The IJICS (International Journal of Informatics and Computer Science)
Vol 9 No 3, November 2025, Page 154-159
ISSN 2548-8384 (online), ISSN 2548-8449 (print)
Available Online at https://ejurnal.stmik-budidarma.ac.id/index.php/ijics/index
DOI 10.30865/ijics.v9i3.9401

Prediction of the Number of Pertalite Consumers at Gas Stations Using the Simple Moving Average Method

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Submitted: **09/11/2025**; Accepted: **28/11/2025**; Published: **30/11/2025**

Abstract—The need for fuel oil, especially one of the Pertalite at Gas Station X in Kisaran, requires the availability of sufficient materials to serve consumers every day. Consumers will move to fill up with fuel oil to another gas station if the availability of fuel at one of the Gas Station X in Kisaran is not sufficient to serve fuel oil to consumers. The next purchase of fuel oil by one of the Gas Station X in Kisaran still uses manual calculations based on old data that has not been updated. Forecasting is an activity to find out what will happen in the future, by using data from the past. Forecasting with the Single Moving Average method is used as an important tool in effective planning, especially in this study. The final result of this study is that using a moving period of 3 because it has the smallest MAPE value of 6.12% and is less than 10% (very good forecasting ability).

Keywords: Fuel oil; forecastin; consumers; Single Moving Averag; fuel stations

1. INTRODUCTION

Forecasting is an activity used to determine what will happen in the future by utilizing data from the past. Forecasting is also an important tool in effective planning. In performing forecasting calculations, the most important aspect is understanding the characteristics of the forecasting method being used so that it aligns with the decision-making situation [1].

Determining the level of production, which represents the level of supply, is influenced by the amount of market demand and can result in cost inefficiencies such as storage costs, capital costs, and product damage costs. A supply level that is lower than the potential market share that can be captured will lead to the loss of profit opportunities, and may even result in losing customers as they switch to competitors. To overcome these issues, forecasting activities are required in production planning. Forecasting is a process used to estimate future needs, including those related to quantity, quality, timing, and location, in order to meet the demand for goods or services [2].

Stock forecasting is an integral part of financial analysis that involves various methods, strategies, and approaches to predict future stock price movements. Stock forecasting is a complex process that includes the collection, analysis, and interpretation of historical data as well as external factors that may influence a company's stock price [3].

Forecasting is an important tool in effective and efficient planning. An essential step after forecasting is verification, conducted to ensure that the results reflect past data and the underlying causal systems influencing growth. As long as the forecasting representation remains reliable, the results can continue to be used. The Single Moving Average method is one of the most widely used methods to determine trend equations because of its mathematical simplicity [4].

The Single Moving Average is a prediction method used to estimate future outcomes based on historical data over a specific period. The longer the time period used for prediction, the higher the likelihood that the prediction results become more accurate [5]. The advantage of the Single Moving Average method is that it can be used for forecasting by calculating the average predicted results for specific periods, continuously updated based on data movement. This method is effective, simple, and more efficient because the calculation system does not require weighting for each data point [6].

The single moving average is a time-series forecasting method, typically used when past data does not exhibit trends or seasonal factors [7]. The Moving Average (MA) is one of the most popular indicators often used by technical analysts because it is easy to apply [8]. The moving average method uses the average value of the most recent periods to forecast the next period [9].

The Single Moving Average method is used in this study because it relies on historical data to estimate future values [10]. The use of petroleum-based energy, such as fuel oil, in Indonesia continues to increase each year. This growth is partly due to the increasing population in Indonesia. In addition, the Indonesian public's dependency on fuel oil remains very high. To remain competitive in an increasingly demanding market, companies must prioritize how to meet customer demand [11],[12],[13].

Fuel is a crucial primary need for the community, especially for transportation. It is essential for daily activities across various sectors, including industry, transportation, and households. The fuel business is highly promising, as it has become a primary income source for many, especially in the city of Kisaran. Today, many business owners are

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opening fuel distribution businesses classified as essential needs. One of them is Gas Station X in Kisaran, whose daily operational activity is to resell fuel purchased from Pertamina depots at a lower cost than the consumer selling price. The types of fuel sold include Pertamax, Dexlite, and Pertalite. Fuel sales are based on the availability of fuel stored in underground tanks. If the fuel stock runs out, consumers will switch to other gas stations. The demand for Pertalite fuel at Gas Station X in Kisaran requires sufficient stock availability to serve customers daily. Consumers will switch to other gas stations if the availability of fuel at Gas Station X is insufficient to meet their needs. Subsequent fuel purchases at Gas Station X still rely on manual calculations based on outdated data that has not been updated.

The purpose of this study is to predict the number of Pertalite consumers at Gas Station X in Kisaran for the upcoming period based on previous consumer data. This study aims to apply the Single Moving Average method to forecast Pertalite consumer demand using the obtained historical data. The benefit of this research is to serve as a reference for forecasting Pertalite consumer demand, assisting business owners at Gas Station X in Kisaran in ensuring adequate fuel availability within Kisaran City District and its surrounding areas

2. RESEARCH METHODOLOGY

2.1 Research Method

The Single Moving Average (SMA) method is a forecasting technique that involves taking a group of observed data values and calculating their average as a prediction for the upcoming period. The Single Moving Average (SMA) method has specific characteristics: first, to generate a forecast for the next period, it requires historical data over a certain time span. Second, the longer the Moving Average time span, the smoother the resulting effect will be.

Determining a forecast using the Single Moving Average (SMA) method is very simple, as it is done by averaging the amount of data according to the number of periods used. The mathematical equation for the Single Moving Average (SMA) method is as follows:

$$Ft + 1 = \frac{Y1+Y2+Y3}{T} \quad (1)$$

Description:
Ft+1 = Forecast for period t+1
Y1 + Y2 + ⋯ Yt = Actual values for period t
T = Moving average time span

2.2 Forecast Accuracy Measurement

a. Mean Square Error (MSE)

Mean Squared Error (MSE) is a method that calculates the average of the squared errors. It amplifies the impact of large error values while reducing the effect of small forecasting errors (less than one unit).

The MSE formula can be written as follows:

$$MSE = \sum_{t=1}^{n} \frac{(Yt-Ft)^2}{n} \quad (2)$$

Where:
Y_t = Actual value in period t
F_t = Forecast value in period t
n = Number of periods

b. Mean Absolute Deviation (MAD)

Mean Absolute Deviation (MAD) is calculated by dividing the sum of the absolute values of individual forecast errors by the sample size (number of forecast periods). The MAD formula is as follows:

$$MAD = \sum_{t=1}^{n} \frac{|Yt-Ft|}{n} \quad (3)$$

Where:
Y_t = Actual data in period t
F_t = Forecast value in period t
n = Number of periods

c. Mean Absolute Percentage Error (MAPE)

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The accuracy measurement using Mean Absolute Percentage Error (MAPE) indicates the average absolute forecasting error expressed as a percentage of the actual data. The MAPE formula is as follows:

$$MAPE = \left(\frac{1}{n}\right)\sum_{t=1}^{n}\frac{IYt-FtI}{n} * (100) \quad (4)$$

Where:
Y_t = Actual data in period t
F_t = Forecast value in period t
N = Number of periods

The lower the MAPE value, the closer the estimates are to the actual values, indicating that the forecasting model has good predictive ability. The range of MAPE values can be seen in Table 1 below:

Table 1. Significance of MAPE Values [12]

No	MAPE (%)	Significance
1	<10	Forecasting ability is very good.
2	10-20	Forecasting ability is good.
3	20-50	Forecasting ability is adequate / reasonable.
8	>50	Forecasting ability is very poor.

3. RESULT AND DISCUSSION

3.1 Input Data Analysis

The following is the data on the number of Pertalite consumers at the Kisaran Gas Station for the period of January 2020 to August 2020.

Table 2. Data on the Number of Pertalite Consumers at the Kisaran Gas Station Period January 2020 – August 2020

No	Period (month)	Number of Consumers
1	January	1500
2	February	1750
3	March	1450
4	April	1550
5	May	1600
6	June	1300
7	July	1650
8	August	1510

3.2 Analysis of the Prediction Process Using the Single Moving Average Method

This stage explains how the existing system process operates in accordance with the proposed procedure. The calculation begins by determining the forecast value for the month following the moving period in order to generate the forecasting result for the period of September 2020. The prediction is carried out using the Single Moving Average method based on the number of Pertalite consumers as sample data.

a. Forecasting the Number of Pertalite Consumers

The forecasting process for the number of Pertalite consumers uses the Single Moving Average (SMA) method with a moving average period of three months.

1. April 2020

$$F1 = \frac{Y1+Y2+Y3}{3}$$
$$F1 = \frac{1500+1750+1450}{3} = 1566{,}666667$$

2. Mei 2020

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$F2 = \frac{1750+1450+1550}{3}$ = 1583,333333

3. Juny 2020
   $F3 = \frac{1750+1450+1550}{3}$ = 1533,333333

The process continues until the forecasting calculation reaches the period of September 2020. After obtaining the forecasting results, the next step is to calculate the MAD, MSE, and MAPE values. To compute these values, it is first necessary to determine the forecasting errors. The formula for calculating the error is as follows:

$Et = Ft - Xt$

Description:
E_t = Error value
X_t = Actual data in period t
F_t = Forecast data in period t
The error calculation begins from April 2020, where the results are obtained from the difference between the actual data and the forecasting results up to August 2020, since the consumer data for September 2020 is not yet available. The following is the error calculation:
E_t April 2020 = $F_t - X_t$ = 16.66666667
E_t May 2020 = $F_t - X_t$ = 16.66666667
E_t June 2020 = $F_t - X_t$ = 233.3333333
The process continues until the error value for the August 2020 period is calculated. The next step is to determine the Absolute Error (MAD). The MAD value is obtained from the absolute value of the forecasting errors. After that, the squared error (MSE) is calculated. The MSE value is derived from the MAD or from the squared forecasting error values. The results of the MSE calculation are shown in Table 3 below:

Table 3. MSE Values for Forecasting the Number of Pertalite Consumers

No	Period (Month)	Number of Consumers	Forecast	Error	ABS Error (MAD)	Error2(MSE)
1	January	1500	0			
2	February	1750	0			
3	March	1450	0			
4	April	1550	1566,666667	-16,666667	16,66666667	277,7777778
5	May	1600	1583,333333	16,6666667	16,66666667	277,7777778
6	June	1300	1533,333333	-233,33333	233,3333333	54444,44444
7	July	1650	1483,333333	166,666667	166,6666667	27777,77778
8	August	1510	1516,666667	-6,6666667	6,666666667	44,44444444
9	September		1486,666667			

After obtaining the MSE value, the next step is to calculate the APE value. The formula for calculating APE is as follows:

$APE = \frac{Aktual}{Absolute\ Error} * 100$

Description:
Actual = actual value
Absolute Error (MAD) = forecasting error

The MAPE calculation is performed only up to August 2020 because the consumer data for September 2020 is not yet available. The calculations are as follows:

$APE = \frac{Actual}{Absolute\ Error} * 100$

$APE\ April\ 2020 = \frac{16,66666667}{1550} * 100$ = 1,08%

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$$APE\ May\ 2020 = \frac{16{,}66666667}{1600} * 100 = 1{,}04\%$$

$$APE\ June\ 2020 = \frac{233{,}3333333}{1300} * 100 = 17{,}95\%$$

The process continues until the APE value for the August 2020 period is calculated. After obtaining all these results, the next step is to calculate the average MAD value. The average MAD represents the mean absolute error over a given period, without considering whether the forecasting result is higher or lower than the actual value. The following are the results of the average MAD calculation:

$$MAD = \sum_{t=1}^{n} \frac{IYt-FtI}{n} = \frac{440}{5} = 88$$

The next step is to calculate the MSE value. Mean Square Error (MSE) is a parameter used in forecasting to evaluate the accuracy of the forecasting results. The smaller the MSE value, the more accurate the forecasting results will be. The following is the calculation of the average MSE value:

$$MSE = \sum_{t=1}^{n} \frac{(Yt-Ft)^2}{n} = \frac{82822{,}22222}{5} = 16564{,}44444$$

The next step is to calculate the MAPE value. MAPE is a measure of relative error. MAPE is generally more meaningful than MAD because it expresses the percentage of forecasting error relative to the actual demand over a given period, providing information on whether the forecasting error is too high or too low.

$$MAPE = \left(\frac{1}{n}\right) \sum_{t=1}^{n} \frac{IYt-FtI}{n} * (100) = \frac{0{,}306081646}{5} = 6{,}12\%$$

The results of the average MAD, MSE, and MAPE calculations can be seen in Table 4 below:

Table 4. MAD, MSE, and MAPE Values for Forecasting the Number of Pertalite Consumers at the Kisaran Gas Station

No	Period (Month)	Number of Consumers	Forecast	Error	ABS Error (MAD)	Error2(MSE)	APE (%)
1	Januari	1500	0				
2	Februari	1750	0				
3	Maret	1450	0				
4	April	1550	1566,666667	-16,666667	16,66666667	277,7777778	1,08%
5	Mei	1600	1583,333333	16,6666667	16,66666667	277,7777778	1,04%
6	Juni	1300	1533,333333	-233,33333	233,3333333	54444,44444	17,95%
7	Juli	1650	1483,333333	166,666667	166,6666667	27777,77778	10,10%
8	Agustus	1510	1516,666667	-6,6666667	6,666666667	44,44444444	0,44%
9	September		1486,666667		0	0	
	Total				440	82822,22222	0,306081646
	MAD				88		
	MSE					16564,44444	
	MAPE						6,12%

b. Comparison of Error Results for Different Moving Periods

The following presents a comparison of the forecasting errors obtained using different moving periods, specifically moving periods of 3, 4, 5, and 6:

Table 5. Comparison of Error Values

Description	Moving Period	MAD	MSE	MAPE	Forecasting
consumer	3	88	16564,444	6,12%	1486,667
	4	294,5	124063,75	18,91%	1115
	5	348	216400	23,01%	892
	6	332	278014,444	20,97%	743,333

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Based on Table 5 above, it can be concluded that the number of Pertalite consumers is most appropriately forecasted using a moving period of 3, as it produces the smallest MAPE value of 6.12%, which is less than 10% (indicating a very good forecasting ability).

4. CONCLUSION

The final result of this study shows that the Simple Moving Average method provides a relatively stable prediction in determining the number of Pertalite consumers at the Kisaran gas station. This method calculates the average of several previous periods, thereby reducing possible data fluctuations. The findings also indicate that a moving period of 3 is the most suitable, as it produces the smallest MAPE value of 6.12%, which is less than 10% (indicating a very good forecasting ability).

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