

## Application of the Single Moving Average, Weighted Moving Average and Exponential Smoothing Methods For Forecasting Demand At Boy Delivery

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**Abstract**— Boy Delivery is a delivery service in the city of Lamongan that has been operating for about 4 years. Boy Delivery has an average of 12,000 demand per month. However, the high demand was not accompanied by good demand management, Boy Delivery often piled up and even rejected several due to the unavailability of drivers at that time, this was due to an incorrect prediction of demand. Therefore this research was conducted to help forecast future demand using the Single Moving Average, Weighted Moving Average, and Exponential Smoothing methods. Of the three methods, the Single Exponential Smoothing method was obtained as the best method with the most accurate results with a smaller error of 5.481%.

**Keywords** : *Forecasting; Moving Average; Exponential Smoothing; MAPE.*

### I. INTRODUCTION

Ride-hailing services, commonly known as online motorcycle taxis, are currently one of the largest service products in Indonesia. Data as of January 2020 from We Are Social 2020-Digital 2020 Indonesia shows that 21.7 million Indonesians using ride-hailing services or 75% of internet users in Indonesia are users of the ride-hailing service application [1]. A large number of service users makes many delivery services come with various concepts, as happened in the city of Lamongan. Lamongan itself is a city in East Java with a population of 1,186,300 people. In Lamongan itself there are dozens of large-scale delivery services such as Gojek, Grab, and Uber as well as local delivery services. On the 452nd anniversary of Lamongan, there were at least eight local delivery services that took part in enlivening the activity. One of the most well-known local delivery services is Boy Delivery Lamongan. Boy Delivery has been operating for 4 years, with dozens of MSME partners, and

various health facilities with hundreds of drivers who have very flexible working hours which are divided into 3 shifts every day. Currently Boy Delivery has three types of transportation fleets namely motorbikes, cars, and pick-ups. Various services provided by Boy Delivery include ordering food delivery, goods, money transfers, as well as services other than delivery, namely moving services, stove services, and house cleaning. The large number of services provided by the Lamongan delivery boy has also resulted in a large demand from the public for these services. At least on average, there are 12 to 13 thousand demands that have been completed each month. Demand often causes the delivery service to be in overloaded condition, forcing customers to wait and even cancel orders. This causes losses both commercially and in terms of the customer's assessment. This overload condition is due to the number of drivers that do not match the demand at that time. This is because management cannot predict the demand in the coming period. One thing that can be done now is to add drivers, but limiting the number of drivers is still being done to maintain the income of the drivers. So that another solution is needed, namely in the form of demand forecasting in the future.

Forecasting is defined as a scientific estimate (educated guess). In Every decision-making concerning the situation in the future, there must be a forecast that underlies the decision-making. In a more specific sense, in general, forecasting is a prediction of a value. One of the most common of these forecasts is the forecast of product demand or sales for the coming period [2]. One of the arts in forecasting is choosing the best forecasting model and being able to identify and respond to historical activity patterns from data. previous research by [3] used the Weight Moving Average and Exponential Smoothing methods to forecast the demand for paving products on The CV. Berlian Abadi. In another study by [4], In this study, forecasting was carried out for an

office stationery shop (ATK) using three methods namely Simple Moving Average, Weighted Moving Average, and Exponential Smoothing, both studies used time series data of past demand or supply as basic data. Time series is based on a sequence of data points that are equidistant in time (weekly, monthly, quarterly, etc.). Popular and commonly applied time series models in demand forecasting are moving averages, exponential smoothing, and trend projection [5].

In this study, we want to forecast demand for the coming period to solve existing problems, as well as compare the forecasting results with the three methods namely Single Moving Average, Weighted Moving Average, and Exponential Smoothing which are most appropriate to the existing data and case studies.

## II. LITERATURE REVIEW

### A. Forecasting

Demand planning in general is better known as forecasting. Forecasting is a method or method used to predict, predict or estimate a value in the future or period to come by using data from the previous period as the basis [3]. Forecasting is very useful for preparing us for conditions that might occur in the coming period. Forecasting is also within the company so that the company can see an overview for decision-making [4]. Predictive accuracy is an important thing for forecasting, namely how to measure the suitability between existing data and forecasting data. There are several calculations commonly used to calculate the total forecasting error. Several methods commonly used are mean absolute deviation (MAD), mean squared error (MSE), and mean absolute percent error (MAPE) [6].

### B. Metode Single Moving Average (SMA)

Single Moving Average is a forecasting method used to predict values in the next period by calculating the average of the data for the last period. Moving Average, this method is done by calculating the average of the actual data from several periods [7]. Forecasting with a single moving average is done to reduce randomness or randomness in time series data, this can be achieved by calculating the average of several values together and eliminating some positive and negative errors that interfere with data values [4].

### C. Metode Weight Moving Average (WMA)

The moving Average (MA) is the average value of data movement. Moving Averages can be used to smooth data. Meanwhile, one variant of MA is the Weighted Moving Average (WMA). The equation used in determining the forecast value with WMA is by weighting each data. the weighting gives a greater value to the last data. WMA is used to estimate data based on trends in previous data [8].

The calculation of the weighted moving average method for each historical period has a different weight, the greatest weight is given to the most recent historical data in each period compared to the previous historical data this is because the data in the most recent WMA method is data that represents the situation, or is relevant in the predictions made [9].

### D. Metode Single Exponential Smoothing (SES)

Exponential Smoothing is a prediction method by assigning a smoothing value to a set of existing data in previous observations to predict a value in the future. [10]. In the Exponential Smoothing method, there is an exponentially weighted moving average for all past observed values [11].

If the actual historical data is volatile or unstable from time to time then we choose an alpha value that is close to 1, otherwise, if the actual historical data is stable from time to time then we choose an alpha value that is close to 0 [12].

### E. Error

This error is the result of subtracting the actual data minus the forecasting results. The following is the equation used to determine the value of the forecasting error:

$$Error = Dt - Ft \quad (1)$$

### F. MAD (Mean Absolute Deviation)

MAD is the value that is noticed first in the error of a prediction result. This value is determined by taking the deviation value and then dividing it by the number of periods (n) [13]. What needs to be remembered here is that MAD is the error value that appears and becomes the first parameter of the success of a model [6].

(2)

$$MAD = \frac{\sum |Actual\ Data - Forecasting|}{n}$$

G. MSE (Mean Square Error)

MSE is an error measure used to assess the average error that arises as a result of reducing actual data with forecasting results then squared, the results are then divided by the number of periods [14].

$$MSE = \frac{\sum |Actual\ Data - Forecasting|^2}{n - 1}$$

H. MAPE (Mean Absolute Percent Error)

MAPE is a value used to measure a relative error. MAPE is considered more accurate than MAD, this is because MAPE contains the percentage of error from the forecast made, in the output of forecasting results against real demand for certain periods whose results will provide information about the percentage of errors including too high or too low [15].

**Table 1 MAPE success indicators**

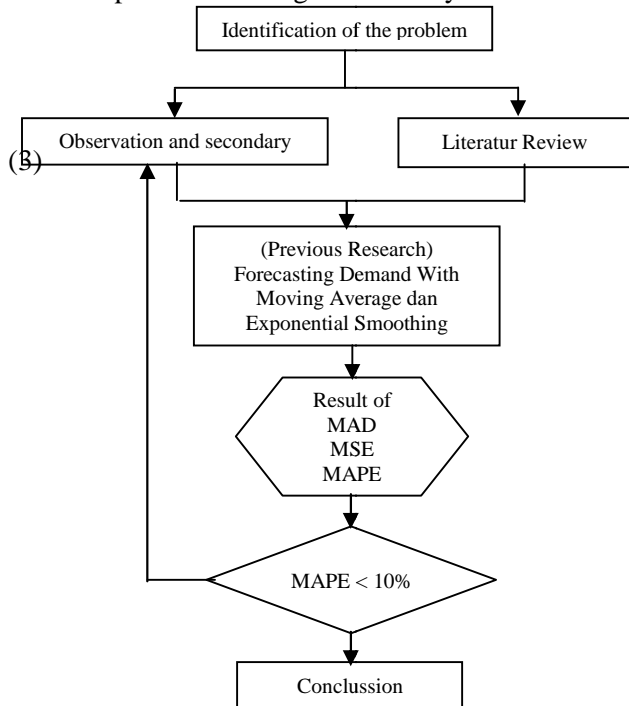
Value of MAPE	Conclusion
< 10 %	Very good
10 % - 20 %	Good
20% - 50%	Sufficient
50 %	Bad

**III. METHODOLOGY**

This research is a quantitative study by analyzing demand data from November 2021 - October 2022 for Boy Delivery Services. The data obtained is secondary data from Boy Delivery monthly reports. This study aims to predict the order demand for Boy Delivery which refers to previous historical data using the Single Moving Average (SMA), Weighted Moving Average (WMA), and Exponential Smoothing methods (ES). Data from predictions with the three methods are then assessed for standard error to determine which method is best for making the forecast. Data processing uses the help of POM QM Software concerning calculations using moving average formulas (period n = 3) and exponential smoothing ( $\alpha = 0,87$ )

The POM QM program is a computer program used to solve problems in the field of production and operations that are quantitative. Attractive graphical displays and ease of operation make POM for Windows an alternative application to

assist decision-making, such as determining the appropriate combination of products to obtain maximum profit [16]. And the following is the flow of problem-solving in this study.



**Figure 1. Flow Chart Research**

**IV. RESULT**

Data processing using the POM QM software in this study began by entering all historical data on Boy Delivery demand, using a period of n = 3 on the moving average and so that  $\alpha = 0.87$  was obtained on exponential smoothing so that the results for each method were obtained as follows:

A. Moving Average (MA)

Measure	Value
<b>ERROR MEASURES</b>	
Bias (Mean Error)	314,481
MAD (Mean Absolute Deviation)	907,074
MSE (Mean Squared Error)	1050061,0
Standard Error (denom=n-2=7)	1162,066
MAPE (Mean Absolute Percent Error)	6,684%
<b>Forecast</b>	
next period	14337,33

**Figure 2. Output Moving Average Solution**

Figure 3: Output Moving Average and Errors

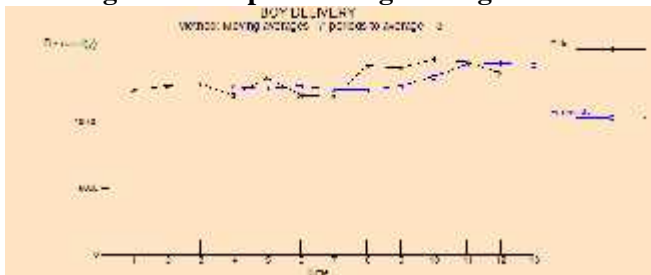


Figure 4: Output Graph Moving Average

Figure 2 shows a bias (mean error) of -314.841, MAD of 907.074, MSE of 1050364, standard error (denom=n-2=7) of 1162.096, MAPE of 6.684%, and for the next period forecast of 14338 or demand forecasting for the November 2022 period of 14338 demand.

In figure 3 moving average details and errors, the forecast or demand in February is 12680.33 or 12680 demand, in March there is 12537 demand, in April there is 12738.33 or 13279 demand, in May there is 12461.33 or 12462 demand, in June it was 12438 demand, in July it was 12741.67 or 12742 demand, in August it was 13437.67 or it was 13438 demand, in September it was 14376.67 or 14377 demand, and in October it was 14467, 67 demand or 14668 demand. Furthermore, Figure 3 is a graphical image of a comparison between actual data and forecasted data using the SMA method.

A. Weighted Moving Average (WMA)

Figure 5: Output Weighted Moving Average Solution

Figure 6: Output Weighted Moving Average and Errors



Figure 7. Output Graph Weighted Moving Average

Figure 5 shows a bias (mean error) of -269.262, MAD of 890.205, MSE of 1021500.0 standard error (denom=n-2=7) of 1146.018, MAPE of 6.588%, and for the next period forecast of 14230.76 or demand forecasting in the November 2022 period of 14231 demand.

In figure 6 the weighted moving average details and errors obtained forecast or demand in February of 12721.48 or 12722 demand, in March of 12455.4 or 12556 demand, in April of 12803.08 or 12804 demand, in May of 12445.92 or 12446 demand, in June 12303.64 or 12304 demand, in July 12982.08 or 12983 demand, in August 13639.36 or 13640 demand, in September 14429.92 or 14430 demand, and in October there were 14504.76 demand or 14505 demand. And Furthermore, Figure 7 is a graphical image of a comparison between actual data and forecasted data using the WMA method.

B. Single Exponential Smoothing (SES)



Figure 8: Output Single Exponential Smoothing Solution

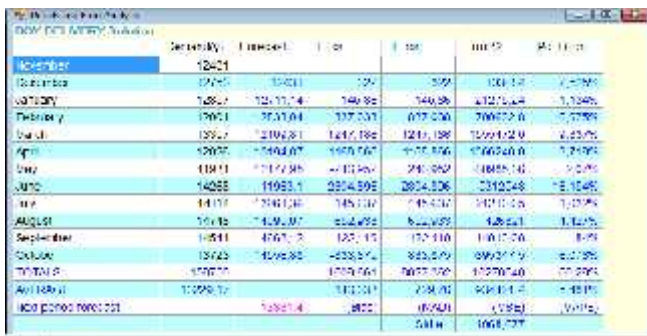


Figure 9: Output Single Exponential Smoothing Detail and Errors

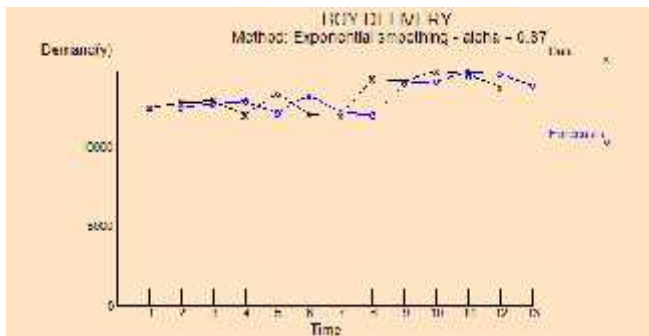


Figure 10: Output Graph Single Exponential Smoothing

Figure 8 shows a bias (mean error) of -146.333, MAD of 729.76, MSE (mean squared error) of 934421, 4 standard errors (denom=n-2=7) of 168.677, MAPE of 5.481%, and for the next period forecast of 13831.4 or demand forecasting in the November 2022 period of 13832 demand.

In Figure 9 Single Exponential Smoothing details and errors, the forecast or demand in December 2022 is 12431 demand, in January it is 12711.14 or 12712 demand, in February it is

12838.04 or 12839 demand, in March it is 12109.81 or 12110 demand, in April 13194.87 or 13195 demand, in May 12177.95 or 12178 demand, in June 11963.1 or 11964 demand, in July 13968.36 or 13969 demand, in August it was 14095.07 or 14096 demand, in September it was 14663.12 or 14664 demand, and in October it was 14556.88 demand or 14557 demand. Furthermore, Figure 10 is a graphical image of a comparison between actual data and forecasted data using the SES method.

V. CONCLUSION

Based on the error values obtained for each method used, the smallest error is obtained when the Single Exponential Smoothing method is used, namely 5.481%. So the forecast value is obtained for the period December 2022 - October 2023 using this method, namely in December there was 12431 demand, in January there was 12712 demand, in February there was 12839 demand, in March there was 12110 demand, in April there was 13195 demand, in May there was 12178 demand, in June there was 11964 demand, in July there was 13969 demand, in August there was 14096 demand, in September there was 14664 demand, and in October there were or were 14557 demand.

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