximize profits (Dagi et al., 2023; Vaka, 2024; Zhao & Tu, 2021). Inventory is a high-value asset in industry, so effective management is needed to reduce expenses (Nuraeni & Santoso, 2024). Good inventory control ensures that the company has the right amount of stock at the right time, so that it can meet demand and maintain smooth production (Rachmawati & Lentari, 2022; Saputra et al., 2021; Haekal, 2023; Zhao & Tu, 2021).

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Inventory is a number of goods or materials that a company has for sale or reprocessing. In trading companies, inventory is in the form of merchandise for resale, while in manufacturing companies, inventory includes raw materials that are processed into finished goods (Almadany, 2021; Amrina & Dewi, 2021; Marisya et al., 2024). As an important part of manufacturing and supply chains, inventory includes raw materials, work-in-progress, finished goods, and production support materials. Its existence ensures the continuity of production and fulfillment of consumer demand (Zharfan & Handayani, 2023; Jaboob et al., 2024). Inventory also plays a crucial role in the smooth running of production and sales. Good management ensures that the company has sufficient stock to meet demand, including raw materials, work-in-progress, and finished goods (Marpaung & Marzolina, 2024; Ogah et al., 2022; Yunusa, 2021; Sah & Furedi-Fulop, 2022; Hossain et al., 2023).

PT XYZ is a strategic power generation unit responsible for stable electricity supply. The reliability of machines and spare parts is highly dependent on good inventory management. However, inaccurate procurement of spare parts leads to overstock or stockouts of 10-20%, which can disrupt operations and increase the risk of downtime by up to 20% due to procurement delays. The lack of an effective monitoring system complicates the determination of optimal inventory levels, increases storage costs, and magnifies the risk of stockouts. To address these issues, the Min-Max Stock and Continuous Review methods are proposed to maintain a balance between the cost and availability of spare parts. This study assumes the spare parts price, storage cost, order cost, and lead time are fixed during the study. This research aims to control spare parts inventory to minimize total costs and prevent stockouts and overstock at PT XYZ.

Table 1. *Stockout* and *Overstock*

Item Name	Overstock/ Stockout
Cable	-20%
Membrant	-12,5%
Transmitter	+14,3%
Belt	-16,7%
Positioner, Valve	+10%

Previous research Rachmawati & Lentari (2022) discussed Min-Max Stock with minimum, maximum, safety stock, and order quantity parameters, while Meirizha & Farhan (2022) studied Continuous Review with order quantity, safety stock, and reorder point (ROP). Tiurlan & Wicaksono (2023) combined both methods to calculate safety stock, minimum-maximum stock, order frequency, and order quantity. This research adds novelty by analyzing safety stock, minimum-maximum inventory, ROP, and order frequency in the Min-Max Stock method. Meanwhile, the Continuous Review method is studied based on order lot size, ROP, safety stock, and service level to determine the lowest total inventory cost. In addition, this research provides updates related to downtime risk mitigation recommendations to optimize spare parts inventory control in the power generation industry.

Methods

This research uses quantitative research methods conducted at PT XYZ. There are dependent variables and independent variables in this study. The dependent variable in the study is the total minimum inventory cost. While the independent variables in this study include spare parts inventory levels, spare parts usage rates, ordering costs, storage costs, shortage costs, and lead times, in August 2023 to September 2024 In this study, the analysis was carried out on the company's historical data by applying the min-max stock and continuous review inventory methods. The data used in this research comes from two sources, namely primary

ISSN: 2716-3865 (Print), 2721-1290 (Online)

data and secondary data. Primary data was obtained from field observations, interviews with the inventory and warehouse departments. Interviews were conducted in a semi-structured manner with 2 employees in the inventory department and 2 employees in the warehouse department who were selected based on their strategic role in inventory management. Field observations were conducted systematically with evaluation metrics that included the level of accuracy of stock recording, ordering efficiency, and reliability of the inventory recording system. Meanwhile, secondary data comes from documents or data obtained through archives related to this research. The secondary data required are spare parts demand data, ordering cost data, storage cost data, lead time data, and spare parts shortage costs. The accuracy and completeness of the secondary data were verified by cross-checking against the company's annual report. To address the issue of data discrepancies, this study applies data cleaning techniques by removing anomalies, handling missing data through imputation methods, and ensuring data consistency by comparison to historical trends. In addition, external factors such as inflation and changes in supplier prices that can affect inventory costs are also considered in the data analysis.

To solve these problems, the data analysis techniques used include (a) calculating the total inventory cost of the proposed method, namely min max stock and continuous review (b) calculating the total inventory cost using the Company's method. According to (Zharfan & Handayani, 2023) at the calculation stage using the min max stock method using the following formulas: (1) Safety Stock = (T-maximum usage) x LT (2) Minimum Stock = (T X LT) + SS (3) Maximum Stock = 2 X (T X LT) + SS (4) Order Quantity (Q) = 2 X T X LT (5) Reorder Point = (T X LT) + SS (6) Ordering Frequency (F) = D / Q (7) Total inventory cost = (Ordering Frequency X A) + ((Q/2+SS) X H). Meanwhile, according to Aryanny & Kurniawan (2020) at the stage of calculating the total cost of inventory using the continuous review method using several formulas, among others: (a) Calculate the value of q_{01} with the equation $q_{01}^* = q_{0w}^* = \sqrt{\frac{2AD}{h}}$ (b) Calculate the value of possible inventory shortages using the equation $\alpha = \int_r^\infty f(x)dx = \frac{h_{q01}^*}{CuD}$ (c) Reorder Point $r_1^* = DL + Z_\alpha S\sqrt{L}$ The Z_α value can be found in the Normal Distribution Table. (d) The q_{02}^* value with the equation $q_{02}^* = \sqrt{\frac{2D\left[A+C_u\int_{r1}^\infty (x-r_1^*)f(x)dx\right]}{h}}$ (e) Expected stockout or inventory shortage with the equation $N = S_L[f(Z_\alpha) - Z_\alpha\psi(Z_\alpha)]$. Nilai fZ_α and (ψZ_α) can be found in the table of normal distribution values. (f) *Reorder Point* $r_2^* = DL + Z_\alpha S\sqrt{L}$. Determining the iteration that is relatively the same if the comparison of the values of r_2^* and r_1^* then the value of$r^* = r_2^*$ and $q_0 = q_{02}^*$. If the iteration result is not the same then by substituting the value of $r_1^* = r_2^*$ dan $q_{01}^* = q_{02}^*$. In Model Q, the optimal inventory policy is calculated in a way: (1) The *Safety Stock* $(SS) = Z_\alpha S\sqrt{L}$ (2) Service Level $(\eta) = 1 - \frac{N}{D_L} X100\%$ (3) Ordering cost $(O_p) = \frac{D}{q_0} X A$ (4) Holding cost $(O_s) = (\frac{1}{2}q_0 + r - DL) X h$ (5) Total inventory cost $(O_T) = O_P + O_S$.

The total inventory cost of the Min-Max Stock and Continuous Review methods compared will be selected with the minimum total inventory cost. Then the proposed method with the minimum total inventory cost is selected and compared with the method used by the company. The proposed method is declared acceptable if the total inventory cost generated by the proposed method is lower than the total real cost of spare parts inventory at PT XYZ. Furthermore, inventory forecasting is carried out based on data patterns for inventory planning with the proposed method. This research applies the Moving Average, Weighted Moving Average, and Single Exponential Smoothing methods without comparing them with other methods. In addition, no evaluation of the forecasting accuracy of alternative approaches was conducted to ensure the reliability of the results. Further analysis of forecasting errors by

ISSN: 2716-3865 (Print), 2721-1290 (Online)

comparing them to industry standards or historical data could improve the accuracy and validity of this research. Then perform inventory planning based on forecasting using the proposed method.

Results and Discussion

Table 1 presents data on spare parts requirements for September 2023 to August 2024 by PT XYZ. The spare parts used are Cable, Membrant, Transmitter, Belt, and Valve.

Table 2. Spare parts request data

Periode	Demand				
	Cable	**Membrant**	**Transmitter**	**Belt**	**Valve**
Sep-23	6	5	3	3	6
Oct-23	9	7	8	5	6
Nov-23	6	9	5	8	7
Dec-23	4	5	10	8	7
Jan-24	6	7	6	8	9
Feb-24	7	8	8	9	5
Mar-24	4	9	8	6	6
Apr-24	5	9	7	5	4
May-24	5	6	11	6	7
Jun-24	4	8	6	5	7
Jul-24	9	4	6	8	8
Agu-24	6	6	7	4	3
Total	**71**	**83**	**85**	**75**	**75**
Average	**6**	**7**	**7**	**6**	**6**

The following will give one example of calculations on cable spare parts using related cost data collected from field observations.

Ordering Cost : Rp 87.000.000

Holding Cost : Rp 240.000

Shortage cost : Rp 2.500.000

Order frequency : 12 Time

Average inventory : 1 Pcs

Lead time : 4 Day

Calculation of Spare Parts Inventory Costs Using the Min-Max Stock Method

In spare parts inventory management, the Min-Max Stock method is used to determine the minimum and maximum stock limits to maintain the availability of goods and optimize inventory costs. The calculations in this method include several main parameters, namely safety stock, minimum inventory, maximum inventory, order quantity, reorder point (ROP), order frequency, and total inventory cost.

$Safety\ Stock = (\text{Maximum usage} - T) x\ LT = (9 - 6) x\ 4/30 = 0{,}41\ pcs \approx 0\ pcs$

$Min\ Inventory = (T\ x\ LT) + SS = (6x4/30) + 0{,}41 = 1{,}20\ pcs \approx 1\ pcs$

$Max\ Inventory = 2\ x\ (T\ x\ LT) + SS = 2(6x4/30) + 0{,}41 = 1{,}98\ pcs \approx 2\ pcs$

$Order\ Quantity\ (Q) = Max - Min = 1{,}98 - 1{,}20 = 0{,}78\ pcs \approx 1\ pcs$

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Reorder Point (ROP) $= (\text{TxLT}) + \text{SS} = (6\text{x}4/30) + 0{,}41 = 1{,}20$ pcs ≈ 1 pcs

Ruralization Frequency (F) $= \frac{D}{Q} = \frac{71}{0{,}78} = 90$ time

Total Inventory Cost (TIC) =(Ruralization Frequency X A) + $\left(\left(\frac{Q}{2} + SS\right) X H\right)$ = $(90 \text{ X } 240.000) + \left(\left(\frac{0{,}78}{2} + 0{,}41\right) \text{X } 87.000.000\right)$ = Rp 91.683.333

The recapitulation of the calculation of spare parts inventory using the min-max stock method is as follows:

Table 3. Recapitulation of Spare Parts Inventory Calculation

No	Sparepart	Ordering Cost	Holding Cost	Total Cost
1	Cable	Rp 21.600.000	Rp 70.083.333	Rp 91.683.333
2	Membrant	Rp 21.600.000	Rp 64.283.333	Rp 85.883.333
3	Transmitter	Rp 12.342.857	Rp 131.104.167	Rp 143.447.024
4	Belt	Rp 28.800.000	Rp 51.112.500	Rp 79.912.500
5	Valve	Rp 28.800.000	Rp 51.112.500	Rp 79.912.500
Total Overall Inventory				**Rp 480.838.690**

Calculation of Spare Parts Inventory Costs Using the Continuous Review Method

The Continuous Review method is used in inventory control to ensure spare parts are always available at an optimal cost. The calculations in this method include several main parameters, namely the ordering lot, possible shortage, expected shortage value, reorder point (ROP), safety stock, and service level.

Standard deviation = $\sqrt{\frac{\sum(Xi-\bar{X})^2}{n-1}} = \sqrt{\frac{\sum(6-5{,}9)^2+(9-5{,}9)^2+(6-5{,}9)^2+\cdots+(6-5{,}9)^2)}{12-1}} = 1{,}7$

The calculation of spare parts inventory control using the continuous review method is carried out using the Q model approach using the Hadley-Within iteration solution. The following is an example of an inventory control calculation using the continuous review method for cable spare parts.

Iteration 1

Value $q_{01}^* = q_{0w}^* = \sqrt{\frac{2AD}{h}} = \sqrt{\frac{2(240.000)(71)}{87.000.000}} =$ 0,62 pcs ≈ 1 pcs

Possible inventory shortage (α) $\frac{h_{q01}^*}{CuD} = \frac{(87.000.000)(0{,}62)}{(2.500.000)(71)} = 0{,}3038$

With an α value of 0,3038 it can be seen from the normal distribution table that the Z_α value is 0,515.

Value of $r_1^* = DL + Z_\alpha S\sqrt{L} = (71)(\frac{4}{30}) + (0{,}515)1{,}7\sqrt{4/30} = 10$ pcs

The values of fZ_α and (ψZ_α) an be found in the table of shortage probability values. The table shows $fZ_\alpha = 0{,}3521$ and (ψZ_α) 0,1978

$N = S_L[f(Z_\alpha) - Z_\alpha \psi(Z_\alpha)] = (1{,}7)\left(\frac{4}{30}\right)$ [(0,3521)-(0,515)(0, 1978)] = 0,0567

Value of $q_{02}^* = \sqrt{\frac{2D\left[A+C_u\int_{r1}^{\infty}(x-r_1^*)f(x)dx\right]}{h}} = \sqrt{\frac{2(71)[(240.000)+(2.500.000)(0{,}567)]}{87.000.000}} = 0{,}52$ pcs ≈ 1 pcs

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Recalculate the value of the possible inventory shortage $(\alpha)= \frac{h^*_{q02}}{CuD} = \frac{(87.000.000)(0,52)}{(2.500.000)(71)} =$ 0,2548

With an α value of 0,2548 t can be seen from the normal distribution table that the Z_α value is 0,66.

Calculate $r_2^* = DL + Z_\alpha S\sqrt{L} = (71)(\frac{4}{30}) + (0,66)1,7\sqrt{4/30}$ = 10 pcs

In the first iteration, the value of $r_1^* = 10$ pcs and the value of $r_2^* = 10$ pcs have the same value, so the iteration is not continued or completed. Thus, the following inventory policy can be obtained:

value *Safety Stock* (SS) = $Z_\alpha S\sqrt{L} = (0,66)1,7\sqrt{4/30}$ = 0,40 pcs ≈ 0 pcs

Service level $(\eta) = 1 - \frac{N}{D_L} X100\% = 1 - \frac{0,0567}{(71)\left(\frac{4}{30}\right)} x\ 100\%$ = 99,4%

Expected total cost of spare parts inventory

Ordering cost $(O_p) = \frac{AxD}{q_0} = \frac{240.000x71}{0,52}$ = Rp 32.769.230

Holding Cost $(O_s) = (\frac{1}{2}q_0 + r - DL)\ x\ h = (\frac{1}{2}0,52 + 10 - (71)(\frac{4}{30}))\ x\ 87.000.000$ = Rp 69.020.000

Total inventory cost $(O_T) = O_p + O_s =$ Rp 32.769.230 + Rp 69.020.000 = Rp 101.789.230

So, the total inventory cost with the continuous review method that must be incurred by the company is Rp 101.789.230.

Tabel 4. Recapitulation of Sparepart Inventory Cost Calculation

No	Sparepart	Ordering cost	Holding Cost	Total inventory cost
1	Cable	Rp 32.769.230	Rp 69.020.000	Rp 101.789.230
2	Membrant	Rp 25.215.189	Rp 61.625.000	Rp 86.840.189
3	Transmitter	Rp 19.245.283	Rp 147.610.000	Rp 166.855.283
4	Belt	Rp 26.470.588	Rp 73.080.000	Rp 99.550.588
5	Valve	Rp 23.076.923	Rp 77.430.000	Rp 100.506.923
Total inventory cost				**Rp 555.542.213**

Calculation of Spare Parts Inventory Costs Using the Company Method

At this stage, the total inventory cost is calculated using the method applied by the company. The results of this calculation will later be compared with the total inventory cost of the proposed method. The following is an example of calculating the total cost of cable spare parts inventory using the company method using the following formula:

Ordering Cost$(O_p) = Order\ frequency\ x\ Order\ cost$= 12 x 240.000 =Rp 2.880.000

Holding Cost $(O_s) = Holding\ Cost\ x\ average\ inventory$ = 87.000.000 x 1,1 = Rp 95.700.000

Total inventory cost $(O_T) = O_p + O_s =$ Rp 2.880.000 + Rp 95.700.000 = Rp 98.580.000

So, the total cost of inventory with the continuous review method that must be incurred by the company is = Rp 98.580.000.

The recapitulation of the calculation of spare parts inventory using the company method is as follows:

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Table 5. Recapitulation of Spare Parts Inventory Calculation

Sparepart	Ordering Cost	Holding Cost	Total Inventory Cost
Cable	Rp 2.880.000	Rp 95.700.000	Rp 98.580.000
Membrant	Rp 2.880.000	Rp 104.400.000	Rp 107.280.000
Transmitter	Rp 2.880.000	Rp 152.250.000	Rp 155.130.000
Belt	Rp 2.880.000	Rp 81.180.000	Rp 79.912.500
Valve	Rp 2.880.000	Rp 195.750.000	Rp 198.630.000
Total Inventory Cost			**Rp 640.800.000**

The following is a comparison and the resulting savings between the total inventory cost of PT XYZ and the total inventory cost of the proposed method. The comparison can be seen in table 6.

Table 6. Comparison of Total Sparepart Inventory Costs

No	**Sparepart**	**Method**		
		Exsisting	**Min Max Stock**	**Continuous Review**
1	Cable	Rp 98.580.000	Rp 91.683.333	Rp 101.789.230
2	Membrant	Rp 107.280.000	Rp 85.883.333	Rp 86.840.189
3	Transmitter	Rp 155.130.000	Rp 143.447.024	Rp 166.855.283
4	Belt	Rp 81.180.000	Rp 79.912.500	Rp 99.550.588
5	Valve	Rp 198.630.000	Rp 79.912.500	Rp 100.506.923
Total Inventory		**Rp 640.800.000**	**Rp 480.838.690**	**Rp 555.542.213**

From the table above, it is obtained that the total inventory cost for the period September 2023 to August 2024 using the Min-Max Stock method is Rp 480.838,690, while the total inventory cost with the Continuous Review method is Rp 555,542,213. Therefore, it can be concluded that the Min-Max Stock method was chosen because it results in the smallest total inventory cost. Thus, the Min-Max Stock method is used as a reference to compare with the method applied by the company. While the percentage of savings in the total inventory cost of the Min-Max Stock method compared to the company's total inventory cost is as follows:

Table 7. Calculation of Cost Savings and Percentage of Sparepart Cost Savings

No	**Sparepart**	**Cost Savings**	**Persentase**
1	Cable	Rp 6.896.667	7%
2	Membrant	Rp 21.396.667	20%
3	Transmitter	Rp 11.682.976	8%
4	Belt	Rp 1.267.500	2%
5	Valve	Rp 118.717.500	60%
Total Inventory		**Rp 159.961.310**	**25%**

Spareparts Forecasting Calculation

Forecasting spare parts demand is a crucial step in inventory management to ensure optimal availability and avoid overstock or stockout. In the forecasting process, analysis of historical data patterns, calculation of forecasting results, and evaluation of forecasting errors are carried out to select the method with the best accuracy. The following is an example of a forecasting calculation for cable spare parts.

ISSN: 2716-3865 (Print), 2721-1290 (Online)

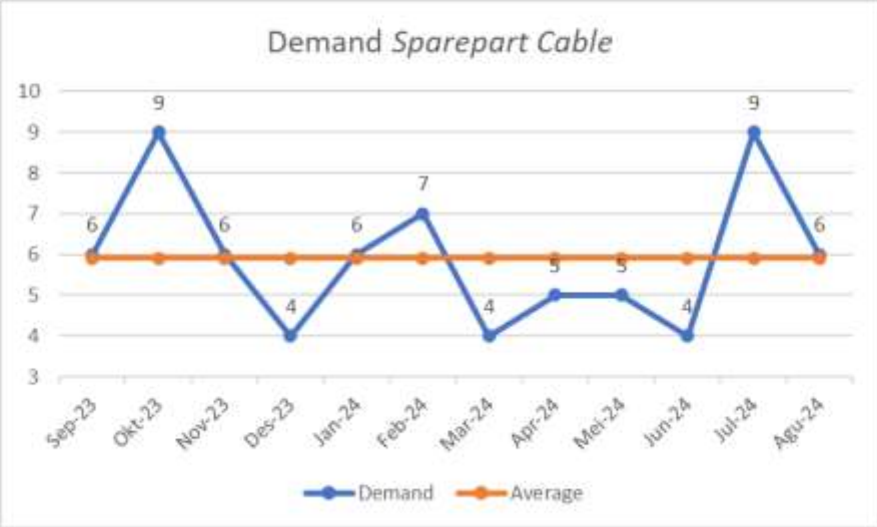

Figure 1. Plot of Cable Spare Parts Requirement Data

Based on Figure 1, cable requirements from September 2023 to August 2024 have an average of 6 pcs per month. The highest demand was recorded in October 2023 and July 2024 (9 pcs), while the lowest occurred in December 2023, March 2024, and July 2024 (4 pcs). The data pattern shows fluctuations around the average, and has a horizontal data pattern. The forecasting process is carried out by applying three methods, namely Moving Average, Weighted Moving Average, and Single Exponential Smoothing. The following are the results of cable spare parts forecasting from the Moving Average, Weigted Moving Average, and Single Exponential Smoothing methods.

Table 8. Cable Spare Parts Forecasting Results

	Demand	**Moving Average**	**Weigted Moving Average**	**Single Exponential Smoothing**
Sep-24	6	-	-	6
Oct-24	9	-	-	6
Nov-24	6	-	-	6
Dec-24	4	7	7	6
Jan-25	6	6	6	6
Feb-25	7	5	5	6
Mar-25	4	6	6	6
Apr-25	5	6	5	6
May-25	5	5	5	6
Jun-25	4	5	5	6
Jul-25	9	5	5	6
Agu-25	6	6	7	6
Sep-25	-	-	7	-
Total	**71**	**51**	**57**	**71**
Average	**6**	**4**	**5**	**6**

Cable Spare Parts Forecasting Error

The processing of cable spare parts inventory control begins with forecasting demand to determine the most appropriate forecasting method based on the smallest error analysis. The three methods are compared to determine the method that produces the smallest error value.

ISSN: 2716-3865 (Print), 2721-1290 (Online)

The results of the comparison of the error analysis of the three forecasting methods can be seen in Table 10.

Table 10. Comparison of Cable Spare Parts Forecasting Error Values

Method	MAD
Moving Average	1,4
Weigted Moving Average	1,5
Single Exponential Smoothing	1,3

Based on Table 10, the Single Exponential Smoothing method produces cable spare parts forecasting with the smallest Mean Absolute Deviation (MAD), which is 1.3 ≈ 1 . The next step is to verify the data using the forecasting results from the Single Exponential Smoothing method.

Moving Range Chart **(MRC)**

After obtaining the forecasting calculation, the forecasting verification is carried out using the moving range chart (MRC). The following is an example of calculating the moving range chart (MRC) for cable spare parts from forecasting results using the following formula as follows:

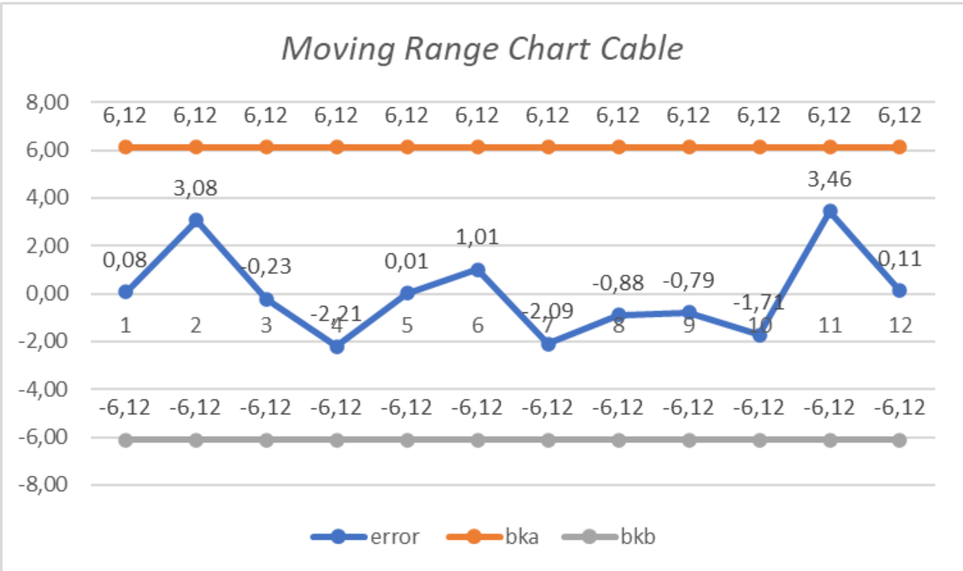

Figure 2. Moving Range Chart

Value MR $= \frac{\sum MR}{n-1} = \frac{25{,}32}{12-1} = 2{,}3$

BKA = + 2,66 x $\overline{MR}$ = + 2,66 x 2,3 = 6,12

BKB = - 2,66 x $\overline{MR}$ = -2,66 x 2,30 = -6,12

Based on Figure 2, it shows that there is a stable system where the forecasting data is within the upper control limit of 6.12 and the lower control limit of -6.12 so that it can be stated that the single exponential smoothing method forecasting can be used for forecasting demand for cable spare parts in the coming period.

Table 11. Sparepart Forecasting Results for August 2024-July 2025

	Sparepart				
	Cable (pcs)	**Membrant (pcs)**	**Transmitter (pcs)**	**Belt (pcs)**	**Valve (pcs)**
Sep-24	6	-	7	-	6
Okt-24	6	-	7	-	6

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Nov-24	6	-	7	-	6
Dec-24	6	7	7	6	6
Jan-25	6	7	7	7	6
Feb-25	6	7	7	8	7
Mar-25	6	7	7	9	6
Apr-25	6	8	7	7	6
May-25	6	9	7	6	6
Jun-25	6	8	7	6	6
Jul-25	6	8	7	5	6
Agu-25	6	6	7	7	6
Sep-25	-	-	-	5	-
Total	71	66	84	67	76
Average	6	6	7	6	6

Table 11 contains the results of forecasting cable, membrant, transmitter, belt, and valve spare parts based on each selected forecasting method. After knowing the forecasting results, the calculation of raw material inventory control will continue using the proposed method, namely the Min-Max Stock Method.

Inventory Control of Spare Parts Forecasting Results with Proposed Methods

The next step after forecasting is to calculate the inventory control of raw materials from forecasting results using the selected proposed method, namely the Min-Max Stock Method. The calculation of sparepart cable is done using the following formula:

Safety Stock = (Maximum usage − T)x LT = (6 − 6)x 4/30 = 0 pcs

Min Inventory = (T x LT) + SS = (6x4/30) + 0 = 0,8 pcs ≈ 1 pcs

Max Inventory = 2 x (T x LT) + SS = 2(6x4/30) + 0 = 1,6 pcs ≈ 2 pcs

Order Quantity (Q) = Max − Min = 1,6 − 0,8 = 0,8 pcs ≈ 1 pcs

Reorder Point (ROP) = (TxLT) + SS =(6x4/30) + 0 = 0,8 pcs ≈ 1 pcs

Ruralization Frequency (F) = $\frac{D}{Q} = \frac{71}{0,8}$ = 90 time

Total Inventory Cost (TIC) = $(\text{Ruralization Frequency X A}) + ((\frac{Q}{2} + SS) \text{ X H})$ = $(90 \times 240.000) + ((\frac{0,8}{2} + 0) \text{ X } 87.000.000)$ = Rp 55.505.212

The following is a recapitulation of the calculation of the cost of ordering and the cost of storing spare parts using the min-max stock method is as follows:

Table 12. Recapitulation of Spare Parts Inventory Calculation

No.	*Sparepart*	Ordering Cost	Holding Cost	Total Inventory Cost
1	Cable	Rp 21.600.000	Rp 33.905.212	Rp 55.505.212
2	Membrant	Rp 21.600.000	Rp 68.633.333	Rp 90.233.333
3	Transmitter	Rp 12.342.857	Rp 74.756.125	Rp 87.098.982
4	Belt	Rp 28.800.000	Rp 49.843.750	Rp 78.643.750
5	Valve	Rp 28.800.000	Rp 30.015.417	Rp 58.815.417
Total Inventory Cost				**Rp 370.296.695**

Based on Table 12, the total cost of cable, membrant, transmitter, belt, and valve spare parts inventory is Rp 370.296.695. The analysis results show that the Min-Max Stock method is

ISSN: 2716-3865 (Print), 2721-1290 (Online)

more efficient in managing inventory than Continuous Review, with a lower total inventory cost of Rp 480.838.690 and a Continuous Review method of Rp 522.482.213. The resulting savings reach 25% compared to the company's method, with Valve providing the highest efficiency (60%). The Continuous Review method requires constant stock monitoring, which is less efficient for low-demand spare parts. In contrast, Min-Max Stock is more suitable as it maintains a balance between item availability and cost efficiency. To optimize inventory management and reduce the risk of downtime, two main strategies are implemented: Min-Max Stock Policy Optimization by Determining ROP and maximum limits based on historical spare parts usage. Forecasting Sparepart Requirements by Using forecasting methods (MA, WMA, SES) with error evaluation (MAD, MSE, MAPE) to improve the accuracy of demand estimation. With the combination of Min-Max Stock and accurate forecasting, PT XYZ can avoid stockouts, reduce overstock, and reduce inventory costs effectively.

Conclusion

The analysis results show that the Min-Max Stock method is more effective in managing spare parts inventory at PT XYZ than the Continuous Review method and the previous company method. The total cost of inventory with Min-Max Stock is Rp 480.838.690, lower than Continuous Review (Rp 555.542.213) and the company method (Rp 640.800.000). The Min-Max Stock method can save costs up to Rp 159.961.310 (25%), with the highest efficiency in valve spare parts (60%). The application of this method can optimize the budget and reduce waste in inventory management.

Future research can implement technology in inventory management with a barcode system to improve stock accuracy and AI in forecasting spare part needs. This integration is expected to optimize inventory, reduce errors, and improve operational efficiency and reliability at PT XYZ. This study has limitations in applying to other spare parts, so further research is needed to produce more optimal findings.

References

Alam, I. A., & Tandra, W. (2021). Analisis Pengendalian Persediaan Bahan Baku Upaya Meminimalkan Biaya Persediaan Pada Perusahaan Elang Sederhana Di Kota Palembang. *OSF Preprints*.

ALMADANY, K. (2021). Comparative Inventory Control Analysis With Economic Order Quantity (Eoq) And Just In Time Method To Minimize Inventory Costs At UD.Melati Jaya. *UNIMAS Review of Accounting and Finance*, *5*(1), 1–7. http://dx.doi.org/10.33736/uraf.2787.2021

Amrina, E., & Dewi, A. Y. (2021). Optimizing Inventory Control System of Crumb Rubber Raw Material: a Case Study. *IOP Conference Series: Materials Science and Engineering*, *1041*(1), 012045.

Aryanny, E., & Kurniawan, Y. D. (2020). Analisis Pengendalian Persediaan Suku Cadang Housing Gowl for Gravel Pump Warman Dengan Metode Periodic Review Dan Continuous Review Di Pt. Xyz. *Tekmapro : Journal of Industrial Engineering and Management*, *15*(1), 13–24. http://dx.doi.org/10.33005/tekmapro.v15i1.131

Dagi, T. F., Morasa, J., & Tirayoh, V. Z. (2023). Raw Material Inventory Analysis Using the Economic Order Quantity (EOQ) Method To Maximize Profits at UD. Panca Putra. *Indonesian Journal of Business Analytics (IJBA)*, *3*(1), 85-98. https://doi.org/10.55927/ijba.v3i1.3307

Haekal, J. (2023). Inventory Analysis at the Inspection Services Division using Economic Order Quantity (EOQ) and Just in Time (JIT) Approach. *International Journal of Scientific*

ISSN: 2716-3865 (Print), 2721-1290 (Online)

and Applied Research (IJSAR), eISSN: 2583-0279, *3*(6), 1-10. https://doi.org/10.54756/IJSAR.2023.V3.6.1

Hossain, N. U. I., Sokolov, A. M., Turner, H. V., & Merrill, B. (2023). Development of an inventory management program for warehouse storage of raw materials in a continuous chemical manufacturing system to prevent production deficiencies. In *Proceedings of the International Conference on Industrial Engineering and Operations Management, Manila, Philippines* (pp. 85-94). https://doi.org/10.46254/AN13.20230016

Jaboob, A. S., Awain, A. M. B., Ali, K. A. M., & Mohammed, A. M. (2024). Introduction to Operation and Supply Chain Management for Entrepreneurship. In *Applying Business Intelligence and Innovation to Entrepreneurship* (pp. 52-80). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-1846-1.ch004

Ledy Vanesa, & Helma, H. (2023). Analysis of Raw Material Inventory Control using the ABC Analysis Method and EOQ Method in the Fajar Onion Crackers Business. *Mathematical Journal of Modelling and Forecasting*, *1*(1), 1–9. https://doi.org/10.24036/mjmf.v1i1.7

Marisya, F., Aryanti, R., Desliana, T., & Putri, V. W. (2024). Prosedur Penerapan Stock Opname Persediaan Spareparts Di PT United Tractors Tbk Cab. Palembang. *Jurnal Ilmiah Mahasiswa Perbankan Syariah (JIMPA)*, *4*(1), 325–334. https://doi.org/10.36908/jimpa.v4i1.327

Marpaung, R. J. M., & Marzolina, P. A. S. (2024). The Utilization of the Economic Order Quantity (EOQ) Method to Enhance the Efficiency of Raw Material Inventory at PT. Trimas Madya in Kampar District, Riau Province. *International Journal*, *5*(11), 3772-3782. http://dx.doi.org/10.61707/ybjn7d43

Meirizha, S. N., & Farhan, M. (2022). Analisis Persediaan Bahan Baku Pt Hakaaston Menggunakan Metode Continous Review System. *Jurnal Surya Teknika*, *9*(1), 370–374. https://doi.org/10.37859/jst.v9i1.3766

Mor, R., Bhardwaj, A., Kharka, V., & Kharub, M. (2021). Spare parts inventory management in warehouse: a lean approach. *International Journal of Industrial Engineering & Production Research*, *32*(2), 4. http://dx.doi.org/10.22068/ijiepr.32.2.179

Nuraeni, N., & Santoso, B. (2024). Peranan Manajemen Persediaan Bahan Baku terhadap Penjadwalan Produksi PT XYZ. *Jurnal Bisnis dan Manajemen (JURBISMAN)*, *2*(2), 1–15. https://doi.org/10.61930/jurbisman.v2i2.614

Ogah, M., Asiegbu, G., & Moradeyo, N. (2022). Effect of raw material inventory on operational performance in an emerging economy insight from the Nigerian manufacturing sector. *International Journal on Recent Trends in Business and Tourism*, *6*(2), 31-43. http://dx.doi.org/10.31674/ijrtbt.2022.v06i02.003

Rachmawati, N. L., & Lentari, M. (2022). Penerapan Metode Min-Max untuk Minimasi Stockout dan Overstock Persediaan Bahan Baku. *Jurnal INTECH Teknik Industri Universitas Serang Raya*, *8*(2), 143–148. https://doi.org/10.30656/intech.v8i2.4735

Sah, G. G., & Furedi-Fulop, J. (2022). The effects of proper inventory management on the profitability of SMEs. *Technium Soc. Sci. J.*, *32*, 340. http://dx.doi.org/10.47577/tssj.v32i1.6634

Saputra, W. S., Ernawati, R., & Wulansari, W. A. (2021). Analysis of Raw Material Inventory Control Using Economic Order Quantity (EOQ) Method at CV. XYZ. *International Journal of Computer and Information System*, *2*(3), 118-124. https://doi.org/10.29040/ijcis.v2i3.63

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Tiurlan, I., & Wicaksono, P. A. (2023). Usulan Penentuan Quantity Order, Reorder Point, dan Safety Stock Material Stroomnet dengan Pendekatan Model Min-Max dan Continuous Review (Studi Kasus: Bagian Inventory PT Indonesia Comnet Plus). *Industrial Engineering Online Journal*, *12*(2).

Vaka, D. K. (2024). Integrating inventory management and distribution: A holistic supply chain strategy. *the International Journal of Managing Value and Supply Chains*, *15*(2), 13-23. http://dx.doi.org/10.5121/ijmvsc.2024.15202

Yunusa, A. (2021). Inventory management practices and performance of manufacturing firms in Kogi State. *Journal of Good Governance and Sustainable Development in Africa*, *6*(3), 54-63.

Zhao, B., & Tu, C. (2021). Research and development of inventory management and human resource management in ERP. *Wireless Communications and Mobile Computing*, *2021*(1), 3132062. http://dx.doi.org/10.1155/2021/3132062

Zhao, B., & Tu, C. (2021). Research and development of inventory management and human resource management in ERP. *Wireless Communications and Mobile Computing*, *2021*(1), 3132062. http://dx.doi.org/10.1155/2021/3132062

Zharfan, D. T., & Handayani, N. U. (2023). Analisis Perbandingan Pengendalian Persediaan Bahan Baku Menggunakan Metode EOQ, POQ, dan Min-Max (Studi Kasus: PT Kimia Farma Plant Banjaran). *Industrial Engineering Online Journal*, *12*(4), 1–9.

ISSN: 2716-3865 (Print), 2721-1290 (Online)