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Evaluation of the implementation of Main Distribution Material (MDU) spare part procurement at seven customer service unit (ULP) in Semarang are using ABC analysis and time series forecasting

Salsabila Khairunnisa and Darminto Pujotomo *

Department of Industrial Engineering, Universitas Diponegoro, Semarang, Central Java, Indonesia.

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Abstract

Evaluation of the Implementation of Main Distribution Material (MDU) Spare Part Procurement at Seven Customer Service Units (ULP) in Semarang Area using ABC Analysis and Time Series Forecasting (Case Study: PT PLN (Persero) UP3 Semarang) Time series forecasting is a method used to predict the number of future needs in a time series. This research was conducted at the company PT PLN (Persero) UP3 Semarang, where the author tried to deal with the company's problems related to the procurement of Main Distribution Material (MDU) which often occurs overstock or lack of stock. The author uses ABC analysis to classify goods based on value ratings ranging from the highest value so that three parts with group A are obtained for forecasting, kWH meters, 2 × 10 mm2 PWR cables, and 4A MCBs. Forecasting is done with four methods, the Multiplicative Decomposition method, the Holt-Winters method, the Moving Average method, and the Exponential Smoothing method. From the results of the error calculation, it is obtained that the Holt-Winters method obtains the lowest percentage error with results of 10% - 20% or is good to use for forecasting. The comparison between the forecasting results and the overall actual demand is above 70%, which means that the forecasting results are close to the actual demand that occurs, thus increasing the accuracy of the Holt-Winters forecasting method. Suggestions for improvement that can be given to the company are to apply the Holt-Winters forecasting method in forecasting MDU spare part inventory at PT PLN (Persero) UP3 Semarang.

Keywords: Forecasting time series; ABC analysis; Procurement; Supply chain management

1. Introduction

Nowadays electricity is a vital need for people in carrying out all their activities such as office activities, traffic, government, factories, teaching and learning processes, household needs, and also all other needs. It causes the provision of electricity power is very necessary to be implemented well because the management and development of electricity can guarantee thatelectricity can be available in sufficient quantity and priceas well as good quality. Therefore, the welfare and prosperity of the people can increase fairly and alsoevenly if the availability of electricity is available properly [1]. In providing all aspects ofelectricity, PT PLN is a State-Owned Enterprise (BUMN)company which is stated in government regulation No. 18 as the Holder of the Power of Electricity Business (PKUK) which is tasked with providing electricity for thepublic interest. PT PLN is tasked with carrying out government duties in the electricity sector to support development and community electricity needs using the principle of Limited Liability Companies.

PT PLN UP3 Semarang is one of the PLN companiesthat provides services for the needs of all aspects of theelectricity community, especially the seven ULPs in theSemarang area such as adding power, installing newinstallations, and meeting the needs of spare parts to bedistributed to ULPs, and meeting other needs for thecommunity. PT PLN's Customer Service Unit (ULP) isone of the state-owned companies that directly providesservices as a service provider

* Corresponding author: Darminto Pujotomo

related to the sale ofelectricity to the community in its area. (Risdah, 2019).PT PLN UP3 has seven Customer Service Units (ULP)located in seven areas namely Central Semarang, EastSemarang, West Semarang, South Semarang, Kendal, Boja, and Weleri. Where UP3 Semarang is responsiblefor meeting the needs of spare parts in the seven ULPareas. So, it is necessary to plan for good material needsso that all material needs in the seven ULPs are also met.PLN UP3 Semarang divides spare parts into two types,namely Main Distribution Material (MDU) and materialaccessories. For the Main Distribution Material (MDU)itself is a material ordered directly to the PLNheadquarters while material accessories are materialspurchased directly from selected vendors. Both types ofspare parts are used to meet the demand and needs ofspare parts from the seven ULPs in the PLN UP3 region.

Based on the results of interviews with the PLN construction section, especially interviews with the headof the PLN UP3 Semarang warehouse, Mr. Wima Asharyand after making direct observations at the PLN UP3Semarang Warehouse located in the Krapyak area, PLNUP3 Semarang has a problem where consumer demand also tends to be difficult to predict and is classified as fluctuating for each month. In addition, the procurement of materials carried out by PLN UP3 itself has not been well scheduled so that it often causes insufficient stock and there is even stock that is actually increasingly accumulating due to declining demand. This can be interpreted that the spare part procurement system in PLN UP3 has not been able to adjust to the actual needs that occur. Spare part procurement that is still not well implemented does not only occur in accessory spare parts,but also in MDU spare parts which are the main spare parts with high demand and needs. Currently, PLN UP3 Semarang procures spare parts without any forecasting used to estimate good procurement. Based on the above problems, it is necessary to carry out an appropriatemethod to be able to evaluate the existing spare part procurement at PT PLN UP3 Semarang using spare partprocurement data from 2021 to 2023 and also estimate theright spare part procurement for the future so that it can help in making decisions based on forecasting results regarding procurement carried out by PLN UP3 to sevenCustomer Service Units (ULP) in the Semarang area.

Therefore, the researcher aims to find out whether the procurement strategy carried out by PLN UP3 is effective or not in procuring each spare part. In conducting the evaluation, the spare part that will be evaluated and forecasted is the Main Distribution Material (MDU) which is the main spare part ordered directly from PLN headquarters and has a fairly high number of requests. An effective evaluation process can be started by classifying MDU spare parts using ABC classification analysis. Then using the time series method, for theselected spare parts, forecasting will be carried out to compare and to be able to obtain the right selected methodto evaluate between the results of demand forecasting for2023 and the actual historical demand that occurred in 2023. After that, spare part forecasting for the nextperiod will be carried out using the selected method as a proposal for improving spare part stock for PT PLN UP3Semarang optimally.

2. Literature review

2.1. Supply Chain Management

Supply Chain Management is a form of combining activities in procuring materials or services, the process of converting materials, and the process of shipping to consumers [2]. Supply chainmanagement can help to reduce costs and meet customerneeds [3]. Supply Chain Management canalso be interpreted as a form of network between companies that are interconnected with the same goal of managing product procurement as optimally as possible [4].

2.2. Inventory

Inventory is everything or a form of asset consisting of products that are stored for sale within a certain period of time, or goods that are still in the production process, or raw materials that are still waiting to be produced so that they are stored first [5].

According to the types, inventory can be divided into five types. The following is a classification of inventory based on its type [6].

- Raw Material Inventory
- Purchased parts/Components
- Work In Process
- Finished Goods
- Supplies

2.3. ABC Analysis

ABC analysis is an analytical concept with a function to classify goods based on value ratings ranging from the largest value to the smallest value by dividing into three value groups referred to as groups A, B, and C [7]. The following are the various classifications of the ABC method [8].

- Class Group A

This group is a group of items that have a high value. Group A is only represented by 20% of the inventory but can generate a value of 80%.

- Class Group B

This group is a group of items that get a medium value. 30% of the total inventory represents group B and yields a value of 15%.

- Class Group C

This group is a group of items that get low value. 50% of the total inventory represents group C but only generates a value of 5%.

2.4. Forecasting

Forecasting is a process for estimating future demand needed to meet demand for goods or services including quantity, time, and location requirements based on demand and the company's production capacity [9]. Types of forecasting based on future operational plans are divided into three categories, among others [10]:

- Demand forecast
- Economic forecast
- Technological forecast

2.5. Time Series Forecasting

Time Series method is a method applied in analyzing data that is a function of time (Ishak, 2010).

2.5.1. Multiplicative Decomposition Method

Method used to perform forecasting and can also be used to obtain information from various factors that exist about periodic series components such as seasonality, trend, irregularity, and cycles in the observed results [11].

There are several steps involved in performing forecasting calculations using the Multiplicative Decomposition method [12].

- Determine the number of seasons that you want to share.
- For the Multiplicative Decomposition - Average All method, it will be continued by calculating the sales average (CTDMA). The following is the formula for calculating the sales average.

$$\text{CMA} = \frac{y_{-1}+y_t+y_{t+1}}{3} \quad \text{..... (1)}$$

For the Multiplicative Decomposition - Centered Moving Average method, we will continue using the formula based on the number of seasons.

- If there are 3 seasons

$$\frac{y_{-1}+y_t+y_{t+1}}{3} \quad \text{..... (2)}$$

- If there are 4 seasons

$$\frac{(0{,}5*y_{t-2})+y_{t-1}+y_t+y_{t+1}+y_{t+2}}{4} \text{ ..... (3)}$$

- Calculating the ratio value. The following is the ratio calculation formula:

$$\frac{\text{Penjualan}}{\text{CTDMA}} \quad \ldots\ldots\ldots\ldots (4)$$

- Calculating the seasonal value. The following is the seasonal calculation formula:

$$\frac{\sum \text{Rasio Seasonal ke}-i}{n} \quad \ldots\ldots\ldots\ldots (5)$$

- Calculating the smoothed value. The following is the smoothed calculation formula:
- Calculating Yunadjusted and Yadjusted.

Yunadjusted is the Y value which is the unadjusted sales. Here is the formula for calculating it.

$$\text{Yunadjusted} = a + bX \quad \ldots\ldots\ldots (6)$$

Yadjusted is the Y value which is the adjusted sales or the result of forecasting. Here is the formula for calculating it.

$$\text{Yadjusted} = \text{Yunadjusted} * \text{Seasonal} \quad (7)$$

To calculate the a and b values in the formula, determine Yunadjusted to find the trend value. Here are some steps that need to be done [13].

- Calculating the value of x (time)

$$x = \frac{\sum x}{n} \quad \ldots\ldots\ldots (8)$$

- Calculating the value of y (sales)

$$y = \frac{\sum y}{n} \quad \ldots\ldots\ldots (9)$$

- Calculate the b value from the results of the x and y values that have been obtained.

$$b = \frac{\sum xy - nxy}{\sum x^2 - nx^2} \quad \ldots\ldots (10)$$

- Calculating the value of a

$$a = y - bx \quad \ldots\ldots\ldots (11)$$

2.6. Holt-Winters Method

A forecasting method that functions to deal with the trend and seasonal factors that often appear simultaneously in an existing time series data, where the Holt-Winters method is based on three elements of data plot types including seasonal elements, trend elements, and stationary elements in each period [14].

2.7. Moving Average Method

A forecasting method to find the average value and use it as a forecasting result for the future [15].

Single Moving Average

A forecasting method that produces a forecast value using actual values for future forecasting and assumes that demand is constant over time [16].

$$T = x$$

$$F_{i+1} = \underline{X} = \sum_{i=1}^{T} \frac{Xi}{T} \quad \ldots\ldots (12)$$

- Double Moving Average

A forecasting method that uses past and present time series as a means of predicting forecasts with data plots as usual or close together, namely trend data plot [17].

$$S'_t = \frac{X_1 + X_{t-1} + X_{t-2} + \cdots + X_{t-N+1}}{N} \ldots\ldots\ldots (13)$$

$$a_t = S'_t + (S'_t - S''_t) = 2S't - S''_t \ldots\ldots\ldots (14)$$

$$b_t = \frac{2}{N-1}(S'_t - S''_t) \qquad \ldots\ldots\ldots (15)$$

$$F_{t+m} = a_t + b_t \ldots\ldots\ldots (16)$$

2.8. Exponential Smoothing Method

Medium-term as well as long-term forecasting methods that use smoothing constant values based on mathematical foundations are mainly used at the operational level of the company [18].

- Single Exponential Smoothing (SES)

The forecasting method develops from the Single Moving Average method to perform short-term forecasting by giving weight to each data to estimate the increase and decrease in data around the mean value without a consistent upward trend [19].

$$F = \alpha X_i + (1 - \alpha)F_{t_{-1}} \ldots\ldots\ldots (17)$$

- Double Exponential Smoothing (DES)

Forecasting method with one parameter to smooth the trend (tendency) in data [20].

$$S'_t = \alpha x \times (1 - \alpha)S'_{t-1} \ldots\ldots\ldots (18)$$

$$S''_t = \alpha S'_t + (1 - \alpha)S''_{t-1} \ldots\ldots\ldots (19)$$

$$a_2 = 2S'_2 - S''_2 \ldots\ldots\ldots (20)$$

$$b_2 = \frac{\alpha}{1-\alpha}(S'_2 - S''_2) \qquad \ldots\ldots\ldots (21)$$

$$F_3 = a_2 + b_2 \qquad \ldots\ldots\ldots (22)$$

- Forecasting Error Measurement

Measurement of forecasting errors is used to be ableto determine how much error or the size of the error thatoccurs from the forecasting methods that have been carried out [21].

2.8.1. Mean Absolute Deviation (MAD)

The error measurement method of the forecasting method is calculated by the sum of the absolute value of each forecasting error divided by the number of data (n) [22].

$$MAD = \frac{\sum_{i=1}^{n} |e_t|}{n} \quad \ldots\ldots (23)$$

$$e_t = A_t - F_t \ldots\ldots\ldots (24)$$

2.8.2. Mean Square Error (MSE)

The error measurement method of the forecasting method is calculated by summing all the squared forecasting errors for each period divided by the numberof forecasting periods (n) [22].

$$MSE = \frac{\sum_{i=1}^{n} {e_t}^2}{n} \quad \ldots\ldots\ldots\ldots (25)$$

$$e_t^2 = (A_t - F_t)^2 \quad \text{..... (26)}$$

2.8.3. Mean Absolute Percentage Error (MAPE)

The method of measuring the error of the forecasting method which states the results of the forecasting method against the actual demand during a certain period which is indicated by the percentage error that occurs to check whether the percentage error is too high or low [22].

$$\text{MAPE} = \frac{\sum_{i=1}^{n} |\text{PE}|}{n} \times 100\% \quad \text{..... (27)}$$

$$\text{PE}_t = \frac{A_t - F_t}{A_t} \quad \text{..... (28)}$$

2.9. Forecasting Method Validation

2.9.1. Moving Range Map

Moving Range Map is a method that is made with the intention to be used as a comparison of the value of the results of forecasting with the value of demand that actually occurs in the same time period with the aim of testing the level of stability of the cause-and-effect system that can affect demand [23].

$$\text{MR} = (X_t - F_t) - (X_{t-1} - F_{t-1}) \quad \text{..... (29)}$$

$$\text{CL} = \sum \frac{|\text{MR}|}{n-1} \quad \text{..... (30)}$$

$$\text{UCL} = 2{,}66 \times \text{CL} \quad \text{..... (31)}$$

$$\text{LCL} = -2{,}66 \times \text{CL} \quad \text{..... (32)}$$

2.10. Research Methodology

The steps or stages carried out in the research are described in detail in Figure 1.

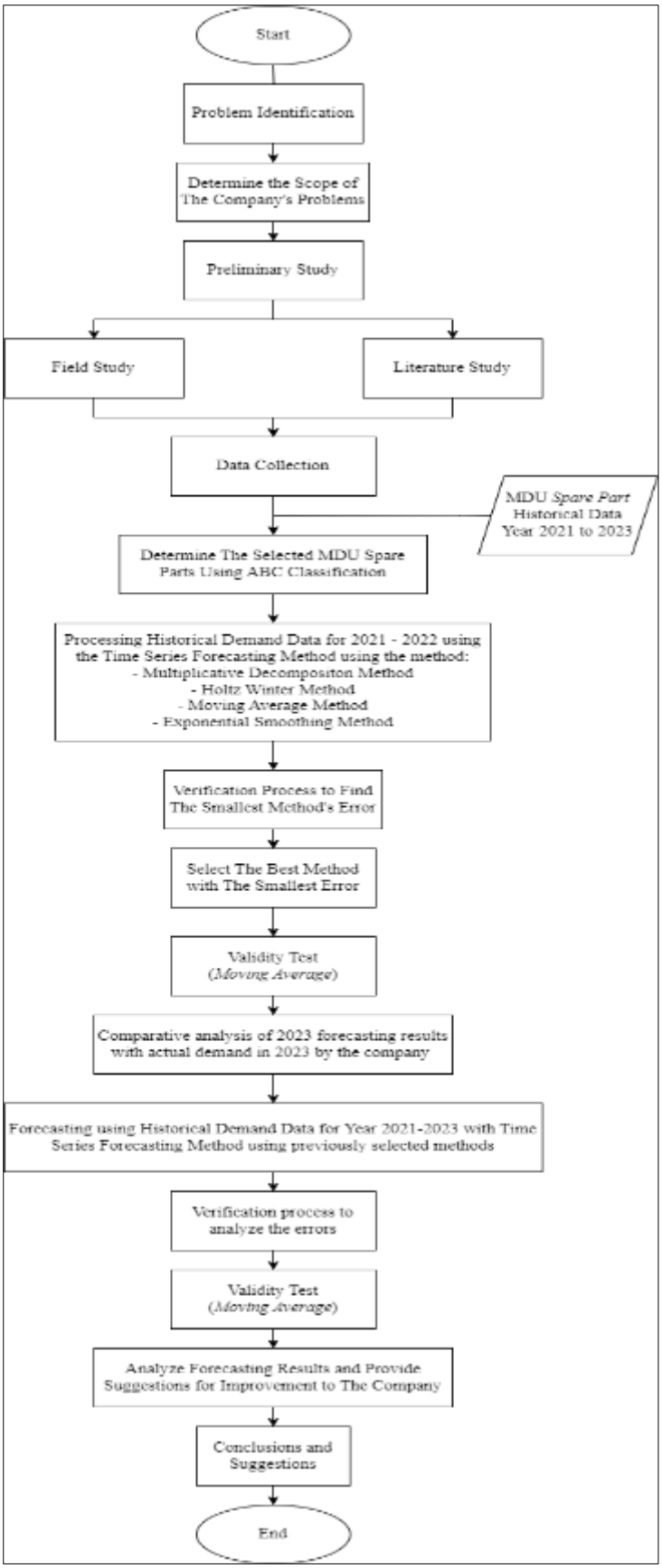

Figure 1 Research Methodology

3. Results and discussion

3.1. Spare Part Classification using ABC Analysis

Due to the results of the calculations carried out by the research, it was found that the kWH Meter spare parts obtained an accumulation value exceeding 77% so that the kWH Meter spare parts were not included in the ABC analysis calculation and would be directly included in the data processing. From the ABC analysis that has been carried out on 10 MDU spare parts, it is found that MDU spare parts that fall into the accumulation value of less than 80% or group A are 2 types of spare parts, namely PWR cable spare parts with a percentage of 56.08% or accumulation of 56.08% and MCB 4A with a percentage of 14.75% or accumulation of 70.82%. So that the three spare parts are selected and will be calculated and analyzed for forecasting results.

Table 1 Selected MDU Spare Parts

No	Part Code	Spare Part Name
1	2190224	MTR;kWH E-PR;;1P;230V;5-60A
2	3110025	CABLE PWR; NFA2X;2X10mm2
3	3250048	MCB;230/400V;1P;4A;50Hz

3.2. Historical Data Pattern

The following is a plot of historical data from 2021 to 2022 for the three selected spare parts.

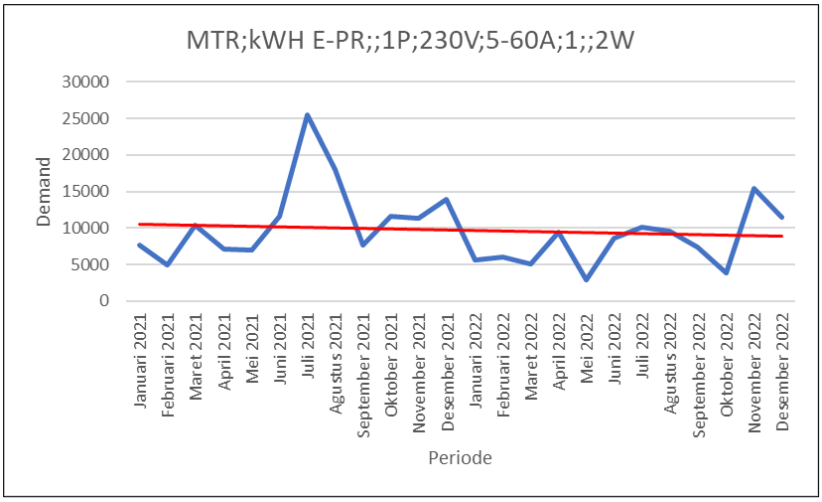

Figure 2 Plot of kWH Meter Spare Part Data

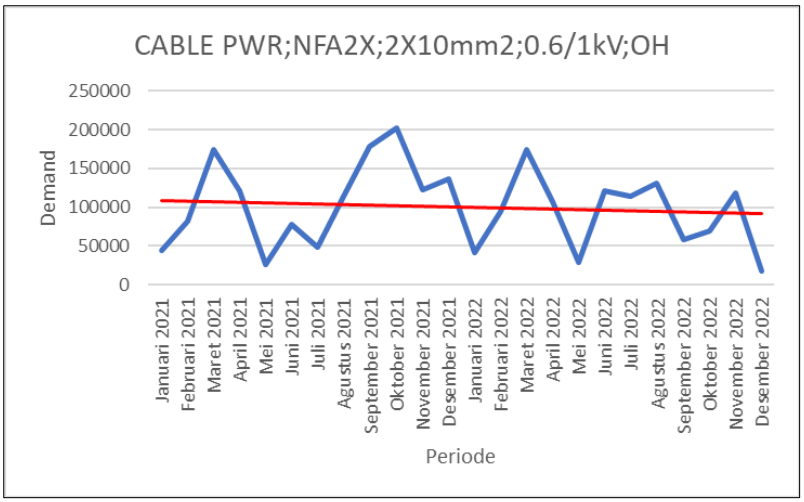

Figure 3 Plot of PWR Cable Spare Part Data

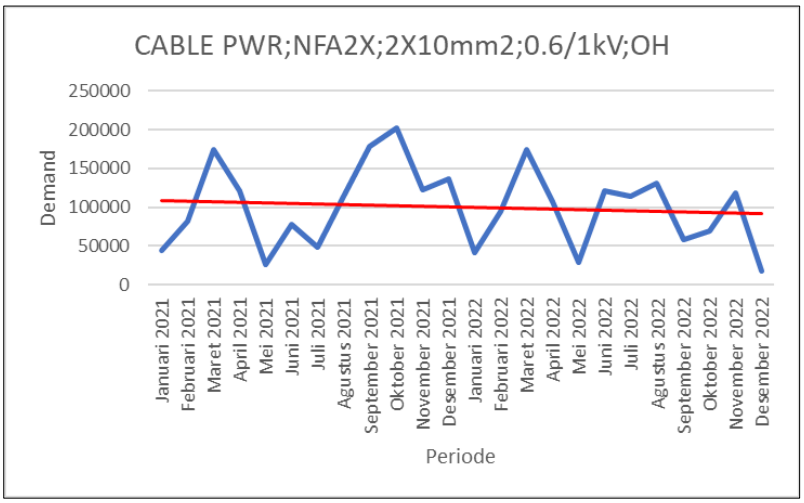

Figure 4 Plot of MCB 4A Spare Part Data

Based on the results of the data plots of the three spare parts above, it is found that the historical data of the three spare parts shows seasonal and fluctuating data patterns.

3.3. Forecasting Results for the Three Selected Spare Parts

After forecasting for 2023 for kWH Meter, PWR Cable, and MCB 4A spare parts by applying four time series forecasting methods, namely multiplicative decomposition, holt-winters, single moving average (SMA), and single exponential smoothing (SES) methods calculated using Excel, Eviews, POM QM, and Minitab software, then proceed with calculating the error for all forecasting method results using the MSE, MAD, and MAPE methods. The following is a recapitulation of the error results and determination of the selected forecasting method for kWH Meter spare parts, PWR Cables, and MCB 4A. The results of the recapitulation.

Table 2 Recapitulation of Spare Part Meter kWHError

Methods	MSE	MAD	MAPE
Multiplicative Decomposition Method	6312730,624	2022,104	23,417%
Holt-Winterss Method	206747,759	364,804	3,811%
SMA Method	34762343,716	4214,614	50,595%
SES Method	27360978,337	3683,970	44,655%

The results of the PWR Cable spare part error recapitulation is shown in Table 3.

Table 3 Recapitulation of PWR Cable Spare PartError

Methods	MSE	MAD	MAPE
Multiplicative Decomposition Method	1000900191,687	23872,224	35,070%
Holt-Winters Method	2869571,561	1456,803	1,590%
SMA Method	3165980652,316	43343,368	79,748%
SES Method	5849009371,876	63146,137	59,354%

The results of the MCB 4A spare part error recapitulation is shown in Table 4.

Table 4 Recapitulation of MCB 4A Spare Part Error

Methods	MSE	MAD	MAPE
Multiplicative DecompositionMethod	1857382,873	1057,574	31,658%
Holt-Winters Method	326553,323	445,447	12,412%
SMA Method	6283726,818	1854,773	58,079%
SES Method	6484656,494	1815,550	49,666%

Of the three forecasting results used to forecast spare parts for kWH meters, 2 × 10mm^2 PWR cables, MCB 4A, it is found that the method with the smallest error is Holt-Winters. The results of the MAPE value of the Holt- Winters method are between 10% - 20%, which means that the ability of the forecasting method is good. Therefore, it can be concluded that the Holt-Winters method is the selected method used for forecasting the three selected MDU spare parts.

3.4. Validation of Selected Forecasting Method

The following is a graph of the validation results of the selected forecasting method, namely the Holt-Wintersmethod for the three MDU spare parts using the MovingRange validation method.

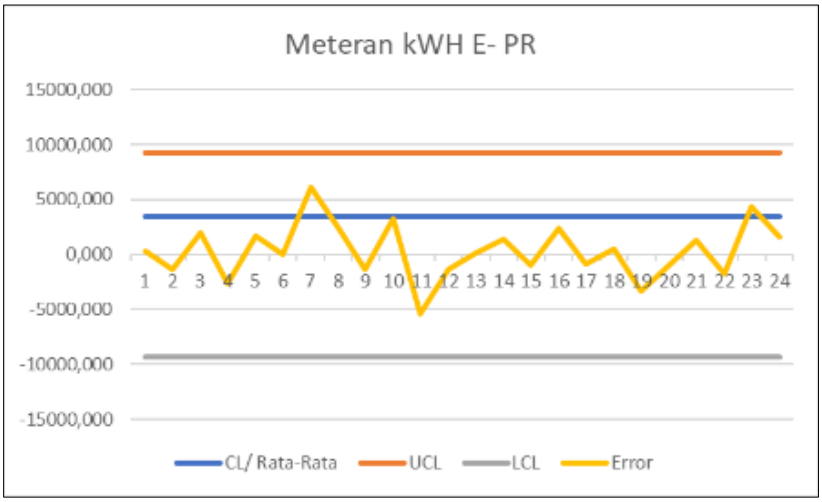

Figure 5 kWH Meter Spare Part Validation

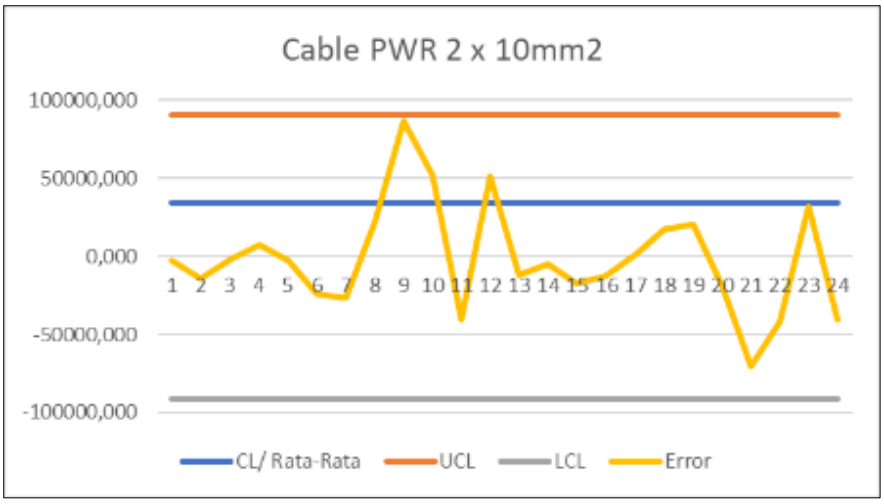

Figure 6 Cable Spare Part Validation

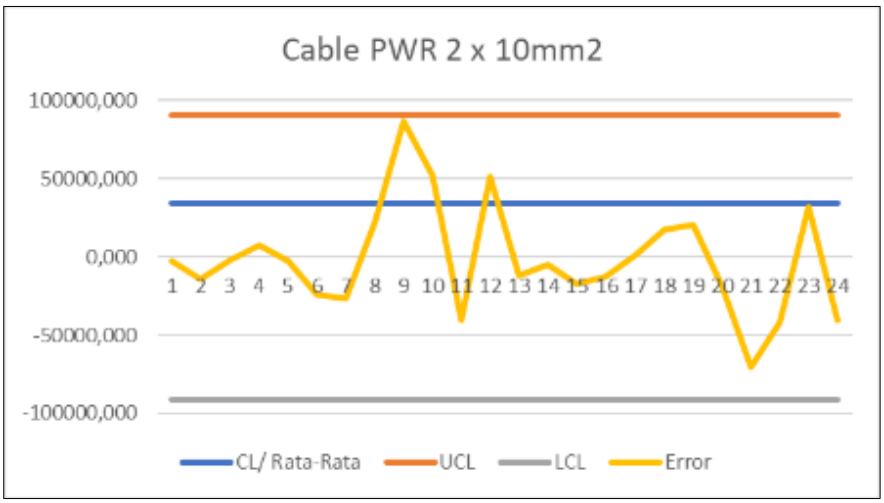

Figure 7 MCB 4A Spare Part Validation

Based on the graph above, it can be concluded that there is no error value that exceeds the UCL limit and LCL limit. With these results, it can be concluded that the validity of the forecasting data is valid using the MovingRange Map method and there is no need to do the T test and F test.

3.5. Comparison of Forecasting Results with Actual Demand in 2023

The following is a recapitulation table of the percentage comparison of forecasting results with actualdemand data in 2023.

Table 5 Comparison of Forecasting with Demand

Spare Part	Month	A	B	C
kWH Meter	January	6921	8332	83%
	February	4464	5620	79%
	March	9166	10025	91%
	April	6275	8343	75%
	May	6142	7035	87%
	June	10048	7535	133%
	July	21962	14189	155%
	August	15341	10805	142%
	September	6442	8785	73%
	October	9811	10364	95%
	November	9451	12026	79%
	December	11566	10225	113%
PWR Cable	January	42677	49910	86%
	February	77759	98491	79%
	March	165031	113895	145%
	April	114416	113068	101%
	May	24508	34021	72%
	June	71605	73015	98%
	July	45082	52227	86%
	August	104532	118376	88%
	September	162873	144326	113%
	October	182354	161099	113%
	November	109763	115209	95%
	December	121130	139894	87%
MCB 4A	January	3101	3146	99%
	February	2289	2043	112%
	March	5260	6329	83%
	April	3094	2156	144%
	May	1164	1671	70%
	June	4887	3267	150%
	July	3681	4688	79%
	August	13773	11423	121%
	September	3617	4327	84%
	October	7693	6061	127%
	November	4874	6505	75%

Spare Part	Month	A	B	C
	December	9058	7590	119%

Table caption: A = Forecasting Results (Holtz Winters Method)B = Actual Historical Demand Year 2023; C = Percentage Comparison (Forecasting / ActualResults * 100%)

Based on the results of the recapitulation of the percentage comparison of forecasting results with actualdemand data in 2023, it can be seen that the dominance of the forecasting results is at a percentage above 70%, which means that all forecasting demand results in 2023can be said to be valid and close to the actual demand results in 2023 that occur.

3.6. Forecasting Results for the Next 12 Periods

The forecasting results of the Holt-Winters method are close to the actual demand in 2023 so that this method can be continued to forecast the demand for MDU spare parts for the period January to December 2024. The Holt- Winters method is calculated using Excel, Eviews, and Minitab software. The following is the output graph of the forecasting results of the three spare parts using Minitab software.

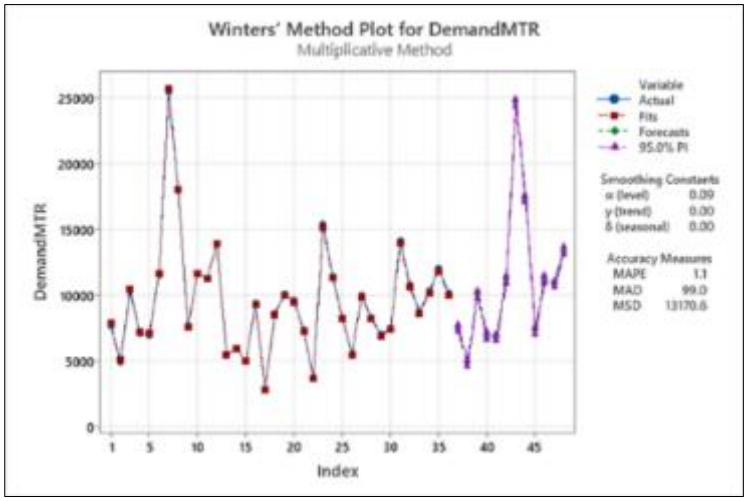

Figure 8 Forecasting Results of Spare Part MeterkWH

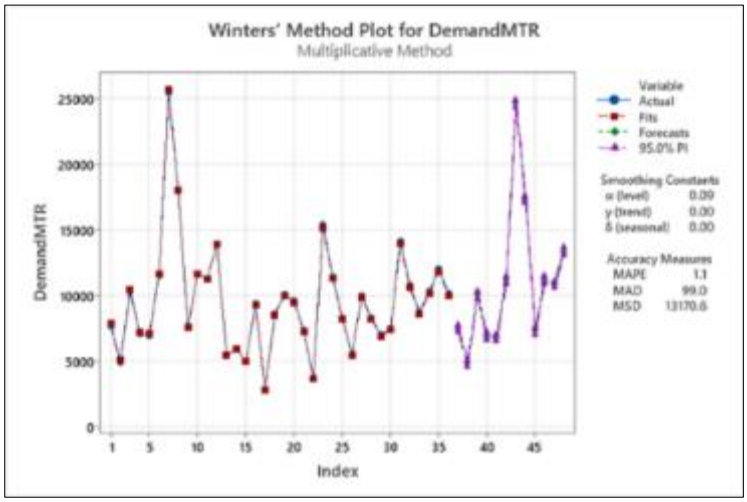

Figure 9 PWR Cable Spare Part Forecasting Results

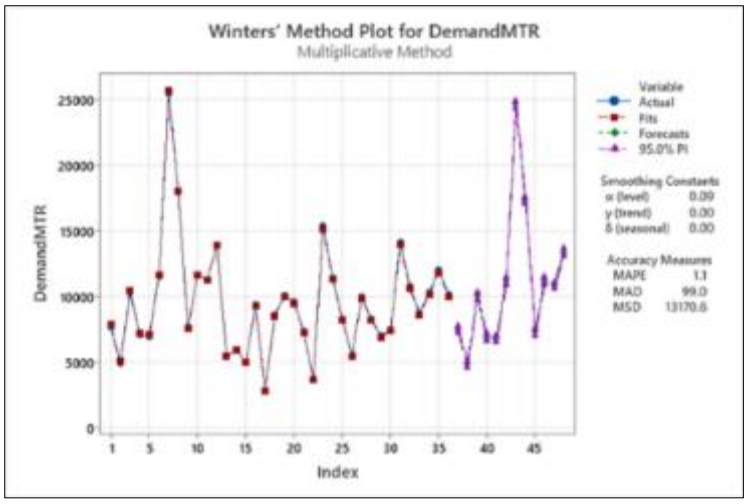

Figure 10 Results of Forecasting Spare Part MCB 4A

From the three forecasting results using the Holt-Wintersmethod, it can be seen that the error value using the MAPE method is very small. The results of the entire recapitulation of the error of spare parts for kWH Meters, PWR Cables, and MCB 4A using the Holt-Winters method are shown in Table 6.

Table 6 Recapitulation of Forecasting Errors for The Year 2024 Period

	kWH Meter	**PWR Cable**	**MCB 4A**
MSE	13170,641	47234,401	1078031,956
MAD	98,971	179,970	749,584
MAPE	1,069%	0,188%	17,955%

Based on the results of the above recapitulation, it can be seen that the results of the MAPE error value for kWH Meter spare parts and 2 × 10mm PWR Cable2 are less than 10%, which means that the ability of the forecasting method is very good. In addition, the results of the MAPE error value for MCB 4A spare parts are between 10% - 20%, which means that the ability of the forecasting method is quite good. So that the results of the forecasting method using Holt-Winterss can be continued to the validity test to determine the validity of the data.

3.7. Validation of Forecasting Method for the Year 2024 Period

The following is a graph of the results of the validation of the forecasting method for the next 12 periods or during the 2024 period, namely the Holt-Winters method for the three MDU spare parts using the Moving Range validation method.

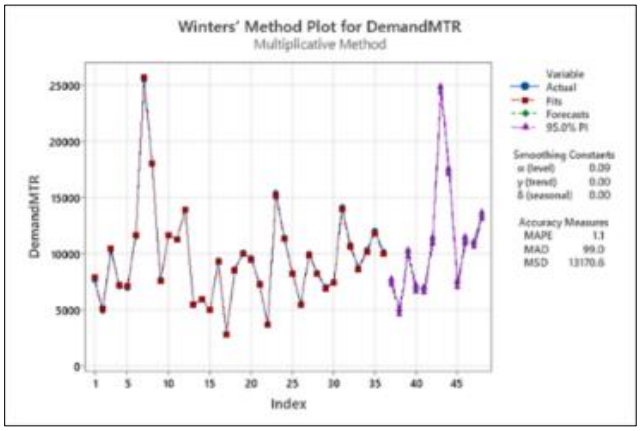

Figure 11 Validation of kWH Meter Spare Parts

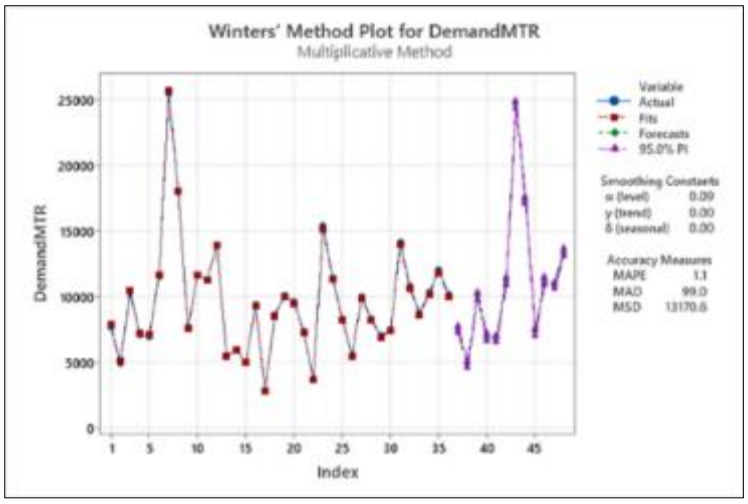

Figure 12 PWR Cable Spare Part Validation

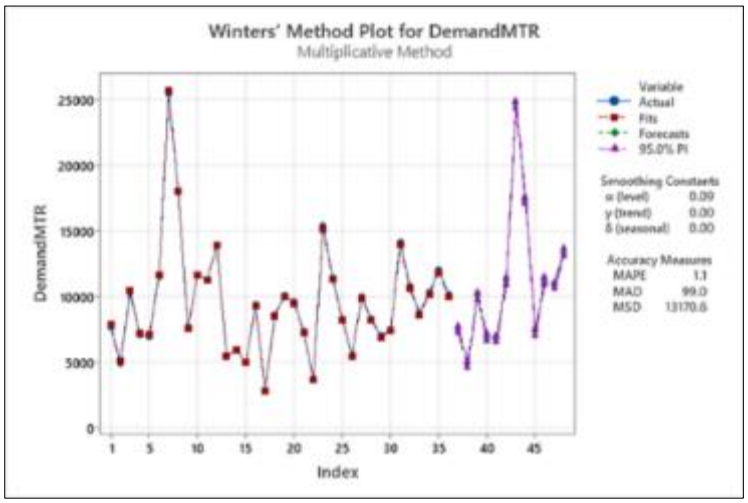

Figure 13 MCB 4A Spare Part Validation

Based on the moving range forecasting validation graph for the next 12 periods, it can be concluded that there is no error value that exceeds the UCL limit and LCL limit. With these results, it can be concluded that the validity of the forecasting data is valid using the Moving Range Map method and there is no need to do the T test and F test.

3.8. Forecasting Recapitulation Results for the Year 2024 Period

A recapitulation of the 12-period forecasting results for the three selected spare parts for the period January 2024to December 2024 is shown in Table 7.

Table 7 Recapitulation of Forecasting Results for the Year 2024 Period

Tahun 2024			
Month	**Meter kWH**	**Kabel PWR**	**MCB 4A**
January	7521	44676	3445
February	4878	81974	2538
March	10073	175207	5820

Tahun 2024			
Month	**Meter kWH**	**Kabel PWR**	**MCB 4A**
April	6936	122339	3417
May	6828	26395	1283
June	11235	77675	5378
July	24703	49262	4044
August	17359	115067	15106
September	7334	180620	3961
October	11239	203743	8412
November	10893	123565	5322
December	13414	137402	9876

3.8.1. Analysis

Analysis of Forecasting Results for the Year 2023 Period

Based on the historical data of spare part demand from January 2021 to December 2022 that has been collected, forecasting is carried out for January 2023 to December 2023. The goal is to evaluate the procurement process that has taken place through the forecasting results of the selected method which will be compared with the actual demand in 2023.

In the ABC analysis classification results, 3 spare parts are obtained that get the value of A or spare parts that will continue to the forecasting process. The three spare parts include kWH meters, 2 × 10 mm^2 PWR cables, and 4A MCBs. The time series forecasting methods used in this study include the Multiplicative Decomposition method, Holt-Winters method, Moving Average method, and Exponential Smoothing method. Based on the calculation of the error value, it can be seen that the Holt- Winters method obtained the smallest error value using the MSE, MAD, and MAPE error methods compared to the other three methods. The results of the Holt-Winters method MAPE value for kWH Meter spare parts are 3.811% and 2 × 10mm^2 Cable which is 1.590% or below 10% which means that the ability of the forecasting method is very good and MCB 4A spare parts are 12.412% or between 10% - 20% which means that the ability of the forecasting method is good. Therefore, it can be concluded that the selected method used for forecasting the three selected MDU spare parts is the Holt-Winters method.

Validation of forecasting results is done using the Moving Range method. Where the results show that all forecasting results using the Holt-Winters method for the three MDU spare parts are within the UCL and LCL limits, so it is concluded that the Holt-Winters method forecasting results can be said to be valid to be used for forecasting spare parts for the company PT PLN (Persero) UP3 Semarang.

Comparison Analysis of Demand Forecasting with Actual Year 2023

Comparison of forecasting results with actual demand data in 2023, it can be seen that the dominance of forecasting results is at a percentage above 70%, whichmeans that all forecasting results of demand in 2023 can be said to be valid and close to the actual demand resultsin 2023 that occur. This proves that the company can apply the forecasting method using the Holt-Winters method because this method has a fairly small forecastingerror (under 20%) so that it can be said to have very goodforecasting results.

Analysis of Forecasting Results for the Year 2024Period

Based on the forecasting results of the selected method, namely the Holt-Winters method, it can be seen that the results of the MAPE error value for spare parts of the kWH Meter and 2 × 10mm PWR Cable^2 are less than 10%, which means that the ability of the forecastingmethod is very good. In addition, the result of the MAPEerror value for MCB 4A spare parts is between 10% - 20%, which means that the ability of the forecasting method is quite good. So, it can be concluded that the Holt-Winterss method obtained overall small error results and is well used for forecasting the three selected MDU spare parts. So, it can be continued to test the validity of the forecasting results.

Validation of forecasting results is done using the Moving Range method. Where the results show that all forecasting results using the Holt-Winters method for thethree MDU spare parts are within the UCL and LCL limits, so it is concluded that the Holt-Winters method forecasting results can be said to be valid and good to usefor forecasting spare parts for the company PT PLN (Persero) UP3 Semarang.

Proposed Improvements to the Company

The proposed improvement that can be given by researchers to PT PLN (Persero) UP3 Semarang in procuring electrical installation spare parts is to use the Holt-Winters time series forecasting method. This provides many benefits that will be obtained by the company because the Holt-Winters method produces a relatively small error in forecasting spare parts. The benefits that can be obtained by the company include optimizing existing inventory so as to minimize the problem of stock shortages or overstock which is the mainproblem that occurs at PT PLN (Persero) UP3 Semarang. In addition, with better procurement planning, it can alsominimize costs associated with storing and supplying spare parts so that it can also reduce company expenses that may occur.

4. Conclusion

By using the ABC Analysis classification, there are three spare parts that are in the A value group for forecasting calculations. The three selected MDU spare parts include kWH Meter, 2 × 10mm PWR Cable^2, and 4A MCB. The smallest error value was obtained by the Holt-Winters Method to perform forecasting for 12 periods in 2023 and also continued to perform forecastingfor 12 periods in 2024. Where 2 forecasting processes arecarried out, the results of the MAPE value for the three spare parts are below 10% and between 10% - 20%, which means that the ability of the forecasting method isgood. The results of the validation test using the Moving Average method, show that the Holt-Winters forecasting results are within the tolerance limits so that there is no error value that exceeds the UCL limit and LCL limit. The percentage comparison of actual historical data in 2023 with Holt Winters forecasting results is above 70%,which means that the forecasting results are close to actual demand, thus increasing the accuracy in using theHolt-Winters forecasting method in procuring Main Distribution Material (MDU) spare parts. So, it can be concluded that the results of the Holt-Winters forecastingmethod can be said to be valid to be used for forecasting spare parts for the company PT PLN (Persero) UP3 Semarang.

Compliance with ethical standards

Disclosure of conflict of interest

All authors declared that there was no conflict of interest.

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