International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

Prediction in the Number of Passengers on Transjakarta Public Transportation Using the Single Exponential Smoothing Method

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***Abstract*—*One of the most extreme transportation problems currently being experienced is traffic congestion. The Provincial Government of DKI Jakarta, along with the Central Government, is undertaking various efforts to control traffic congestion. Among these efforts is the implementation of mass transportation with a special bus lane system (busway) to reduce dependence on private vehicles. PT Transjakarta is an institution trusted to manage Bus Rapid Transit (BRT) under the supervision of DKI Jakarta Provincial Government Transportation Service. According to statistical data held by PT Transjakarta, the growth in bus passengers tends to increase, but this increase is fluctuating with unpredictable daily rises and falls in the number of passengers. Forecasting is a method used to predict future conditions by using historical data projected into a model. In this study, the Single Exponential Smoothing method is used, which is a forecasting method suitable for continuous time series data based on historical data or previous observations. This is in accordance with data on the number of Transjakarta bus passengers, which tends to be constant and is not affected by seasonal factors. Prediction of the increase in the number of passengers in this study is conducted to provide information for the management of PT Transportasi Jakarta, enabling them to prepare Transjakarta facilities and infrastructure, such as the readiness of bus stop capacity in case of a passenger surge, ensuring the sufficiency of Transjakarta bus fleet to prevent overcrowding on a single bus, and adding new routes (corridors).*

***Keywords*—** *Transjakarta, Prediction, Exponensial Smoothing, method.*

I. INTRODUCTION

Jakarta as the capital city and the centre of government, faces various transportation problems including traffic congestion, public transportation services and conditions that still do not meet public expectations, frequently contradictory public transportation fares, relatively high levels of traffic violations and accidents, as well as many other transportation issues. Many transportation problems faced, and their interrelationships have made the transportation issues in DKI Jakarta increasingly complex. One of the most extreme transportation problems currently experienced is traffic congestion. The Provincial Government of DKI Jakarta, together with the Central Government, is making various efforts to control traffic congestion. These efforts include implementing an odd-even license plate policy during certain hours on specific roads, constructing flyovers and underpasses at road intersections, implementing mass transportation with a special bus lane system (busway), adjusting work and school start times, and improving the quality and quantity of traffic infrastructure.

The implementation of mass transit with a dedicated bus lane system (busway) is part of the discussion in this study, where the Provincial Government of DKI Jakarta has made various efforts to develop public transportation. This is to support social and economic activities of the community, as well as to reduce dependence on private vehicles. PT Transportasi Jakarta (Transjakarta) is an institution trusted to manage Bus Rapid Transit (BRT) under the supervision of DKI Jakarta Provincial Government Transportation Service. PT Transportasi Jakarta is fully responsible for the planning, maintenance, and operation of Transjakarta buses, commonly known as the busway.

Forecasting is a process of estimating the requirements needed to meet the demand for goods, services, and production [1]. Forecasting is classified based on the future timeline with several categories, including short-term, medium-term, and long-term forecasting. Forecasting can be differentiated into qualitative forecasting, which uses intuition in decision-making, and quantitative forecasting, which uses methods such as the naive approach, moving average method, exponential smoothing method, trend smoothing method, and linear regression method [2]. Pintoarsi defines forecasting as an effort made to predict future conditions by using historical data (past data) projected into a model and using the created model to estimate future conditions.

According to statistical data held by PT Transjakarta, the growth in bus passengers tends to increase, but this increase is fluctuating with unpredictable daily rises and falls in the number of passengers. This can be an obstacle in predicting the number of passengers in the future, which can hinder the operational service planning strategy for users. In daily use of the busway, there are still pregnant women who are forced to stand because Transjakarta buses are overcrowded, and there are many instances where bus headways are not maintained, causing passenger congestion at busway stops [3]. This is the reason for conducting this study.

In this study, the Single Exponential Smoothing method is used, which is a forecasting method suitable for continuous time series data based on historical data or previous observations. This is in accordance with data on the number of Transjakarta bus passengers, which tends to be constant and is not affected by seasonal factors. Here are a couple of studies that illustrate the results of using the Single Exponential

Diana Ikasari, Rifqi Arief Permana, and Widiastuti, “Prediction in the Number of Passengers on Transjakarta Public Transportation Using the Single Exponential Smoothing Method,” *International Research Journal of Advanced Engineering and Science*, Volume 9, Issue 2, pp. 146-153, 2024.

International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

Smoothing method. In a previous study which forecasting the sales of packaged meatballs by Rumah Bakso Bang Ipul, the Single Exponential Smoothing method yielded the smallest MAPE value of 6.23 with α = 0.1 [4]. Another forecast regarding the production of Electronic ID Cards (E-KTP) in Marpoyan Damai resulted in the smallest MAPE value of 9.65% with α = 0.9 [5]. Based on the previous studies mentioned, it appears that Single Exponential Smoothing is a good forecasting method as it yields MAPE values below 25%. Therefore, in this study, Single Exponential Smoothing will be used to predict the number of passengers using the public transportation mode Transjakarta. This method is chosen because the data obtained from PT Transportasi Jakarta is stationary or relatively stable, fluctuating around the mean value without exhibiting consistent upward trends or patterns. The forecast accuracy will be evaluated using the Mean Absolute Percentage Error (MAPE) to obtain the accuracy value of the forecast. Results of this study can be used by management to improve facilities, suggestions, and infrastructure due to sudden increases in passenger numbers. Predictions of passenger numbers showing upward or downward trends can serve as indicators to prepare both technical and non-technical aspects for the comfort of Transjakarta users.

II. LITERATURE REVIEW

A. *Transportation Mode*

Transportation mode is a term used to describe a means of conveyance used to move from one place to another [6]. Transportation modes are crucial factors in transportation implementation and are categorized according to their operating location. The modes typically used in transportation can be grouped into modes that operate on land, sail on sea, inland water, and fly in the air. Each mode of transportation has different characteristics, namely in terms of [7]:

1) Speed, indicating how long it takes to move between two locations.
2) Availability of service, concerning the ability to establish connections between two locations.
3) Dependability of operation, showing the difference between reality and the scheduled timetable.
4) Capability, the ability to handle all forms and needs of transportation.
5) Frequency, the number of scheduled movements or connections.

One of the land transportation modes is urban transportation, such as Transjakarta. Transjakarta, commonly known as the busway, is a Bus Rapid Transit (BRT) system designed as a transportation mode for Jakartans, which has been in operation since 2004 [3]. Transjakarta is managed by PT Transportasi Jakarta, an institution trusted to manage Bus Rapid Transit (BRT) under the supervision of DKI Jakarta Provincial Government Transportation Service. PT Transportasi Jakarta is fully responsible for the planning, maintenance, and operation of Transjakarta buses, commonly known as the busway. The management form, infrastructure, and planning system of Transjakarta (busway) are provided by the Jakarta provincial government, while for ticket payments and other services, the government collaborates with private parties.

B. *Time Series Forecasting Method*

Forecasting is a technique for estimating or predicting a future value by taking past historical data and current data [8]. Forecasting methods are an approach to estimate something that will happen in the upcoming periods based on historical data [9].

One of the important aspects in selecting an appropriate forecasting method for time series data is by examining the type of data pattern. There are four types of data patterns, namely:

1. Horizontal pattern: A horizontal pattern occurs when data fluctuates around a constant average or is stationary with respect to its average value.
2. Seasonal pattern: A seasonal pattern is a movement where the tendency of data to rise and fall occurs periodically or repeats over the same time period. This pattern is influenced by seasonal factors such as events in certain quarters.
3. Cyclical pattern: A cyclical pattern is a movement where the tendency of data to rise and fall is irregular over the long term with an almost certain frequency. Cyclical movements typically occur in business or economic contexts.
4. Trend pattern: A trend pattern is a movement where the tendency of data to rise and fall occurs over a specific period.

Graphs of the four data patterns can be seen in Figures 1 to 4.

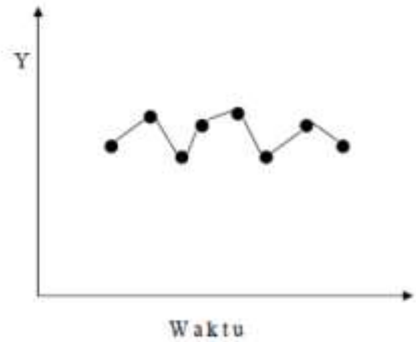

Figure 1. Horizontal Data Pattern [9]

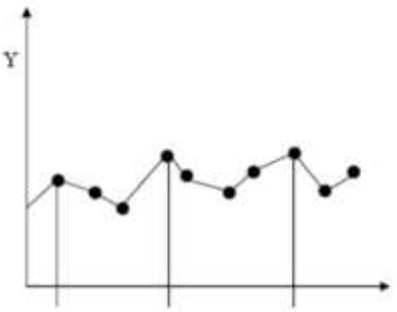

Figure 2. Seasonal Data Pattern [9]

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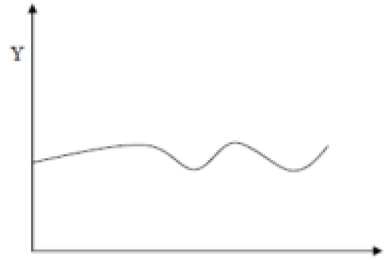

Figure 3. Cyclic Data Pattern [9]

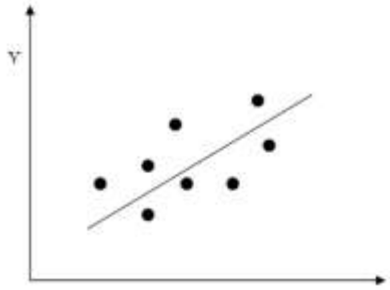

Figure 4. Trend Data Pattern [9]

Time Series Forecasting is a quantitative forecasting method based on a series of data associated with time period variables [10]. The data used in this method are historical data obtained from observations based on the time series used. Some commonly used time series forecasting methods are mean forecast, naïve forecast, linear trend forecast, non-linear forecast, exponential smoothing, and moving average [10]. In this study, the Single Exponential Smoothing Method is used.

Single Exponential Smoothing method is a procedure that continuously improves forecasts by averaging and smoothing past values of a time series in an exponential manner using only one alpha parameter [14]. The SES method is used for short-term predictions, typically forecasting for one period ahead. The model assumes that data fluctuates around a constant mean value, without any consistent trend or growth pattern [11]. Single Exponential Smoothing method considers the weight of previous data by assigning a weight to each data period to differentiate the priority of certain data [14]. The model for SES is as follows [14]:

$$F_{t+1} = \alpha A_t + (1-\alpha)F_t \quad (1)$$

F_t = forecasting for t period
α = smoothing constant with interval 0<α<1
A_t = actual time series score
F_{t+1} = forecasting for $t+1$ period

C. *Mean Absolute Percentage Error (MAPE)*

In forecasting, accuracy of the forecast is crucial and can be assessed by the forecast error, which serves as the basis for comparing forecasting performance. In this study, Mean Absolute Percentage Error (MAPE) is used for this purpose.

Mean Absolute Percentage Error (MAPE) is the average absolute error over a certain period, multiplied by 100% to obtain the result as a percentage [1]. MAPE is calculated by using the absolute error for each period divided by the actual observed value for that period. The MAPE value can be calculated using the formula:

$$MAPE = \left(\frac{1}{n}\right)\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right| \times 100\% \quad (2)$$

MAPE = *Mean Absolute Percentage Error*
n = total sample of t
A_t = t period data values
F_t = t period forecast values

D. *Stationer Analysis*

Stationary data refers to data whose variance and mean values remain constant or do not change systematically over time. Stationarity implies that data fluctuations are around a constant mean value, independent of time and the variance itself [11]. The stationarity of data can be tested using the Box-Cox test, the differencing method, and the correlation test. In this study, the correlation test is used. In time series methods, the main tools for identifying the model from the data are Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF). These functions are used to analyze stationarity by examining the correlogram through ACF and PACF.

1. *Autocorrelation Function* (ACF)
   Autocorrelation Function (ACF) is a relationship between autocorrelation and lag which is formed from the set of autocorrelations between k-lag and $Z_t + Z_{t+k}$ [12]. *Autocorrelation function* is symbolized with r_k and formulated as:

   $$\hat{\rho}_k = r_k = \frac{\sum_{t=1}^{n-k}(Z_t-\bar{Z})(Z_{t+k}-\bar{Z})}{\sum_{t=1}^{n}(Z_t-\bar{Z})^2} \quad (3)$$

   $$\bar{Z} = \frac{\sum_{t=b}^{n}(Z_t)}{(n-b+1)} \quad (4)$$

   n = number of observations
   k = lag
   Z_t = data at t time
   Z_{t+k} = data at $t+k$ time
   $\bar{Z} = Z_t$ mean
   This value relates to the linear relationship between time series samples separated by a lag of k time unit and can be proven with r_k always being within the interval -1 and 1 [13]. The ACF graph can be used to detect data stationarity. If the ACF graph tends to die down slowly, the data is said to be non-stationary in terms of the mean [11].
2. Partial Autocorrelation Function (PACF)
   Partial Autocorrelation Function (PACF) is the correlation between Yt and Y(t+k) after removing the effects of the Y values that lie between Yt and Y(t+k), so that Yt is considered a constant [12]. The Partial Autocorrelation Function is formulated in equations 5 and 6.

   $$\hat{\phi}_{kk} = \frac{r_k - \sum_{j=1}^{k-1}\hat{\phi}_{k-1,j}r_{k-j}}{1-\sum_{j=1}^{k-1}\hat{\phi}_{k-1,j}r_j} \quad (5)$$

   $$\hat{\phi}_{kj} = \hat{\phi}_{k-1,j} - \hat{\phi}_{kk}\hat{\phi}_{k-1,k-j}$$

   For $j = 1,2,\ldots,k-1$

Partial Autocorrelation Function (PACF) is similar to the ACF but has different characteristics, such as the ability to cut off for non-seasonal time series. Therefore, the PACF at lag *k* can be expressed if the absolute value.

$$t_{rkk} = \frac{r_{kk}}{s_{rkk}} > 2 \qquad (6)$$

III. RESEARCH METHODOLOGY

The research methodology in this writing describes the stages, methods, and techniques used to obtain the information and data sources that will be used in the study. The study conducted is quantitative and descriptive, where the data sources are taken through mathematical sampling and then calculations are performed to create a description of the analysis results from the data that has been obtained and processed. The stages of this research are shown in Figure 5, starting with data collection techniques, followed by data processing using Single Exponential Smoothing, and then analyzing the processing results until conclusions are drawn from the outcomes.

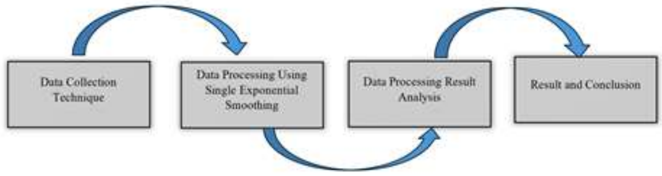

Figure 5. Research Gate

A. Data Collection Technique

The data collection technique and process are carried out through a request to PT Transportasi Jakarta for passenger boarding and tapping information data during a certain time period and specific place. Data were collected using Microsoft Excel software. The data collection method was carried out using two methods, namely:

1. Interview
   Interviews are one of the data collection techniques conducted through direct or indirect question-and-answer sessions aimed at obtaining information on the needs for Transjakarta passenger boarding and alighting data, as well as other necessary supporting data. Interviews and discussions were held with the operations section of the Data Analytics Department, Directorate of Engineering and IT. The data obtained are secondary data in the form of the number of passengers on Transjakarta buses in Corridor Blok M-Kota from 5:00 AM to 10:00 AM, starting from January 1, 2022, to December 31, 2023.
2. Literature Review
   Literature review was used by the author to gather additional data and information through journals, articles, websites, and other references related to the topic and issues. The data obtained are secondary data, where the data collection is done indirectly and can serve as supplementary data. Secondary data sources can include interview results, articles, literature, journals, and internet sites relevant to the research conducted. The data sources were obtained from survey activities and direct interviews for data collection at PT Transportasi Jakarta, Cawang, East Jakarta. The data obtained includes the number of passengers boarding (card tapping) Transjakarta buses in Corridor Blok M-Kota from 5:00 AM to 10:00 AM, starting from January 1st, 2022, to December 31st, 2023 with a quarterly period, as shown in Table 1.

TABLE I. Passenger Tapping Data Year 2022-2023.

Period	Quarter	Passenger
1	January – March 2022	715.455
2	April – June 2022	702.347
3	July – September 2022	818.768
4	October – December 2022	2.038.014
5	January – March 2023	1.656.808
6	April – June 2023	855.507
7	July – September 2023	801.104
8	October – December 2023	1.129.261

B. Data Processing Using Single Exponential Smoothing

The data processing was conducted using the Single Exponential Smoothing method, implemented in Minitab17 and Microsoft Excel software. The data processing method in Single Exponential Smoothing involves exponentially decreasing weighting of previous observation values, where newer values are given relatively higher weights compared to older observation values. In Single Exponential Smoothing, forecasting can be performed by recalculating new data and assigning weights to each data point [15]. The sequence of steps performed in using the Single Exponential Smoothing method is illustrated in the form of a flowchart shown in Figure 6, with the following explanation:

1. Historical data on passenger tapping stationery checking.
   In forecasting using the Single Exponential Smoothing method, the data must be stationary or relatively stable, fluctuating around the mean without containing any consistent trend or growth pattern. Therefore, after the data is collected, the first step is to check whether the data is stationary. In this study, this check is performed using Minitab17 software.
2. Finding the best alpha value.
   The alpha value in Single Exponential Smoothing serves as the smoothing parameter weight with a range of $0<\alpha<1$. In this study, calculation of the optimal α value is done using the Trial-and-Error method in Microsoft Excel software. The α value that yields the smallest error rate is selected for the forecasting calculation.
3. Calculating error value MAPE.
   Mean Absolute Percentage Error or MAPE is a precision measurement that calculates the average absolute percentage error, indicating the average absolute forecasting error in percentage terms relative to actual data. It is calculated using equation 2.
4. Calculating the forecast using *Single Exponential Smoothing.*
   Forecasting using Single Exponential Smoothing or Exponential Smoothing Method is done by inputting the current demand forecast with actual demand data or actual demand data into the Exponential Smoothing formula, as shown in equation 1.

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International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

5. Calculation Values.
   The calculation result is in the form of values obtained from the exponential smoothing method calculation, serving as the predicted outcome that can be utilized for various informational needs.

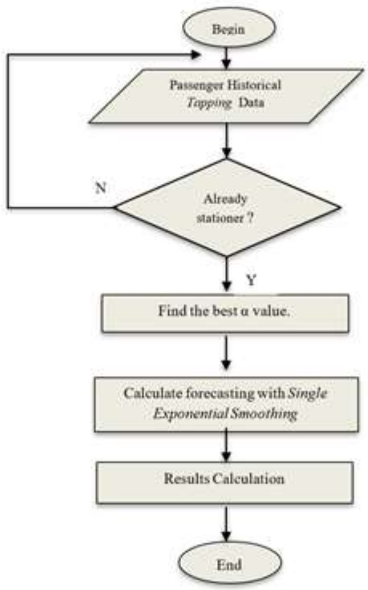

Figure. 6. Data Processing Flowchart

C. Data Processing Result Analysis

In this stage, a comparative analysis is conducted on the forecasting results obtained through manual calculations aided by Microsoft Excel and calculations using Minitab software. Subsequently, the accuracy of both calculations will be examined to determine if the results are consistent.

D. Result and Conclusion

In this section, it explains how the forecasting calculation results are obtained using the Single Exponential Smoothing method based on data that has undergone the stage of defining whether the data is stationary or not. It also involves error calculation to determine the level of accuracy of the forecasting method, enabling conclusions to be drawn from the research results in the form of Mean Absolute Percentage Error.

IV. Result and Discussion

In this section, it explains the results obtained from predicting the increase in the number of Transjakarta passengers on Blok M - Kota corridor using Single Exponential Smoothing method.

A. Data Collecting Technique

The data collection used in this study is the result of requests for Transjakarta bus passenger data taken at specific periods, starting from January 2022 until December 2023, in the form of an Excel file.

B. Data Processing

The data processing stages have been explained in the research methodology section, illustrated by Figure 6 flowchart.

1. Passenger Historical Tapping Data
   The passenger tapping data used is secondary data containing the number of passengers tapping cards in Transjakarta buses on Blok M - Kota corridor from 05:00AM to 10:00AM starting from January 2022 until December 2023, as shown in Table I.
2. Stationer Analysis
   Initial step in data processing in this study is testing the stationarity of the data using Minitab software. First, the data is transformed into a time series plot, as shown in Figure 7.

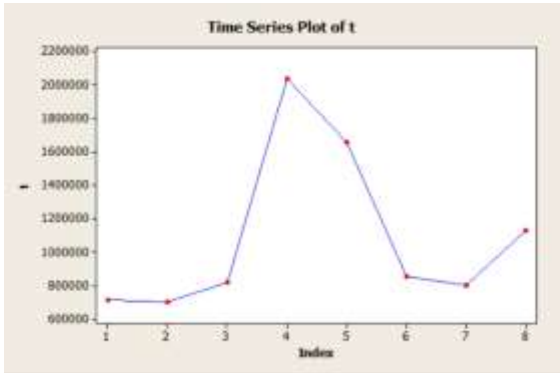

Figure 7. Time Series Plot Graphic

Based on time series plot in Figure 7, the data follows a cyclic pattern because the points on the graph still fluctuate around a constant mean value, and the fluctuations present in the graph are not very significant (no trend element) or can be considered stationary. Since there are no standard values in determining whether the data is stationary or not using the graph, but relying on visual analysis of the graph, the next step to reinforce the results of the time series plot is conducting an autocorrelation test. The graph of the autocorrelation test results can be seen in Figure 8.

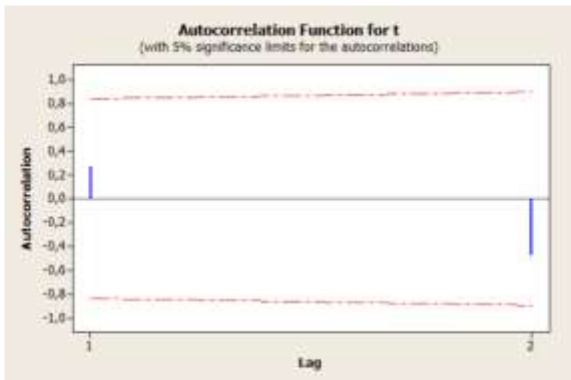

Figure 8. Autocorrelation Function (ACF) Graphic

Based on the graph results of autocorrelation test in Figure 8, it shows that none of the 2 lags intersect the red boundary. If there are no lags or fewer than three lags crossing the red line, the data is considered stationary. Therefore, based on the autocorrelation function graph, it can be said that the data is stationary. Additionally, the output results from ACF can also be observed in Table 2.

TABLE III. Autocorrelation Test Output

Lag	ACF	T
1	0,263411	0,75
2	-0,472452	-1,25

Based on Table II, it can be observed that from the first lag to the second lag, there is a decrease in the T value, indicating that the data is stationary. The next step is to conduct a partial autocorrelation test. The graph of the PACF test results can be seen in Figure 9.

Figure 9. Partial AutoCorrelation Function (PACF) Graphic

Similar to the ACF test, the graph results of the PACF test show that none of the 2 lags intersect the red boundary or fall outside the interval. Therefore, based on the PACF graph, it can be said that the data is stationary. Additionally, the output results from PACF can also be observed in Table III.

TABLE III. Partial Autocorrelation Test Output

Lag	PACF	T
1	0,263411	0,75
2	-0,582235	-1,65

From Table III, it is evident that there is a decrease in T value from the first lag to the second lag, indicating that the data is stationary. Based on the time series plot, ACF, and PACF tests conducted, it can be concluded that the passenger data of Transjakarta public transportation used in this study is stationary.

3. Best Alpha Value Analysis

The best alpha value analysis is conducted using the trial-and-error method within the alpha range of 0.1 to 0.9, which will be used to calculate the forecast. In the first forecast (F1), it is left blank because the first data cannot be used to perform the Single Exponential Smoothing function since it cannot retrieve previous data. Therefore, the first data is considered a forecast for the second data (F2).

a. For the constant $\alpha = 0{,}1$, calculate the forecast against

$F_2 = 0{,}1 * 715455 + (1 - 0{,}1) * 715455 = 715.455$

$F_3 = 0{,}1 * 702347 + (1 - 0{,}1) * 715455 = 714.144{,}2$

Results of the forecast calculations with constant $\alpha = 0{,}1$ shown in Table IV.

TABLE IV. Calculation Results for Alpha = 0,1

Period	Tap	Forecast
January – March 2022	715.455	715.455
April – June 2022	702.347	715.455
July – September 2022	818.768	714.144,2
October – December 2022	2.038.014	724.606,58
January – March 2023	1.656.808	855.947,322
April – June 2023	855.507	936.033,389
July – September 2023	801.104	927.980,75
October – December 2023	1.129.261	915.293,075

b. For the constant $\alpha = 0{,}2$, calculate the forecast against

$F_2 = 0{,}2 * 715455 + (1 - 0{,}2) * 715455 = 715.455$

$F_3 = 0{,}2 * 702347 + (1 - 0{,}2) * 715455 = 712.833{,}4$

Results of the forecast calculations with constant $\alpha = 0{,}2$ shown in Table V.

TABLE V. Calculation Results for Alpha = 0,2

Periode	Tap	Forecast
January – March 2022	715.455	715.455
April – June 2022	702.347	715.455
July – September 2022	818.768	712.833,4
October – December 2022	2.038.014	734.020,32
January – March 2023	1.656.808	994.819,056
April – June 2023	855.507	1.127.216,845
July – September 2023	801.104	1.072.874,876
October – December 2023	1.129.261	1.018.520,701

Calculation of the alpha value is repeated starting from $\alpha = 0{,}1$ to $\alpha = 0{,}9$ to find the best alpha value for the forecasting results. To shorten it, here are calculation results for the alpha value $\alpha = 0{,}9$.

$F_2 = 0{,}9 * 715455 + (1 - 0{,}9) * 715455 = 715.455$

$F_3 = 0{,}9 * 702347 + (1 - 0{,}9) * 715455 = 703.657{,}8$

Results of the forecast calculations with constant $\alpha = 0{,}9$. shown in Table VI.

TABLE VI. Calculation Results for Alpha = 0,9

Period	Tap	Forecast
January – March 2022	715.455	715.455
April – June 2022	702.347	715.455
July – September 2022	818.768	703.657,8
October – December 2022	2.038.014	807.256,98
January – March 2023	1.656.808	1.914.938,298
April – June 2023	855.507	1.682.621,03
July – September 2023	801.104	938.218,403
October – December 2023	1.129.261	814.815,44

4. Mean Average Percentage Error (MAPE) calculation.

After carrying out calculations using the constant range $\alpha = 0{,}1$ to $\alpha = 0{,}9$ the error value will be calculated using MAPE. First, the calculation is done for the Average Percentage Error (APE) value, ranging from $\alpha = 0{,}1$ to $\alpha = 0{,}9$. The calculated APE values for $\alpha = 0{,}1$, shown in Table VII.

Based on Table VII, for $\alpha = 0{,}1$ the total *summary* of APE values obtained is 1,71625589. Subsequently, MAPE calculation can be performed.

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TABLE VII. APE Calculation Results for $\alpha = 0{,}1$

Period	Tap	Forecast	APE
January – March 2022	715.455	715.455	
April – June 2022	702.347	715.455	0,018663139
July – September 2022	818.768	714.144,2	0,127781985
October – December 2022	2.038.014	724.606,58	0,644454562
January – March 2023	1.656.808	855.947,322	0,483375671
April – June 2023	855.507	936.033,389	0,094127096
July – September 2023	801.104	927.980,75	0,158377378
October – December 2023	1.129.261	915.293,075	0,189476059
		Total APE Value	1,71625589

$$MAPE = \left(\frac{1}{n}\right)\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right| \times 100\%$$

$$MAPE = \frac{1}{8} \times 1{,}71625589 \times 100\%$$

= 21%

The calculation is carried out until the constant $\alpha = 0{,}9$ and the result of MAPE calculations can be seen in Table VIII.

TABLE VIII. MAPE Calculation Results

α constant	MAPE
0,1	21%
0,2	25%
0,3	25%
0,4	25%
0,5	25%
0,6	29%
0,7	29%
0,8	29%
0,9	29%

The smaller the error value produced, the more accurate the forecasting method used. Based on the analysis results above, the best alpha value obtained is $\alpha = 0{,}1$ with the MAPE value 21%.

5. Forecasting using Single Exponential Smoothing (SES)

   The forecast is conducted using alpha value $\alpha = 0{,}1$ for the number of passengers of Transjakarta public transportation in the year 2024. Therefore, the forecast result for the 9th period, which is January to March 2024, is obtained using Single Exponential Smoothing with a constant $\alpha = 0{,}1$.

$$F_9 = 0{,}1 * A_8 + (1 - 0{,}1) * F_8$$
$$= 0{,}1 * 1129261 + (0{,}9) * 915293{,}075$$
$$= 936.689{,}868$$

   Based on the forecast calculation using Single Exponential Smoothing, the comparison graph of actual data with smoothed results can be seen in Figure 10. In this graph, the forecast results using SES do not fluctuate upwards and have an outcome that aligns with the actual data.

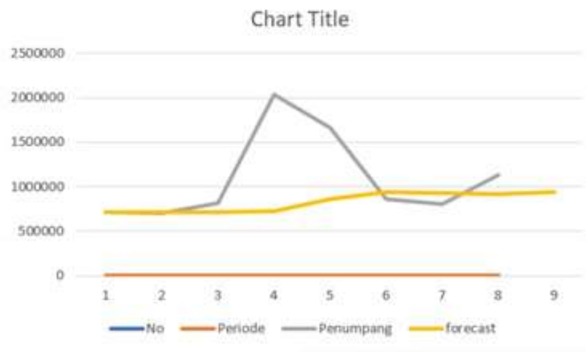

Figure 10. Comparison graph of actual data and forecasting results

C. Data Processing Result Analysis

The forecasting is also conducted using Minitab software to compare the results obtained manually using Excel with Single Exponential Smoothing method. The process involves testing the calculation results obtained with Single Exponential Smoothing method using Minitab software to improve the accuracy of the obtained results. The forecasting results using Minitab can be seen in Figure 11, and Figure 12 explains the smoothing plot graph using Minitab.

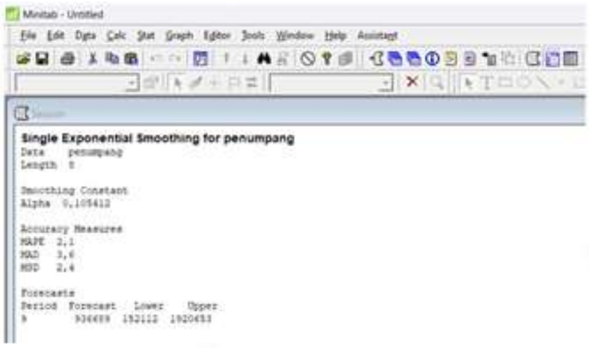

Figure 11. SES Forecasting result using Minitab

Based on Figure 11, the best alpha value obtained is 0.1, with a MAPE value of 21%. The forecasted number of passengers for period 9, which is January to March 2024, is 936,689.

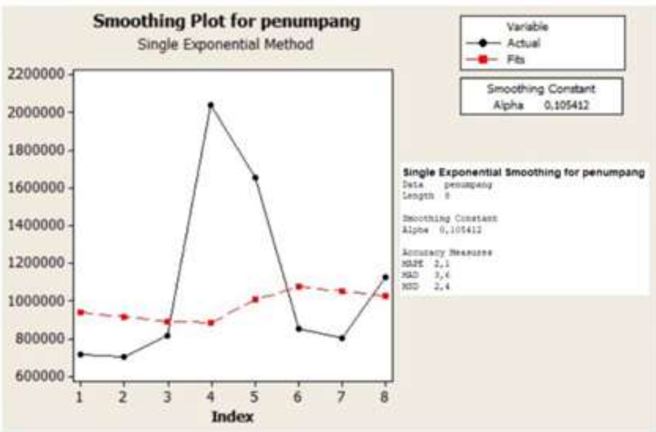

Figure 12. Smoothing Plot Graphic using Minitab.

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D. Result and Conclusion

After several stages of data definition, processing, and forecasting calculations on the data available, based on the forecast calculation results for the number of passengers of Transjakarta public transportation for period 9, which is January to March 2024, conducted manually using the Single Exponential Smoothing method, the forecast value obtained is 936,689 with an alpha value $\alpha = 0{,}1$ and MAPE error value of 21%. The result obtained is consistent with the calculation using Minitab software, indicating that both calculations are accurate and yield consistent results.

V. CONCLUSION

In this study, successful prediction of the number of Transjakarta bus passengers on the Blok M - Kota corridor has been achieved using Single Exponential Smoothing method, based on data obtained from PT Transportasi Jakarta. The data consists of the number of passengers tapping cards in Transjakarta buses on Blok M - Kota corridor from 05:00 to 10:00 WIB starting from January 1st, 2022, until December 31st, 2023. The data used is stationary and follows a cyclic pattern, enabling forecasting calculations using the Single Exponential Smoothing method.

The accuracy calculation of the forecast values using Mean Absolute Percentage Error (MAPE) has been successfully conducted to determine accuracy of the forecast in predicting Transjakarta bus passengers based on the prediction results. After calculations using α=0,1 and α=0,9, the smallest MAPE value obtained is 21% at α=0,1. Subsequently, using α=0,1 both manual calculations and calculations using Minitab software resulted in a forecasted number of Transjakarta public transportation passengers for period 9, which is January to March 2024, of 936,689. The results of both calculations indicate that the obtained values have the same accuracy.

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Diana Ikasari, Rifqi Arief Permana, and Widiastuti, "Prediction in the Number of Passengers on Transjakarta Public Transportation Using the Single Exponential Smoothing Method," *International Research Journal of Advanced Engineering and Science*, Volume 9, Issue 2, pp. 146-153, 2024.