

Analysis of the Performance of the Moving Average Method in Forecasting the Increase in the Number of PLN Customers on Batam Island

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Abstract: Electricity demand is a crucial factor in regional development, requiring accurate forecasting to ensure efficient distribution. This study analyzes the performance of two forecasting methods, Simple Moving Average (SMA) and Weighted Moving Average (WMA), in predicting the increase in PLN customers on Batam Island for the period 2023-2024. The accuracy of these methods was evaluated using Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percent Error (MAPE), and performance indicators. The results indicate that both SMA and WMA provide accurate forecasts, with WMA showing slightly better accuracy due to its ability to assign different weights to past data. Based on the findings, the forecasted number of additional PLN customers in January 2025 using the WMA method is 386. This study demonstrates that the Moving Average method is a viable option for short-term electricity demand forecasting. However, its limitations in handling external factors suggest the need for more advanced forecasting models in future research.

Keywords: Customer, demand, electricity, forecasting, moving average

1. Introduction

In the modern era like today, the need for electricity is a basic need for the community. The availability of adequate electricity is one of the indicators of the progress of a region, including on Batam Island. As one of the main electricity providers, PLN faces challenges to accurately plan customer needs to ensure efficient and sustainable distribution. One of the approaches that is often used for data forecasting is the Moving Average method.

The Moving Average method is one of the most widely used forecasting methods because it is simple and easy to implement (Sulistyanto, 2016). Moving average forecasting is widely used to estimate trends over a certain period of time (Nurlifa & Kusumadewi, 2017). However, this method has limitations, especially in dealing with data that is influenced by external factors or fluctuations that cannot be predicted only from historical data. By understanding the performance of this method, this study seeks to evaluate the accuracy of the Moving Average method in forecasting the increase

in the number of PLN customers on Batam Island.

This study aims to analyze the performance of two types of Moving Average methods, namely the Simple Moving Average (SMA) and the Weighted Moving Average (WMA), in predicting the increase in the number of PLN Batam Island customers during 2023-2024. We use these methods because SMA and WMA are simplicity and ease of implementation, suitability for short term forecasting, focus on baseline model evaluation, accuracy, and efficiency. Accuracy measurement indicators such as MAD (Mean Absolute Deviation), MSE (Mean Squared Error), and MAPE (Mean Absolute Percent Error) are used to determine the most appropriate forecasting method. In addition, this study is also expected to provide an overview of the efficiency of the Moving Average method in dealing with data influenced by external factors.

With this approach, this research aims to contribute to the improvement of customer needs planning methods, so that it is expected to support the smooth distribution of electricity and strategic planning of PLN Batam Island in the future.

2. Methods

Moving average is a forecasting method by utilizing the average obtained from the previous period's data to forecast data in the next period. This method has limitations in forecasting, namely it can only predict one period after the previous period because this method uses the average of historical real data before. It also does not take into account external factors or new information that could affect future data movements. There are several types of Moving Averages that are commonly used in data analysis, including:

- a. Simple Moving Average (SMA) is the most basic form of the Moving Average. The SMA calculates the average score of a number of data over a given period of time. For example, to calculate the 3-month SMA, we will take the average of the last three months. Forecasting using the simple moving average method is formulated by (Annisya & Wandhya, 2016):

$$SMA = \frac{\sum_1^n d_{t-1}}{n} \quad (1)$$

where d_{t-1} is the demand in the previous n periods, and n is the number of periods in the SMA.

- b. Weighted Moving Average (WMA): The WMA gives different weights to each value in the period used. Values with greater weight are considered more important in the calculation of averages (Sari & Hasanuddin, 2020).

$$WMA = \frac{\sum P_n \cdot W_n}{\sum n} \quad (2)$$

where P_n is the value in the n period, and W_n is the weight in the n period, and $\sum n$ is the total weight of the data.

To measure the error or accuracy of forecasting in the calculation, it is necessary to measure the number of errors using the MAD (Mean Absolute Deviation), MSE (Mean Squared Error) and MAPE (Mean Absolute Percent Error) indicators.

- a. MAD (Mean Absolut Deviation).

MAD calculates the average absolute distance between each data value and the mean or median value in a data set (Azis & Kustanto, 2023).

$$MAD = \frac{\sum_{t=1}^n |d_t - d'_t|}{n} \quad (3)$$

- b. MSE (Mean Squared Error).

MSE is the mean difference, which is squared between the predicted and observed values.

$$MSE = \frac{\sum_{t=1}^n (d_t - d'_t)^2}{n} \quad (4)$$

- c. MAPE (Mean Absolute Percent Error).

MAPE is used to reflect errors symbolized in the form of percentages.

$$MAPE = \frac{1}{n} \sum_{t=1}^n \left[\frac{d_t - d'_t}{d_t} \right] \times 100\% , \quad (5)$$

Note:

- n : amount of data
 d_t : original value
 d'_t : prediction value

The interpretation of MAPE values can be seen in the table 1 below.

Tabel 1. Interpretation of MAPE Value (Oktavia et al, 2023)

MAPE Value	Interpretation
≤ 10	Forecasting results are very accurate
10 - 20	Forecasting results is good
20 - 50	Forecasting results are reasonable (good enough)
> 50	Forecasting results are not accurate

Results and Discussion

This study aims to determine the performance of the Moving Average method in forecasting the increase in PLN Batam Island customers in 2023-2024. This study uses two types of Moving Average methods, namely the Simple Moving Average (SMA) and Weighted Moving Average (WMA) methods. SMA and WMA use an average of every two months. To measure the accuracy of forecasting in the calculation of SMA and WMA using the measurement of error values using MAD (Mean Absolute Deviation), MSE (Mean Squared Error) and MAPE (Mean Absolute Percent Error) indicators.

A method that shows a more accurate value forecast will be used as a method to forecast the value in the next period. The data used in this study is data on the increase in PLN Batam Island customers in 2023-2024, which can be seen in table 2. This data includes data whose growth does not depend on the value in the previous period because it has a tendency to correlate with external factors.

Table 2. Data on the addition of PLN customers

CUSTOMER ADDITION DATA PLN BATAM ISLAND		
Moon	Year	
	2023	2024
Jan	242	236
Feb	417	282
Mar	344	471
Apr	140	283
May	175	201
Jun	342	284
Jul	386	408
Aug	452	285
Sep	360	441
Oct	312	286
Nov	496	250
Dec	281	287

Simple Moving Average (SMA) dan Weight Moving Average (WMA)

Forecasting the increase in the number of customers using the Simple Moving Average (SMA) method using an average movement every two months, while the forecasting formula has been written in equation (1). So that the results of SMA forecasting are obtained in table 3.

Forecasting the increase in the number of customers using the Weight Moving Average (WMA) method with an average movement every two months, while the forecasting formula has been written in equation (2). So that the results of WMA forecasting are obtained in table 4. The results of the calculations from the SMA and WMA methods obtained a considerable difference between the real data and the forecast data using the SMA and WMA methods.

Table 3. The Result of Simple Moving Average

Year	Moon	Number of Customers	SMA	Error
2023	Jan	242		
	Feb	417		
	Mar	344	329.5	14.50
	Apr	140	380.5	-240.5
	May	175	242	-67.00
	Jun	342	157.5	184.50
	Jul	386	258.5	127.50
	Aug	452	364	88.00
	Sep	360	419	-59.00
	Oct	312	406	-94.00
	Nov	496	336	160.00
	Dec	281	404	-123
2024	Jan	236	388.5	-152.5
	Feb	282	258.5	23.50
	Mar	471	259	212.00
	Apr	283	376.5	-93.50
	May	201	377	-176.0
	Jun	284	242	42.00
	Jul	408	242.5	165.50
	Aug	285	346	-61.00
	Sep	441	346.5	94.50
	Oct	286	363	-77.00
	Nov	250	363.5	-113.5
	Dec	287	268	19.00
\sum error				-126.00

Table 4. The Result of Weighted Moving Average

Year	Moon	Weight	Number of Customers	WMA	Error
2023	Jan	1	242		
	Feb	2	417		
		3	344	358.67	-14.67
	Apr	4	140	373.2	-233.20
	May	5	175	227.43	-52.43
	Jun	6	342	159.44	182.56
	Jul	7	386	266.09	119.9
	Aug	8	452	365.69	86.31
	Sep	9	360	421.2	-61.2
	Oct	10	312	403.29	-91.29
	Nov	11	496	334.74	161.26
	Dec	12	281	408.38	-127.3
2024	Jan	13	236	383.83	-147.8
	Feb	14	282	257.60	24.40
	Mar	15	471	259.85	211.2
	Apr	16	283	379.76	-96.76
	May	17	201	373.97	-172.97
	Jun	18	284	240.76	43.24
	Jul	19	408	243.69	164.3
	Aug	20	285	347.68	-62.68
	Sep	21	441	344.92	96.08
	Oct	22	286	364.90	-78.9
	Nov	23	250	361.70	-111.7
	Dec	24	287	267.60	19.4
				Σ Error = -142.38	

Measurement Of Forecasting Error or Accuracy

In measuring the error or accuracy of forecasting in the calculation of SMA and WMA, the error value measurement is used using MAD (Mean Absolute Deviation), MSE (Mean Squared Error) and MAPE (Mean Absolute Percent Error) indicators. To calculate the MAD, MSE, and MAPE values use the formulas in equations (3), (4), and (5). The results of the calculation of the accuracy of forecasting the Simple Moving Average (SMA) and Weight Moving Average (WMA) methods can be seen in table 5.

Table 5. Result of MAD, MSE, MAPE

Method	MAD	MSE	MAPE
SMA	5,73	15594,3	12,48%
WMA	6,47	15191,7	12,33%

The most accurate method can be assessed from the results of the smallest MAD, MSE, and MAPE calculations. Based on table 5, it can be seen that the difference in the accuracy calculation values of the Simple Moving Average (SMA) and Weight Moving Average (WMA) methods is not so significant. The error value obtained from these three indicators also not tend to be large. This means that forecasting the addition of PLN customers using the SMA or WMA method is efficient enough. In the calculation of MAD value SMA<WMA, in the MSE calculation of SMA>WMA value, in the calculation of MAPE value SMA>WMA, from these results, the Weight Moving Average (WMA) method is considered more accurate as a method to forecast the increase in the number of customers in the next period.

Forecast in January 2025

Based on the calculations that have been made, to obtain a forecast of the increase in the number of PLN customers using the Weight Moving Average (WMA) method with an average movement every two months. It is thought that this method can only predict one period after the previous period, so forecasting can only be done for January 2025. Forecasting the value of the increase in the number of customers in January 2025 can be done using equation (2) and paying attention to the data in Table 6. From the results of the calculation using the Weight Moving Average method, it is estimated that the increase in PLN customers on Batam Island in January 2025 will be 386 customers.

Table 6. Real Data of Previous Period

Year	Month	Weight	Real
2024	Nov	23	250
	Dec	24	287
2025	Jan	25	?

$$WMA = \frac{\sum P_n \cdot W_n}{\sum n}$$

$$WMA = \frac{(23 \cdot 496) + (24 \cdot 281)}{23 + 24}$$

$$WMA = \frac{18152}{47}$$

$$WMA = 386,21$$

Conclusion

This study evaluated the accuracy of the Simple Moving Average (SMA) and Weighted Moving Average (WMA) methods in forecasting the increase the number of PLN customers on Batam Island for the period 2023-2024. The results shows that both methods provided efficient forecast, with the WMA method demonstrating slightly higher accuracy based on MAD, MSE, and MAPE values. Although the differences between SMA and WMA were not significant, WMA was identified as the better method for forecasting future customer growth due to its ability to assign different weights to past data, making it more responsive to fluctuations. Based of this study, the estimated number of additional PLN customers in January 2025 using the WMA method is 386.

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