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ANALYSIS OF MOVING AVERAGE AND HOLT-WINTERS OPTIMIZATION BY USING GOLDEN SECTION FOR RITASE FORECASTING

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ABSTRACT

Moving average and exponential smoothing holt winter's is a method for forecasting calculations of some existing statistical and computational method. The selection of two methods in this research is based on ritase data from January 2013 – December 2015 to view the average, trend and seasonal pattern that will occur in one period of future forecasting research. However, the weakness from *Exponential Smoothing Holt Winter's* is the determination for initial values (α, β, & γ) are inputted with trial value from 0 to 1 which may not yield maximum results. Golden section method is added in this research to assist the optimum determination for initial values (α, β, & γ) from *Exponential Smoothing holt Winter's* to produce the accurate results. This research aims to know the forecasting model for the amount of income ritase at Department of transportation Yogyakarta – UPT Giwangan terminal management with *Exponential Smoothing holt Winter's* and *moving average.* Furthermore, to know the comparison of forecasting results with both methods. To obtain the right method, the measuring instrument is needed to detect the accuracy of the prediction value, while the one used in this research is the *mean absolute percentage error* (MAPE), *mean square deviation* (MSD) and *Mean Absolute Deviation (MAD).*The determination of forecast value and selection of MAPE, MSD, and smallest MAD is using the two methods above. The results of data analysis shows that Exponential Smoothing holt Winters is considered as the right method for the amount of ritase income at Department of Transportation, city of Yogyakarta - UPT Management of Giwangan Terminal because it produces the smallest value of MAPE = 4%, MSD = 446841 and MAD = 496.

Keywords: *Forecasting, Golden Section, Exponential Smoothing Holt Winters, Moving Average*

1. INTRODUCTION

Public transport of the highway is certainly not separated of the presence of public transport terminal. Terminal of public transport type A Transportation Department of city of Yogyakarta – Terminal Management Unit of Giwangan is a road transport infrastructure which is a place for facility provision of entry and exit of public transport, a place where passenger flows from one type of public transport to another type of public transport for convenience and movement efficiency. However, there are still many drivers tend to take and drop off the passengers in the outside of the terminal because of the route that passed is close to the settlement. Therefore, bus is not enter the terminal as well as the lack of public transport drivers awareness in paying retribution. The lack of maximum sense of responsibility of the collector happened because there is a lack supervision factor that cause the collector officer less firmly against the transport drivers who do not obey the rules that have been determined.

This indirectly can reduce the revenue of terminal retribution which is stated in the local regulation of Yogyakarta City No.4 Year 2012, and as it is known, the greater the income of a region, the more the area can improve it's ability in the implementation of regional affairs [1]. Ritase is an activity of retribution withdrawal which held at Transportation Departement city of Yogyakarta – Giwangan (UPT) Terminal Management Unit for every bus which enter the terminal. Then, collecting levy officer give bonus ticket for bus driver and bus driver pay based on tariff which is subject to the type of bus. According to data provided by management of Giwangan (UPT)Terminal Management Unit from January 2013 – Desember 2015, number of ritase from four kinds of bus routes are : AKAP Economy, AKAP

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non Economy, AKDP, and KOTA got fluctuate. While the movements of data pattern are shown in :

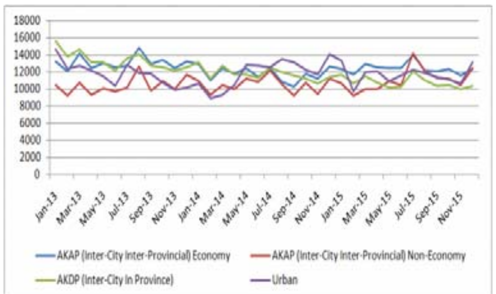

Figure 1. The movement of ritase data pattern at terminal management unit (UPT) Giwangan from January 2013 to December 2015 period

Based on Figure 1, if data is accumulated from January 2013 to December 2015, it showed that the data is *moving average* data, stationary data patterns occur when there is fluctuating data around constant average value [2]. However, from the movement of data there are certain periods of the month which are not among the constant averages, but rather indicate the presence of seasonal pattern elements and trend patterns, the *Holt Winters* method is a method that can handle seasonal factors and trends directly. This method is based on three smoothing equations with three parameters, one for stationary elements, one for trend, and one for seasonality [3].

The main contribution of this research is to find the best model in forecasting of ritase income at Transportation Department city of Yogyakarta, Terminal Management Unit (UPT) of Giwangan using *moving average* method and *exponential smoothing holt winters* with the help of optimization of golden section for forecasting one further period.

2. RELATED WORK

Time prediction series is an exciting and challenging activity in the field of statistic and computing, as already described in this paper previously that it will use some methods. Research that was previously associated with time series, using *the moving average* method has been done, the *moving average* (MA) is the smoothing approach, which predicts the target variable with the previous data sequence, the simple approach from *moving average* makes it easy to work [4].

In previous research on time series forecasting in 2010, in Grand Competition for Computational International (NNGC) using statistical approach. That is moving average method and grey prediction as a comparison with other research. In the research (NNGC) giving a concept of workflow that the calculation results of moving average and grey prediction is forwarded into Support Vector Regression concept and then in process again in Bagging Ensemble Technique. The results is based on the criteria of MAPE, SMAPE, and RMSE which are based on using of moving average method, grey prediction, support vector regression and bagging. Moving average (MA) is in second position and the forecasting level is under of support vector regression in the first position [5].

In moving average (MA) also applied smoothing method with aims to find stationary time series data whereas the balance of the data is around of constant value with constant variation and allegedly is containing trend data [6] [7].

In another research with Moving Average (MA) method for analyze the time series data rainfall data forecasting which obtained at Bandung Agricultural Department where to predict the results of rainfall forecasting for a month in Bandung regency as a planning information for the proper planting season. Strength of this research is the all type of *moving average* is used to analyze from simple MA, Centered MA, Double MA, Weighted MA, Modified WMA and to test forecasting error rate using MAPE Method. From all adopted methods, the smallest MAPE value is obtained from the centered MA method, it is 15,66 % [8].

This research also using *exponential smoothing holt winters* method in time series prediction, *Holt-winters* method used three smoothing parameter that are constant smoothing, parameter for trend and parameter for seasonal. *The Holt-Winters method* [9] [10] is an extension of the *Holt model* (1957) [11] and the Winters model (1960) [12] method for seasonality. Method *Holt – Winters* has two variants, *additive* (seasonal variation unchanged) and *multiplicative* method (season variation changed). In another research with *Holt winters* method which is used for forecast on workload analysis of volunteers resources. Strength of this research is smoothing parameter (α, β, & γ)are chosen differently depending on the available data series for the weather forecasting. The results show that workload forecast can be improved by varying smoothing parameters (α, β, & γ) depending on the original available data and the variant of the *Holt-Winters* method. Moreover, the results of curve which obtained for showing the results of the *Additive* and *Multiplicative* models [13].

In another research with forecasting method which implemented in an application for tourism sector using *Holt - winters method*. Strength of this research using *Holt - winters* are using spreadsheet modeling to optimize smoothing parameter from *Holt winters*. The range of initial values of optimum values ranging from 0 <1 for α, β, & γ, and then are processed to obtain the forecasting results. The function of this tool is the initial optimum value for α, β, & γ, and made into a free plugin program that is combined with Microsoft applications. Results Model curves is obtained by *addivite* and *multiplicative models* [14]. An addition in this Research is the use of optimization methods, which are intended to provide an optimum initial value to exponential smoothing holt winters. The approach to determine the optimum parameters is usually by trial and error [15] In previous research the method was *Particle Swarm Optimization* (PSO). Although, already used widely in any fields, it still has a size of less good problem for optimization, the advantages in this research is by designing a filter that will improve the optimization performance of the proposed algorithm, the effectiveness of the algorithm by using *Golden Section Search* is expected this can be completed. The results in this optimization are used in NC systems with two motors and computers which are optimized with control parameters for the NC Controller in industry [16].

The *golden section method* in previous studies for an optimum value has been used, for example is a research that conducted on the use of optimization of average price of Indonesian crude oil (ICP), January 2011 until May 2016 using golden section for brown parameter optimization and holt double exponential smoothing [17]. Based on several methods discussed above, the author tries to use the moving *Average Method and Exponential Smoothing Holt Winters.* As well as, reinforcement to find the best optimization using the *Golden Section method*, to perform the forecasting process which the results will be in the form of a certain period, trend and seasonal of ritase data. The method of accuracy of forecasting values in this research is *mean absolute percentage error* (MAPE), (MSD), (MAD) and *Multiplicative.*

3.RESEARCH METHOD

Moving average is a using method to eliminate or reduce randomness in a series of time and then process the data smoothing. Especially, for time series data that aims to estimate or predict data trends. The basic technique of moving averages in time series consists of taking a collection of values observed, earned an average of this value, and then used the averaged value as a forecast for upcoming period [6] [7]. Each new observation value arises, the new average value can be calculated by removing the oldest observational value and entering the most recent observation value. Algebraically, a single moving average can be written as in the equation. [18].

$$FT = \frac{A_{t-1} + A_{t-2} + \cdots + A_{t-n}}{n} \quad (1)$$

Information :
FT : Activity Forecast in period t
N : Number of periods in moving average
At-1, At-2, .., At-n: Activities in previous period

Exponential smoothing is a procedure that repeats the calculations continuously using the latest data based on the exponential calculation of the past exponential average data. In the method that proposed by *winter*, it is based on three smoothing parameters, one for stationary elements, one for trend, and one for seasonality [22*]. Holt-Winter Exponential Smoothing multiplicative* model equations are as follows [3]

Overall Smoothing

$$S_t = \alpha + \frac{X_t}{I_{t-L}} + (1-\alpha)(S_{t-1} + b_{t-1}) \quad (2)$$

Trend Estimates

$$b_t = \beta(S_t - S_{t-1}) + (1-\beta)b_{t-1} \quad (3)$$

Seasonal Estimates

$$I_t = \gamma\frac{X_t}{S_t} + (1-\gamma)I_{t-L} \quad (4)$$

Forecasting for future period P

$$F_{t+m} = (S_t + b_t m)I_{t-L+m} \quad (5)$$

Information :
X_t :the actual value in the final period t
α :smoothing for data (0 ≤ α ≤1)
β :refinement for trend estimation (0 ≤ β ≤1)
γ :smoothing for seasonality (0 <γ <1)
S_t :seasonal estimates
I :Seasonal seasoning factor
L :long season
F_{t+m} :forecast for future period m of t

Nonlinear programming can be applied to a case where the function f (x) is nonlinear or the value of x is determined by a nonlinear equation or inequation. [19]. In general, *the Golden Section* algorithm is used to solve the NLP *(Non-Linear*

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Programming) of one variable in the form of: f (x), with constraint: a ≤ x ≤ d. This algorithm using the principle of reducing the boundary area x which may produce the optimum objective function price (maximum or minimum) iteratively (repeatedly) and to obtain a symmetric new point, it needs a value of r (*Golden Ratio*) [20]

The use of forecasting methods depends on the pattern of data to be analyzed. If the method used is considered correct for the forecasting, then the selection of the best forecasting method is based on the level of misconception. As it is known that there is no forecasting method that can precisely predict the state of the data in the future. Therefore, any forecasting method must produce an error. If the resulting error rate is smaller, then the forecasting result will be closer to exact. The measuring tool used to calculate prediction errors is [21]

$$\mathrm{MAPE} = \frac{100\%}{n}\sum_{t=1}^{n}\left|\frac{Z_t - \hat{Z}_t}{Z_t}\right| \tag{6}$$

$$\mathrm{MAD} = \frac{1}{n}\sum_{t=1}^{n}\left|Z_t - \hat{Z}_t\right| \tag{7}$$

$$\mathrm{MSD} = \frac{1}{n}\sum_{t=1}^{n}\left(Z_t - \hat{Z}_t\right)^2 \tag{8}$$

Information :
Zt : actual data in period t
Zt : forecasting value in period t
N : the amount of data

By using the time series data of UPT Giwangan from January 2013 - December 2015, the method of *moving average method* is to plot the data first, then the calculation process will be done based on the formula of the moving average method. After that there will be generating the forecasting calculation for the income of ritase. The results of that calculation, then will be analyzed it's level of accuracy of errors, by using MAPE, MSD and MAD. If the resulting error rate is smaller, then the forecasting result will be closer to exact

For the *exponential smoothing holt winters method*, we will first use the *golden section method,* which aims to provide the best output values for (α), (β), and (γ) values. The way to get the output is to try several iterations / steps to what the values of (α), (β), and (γ) are close to the small MAPE values that specially created in the golden section method. Then proceed to smoothing calculations for a whole exponential, smoothing for trend, resuming seasonal smoothing, and forecasting for P period in the future. The results of that calculation, then will be analyzed the level of accuracy of errors, by using MAPE, MSD and MAD. If the resulting error rate is smaller, the forecasting result will be closer to the right, then the best method will be selected for forecasting ritase. For more details, the use of *moving average and golden section methods* for *exponential smoothing holt winters* optimization for forecasting analysis of ritase, is shown in flowchart form in Figure 2 below.

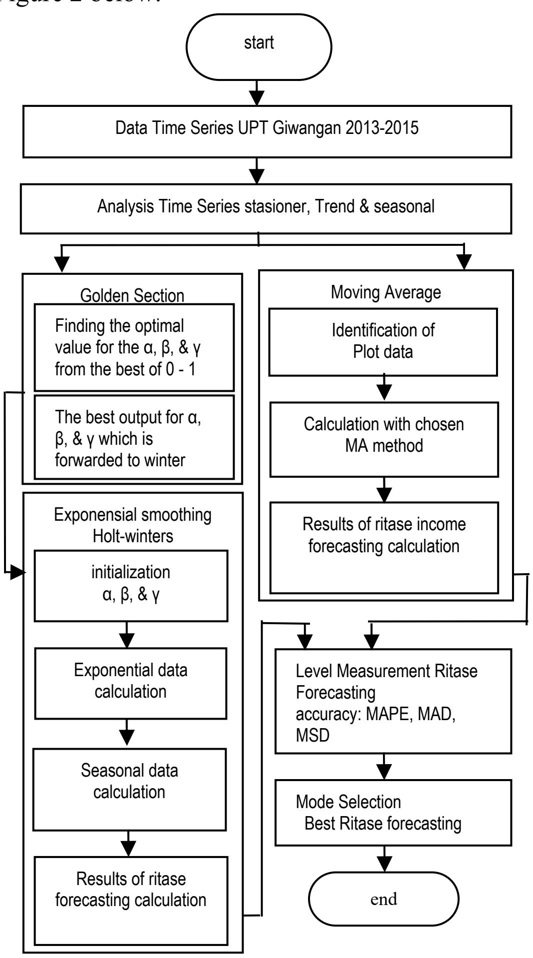

Figure 2. The analysis flow of two models of ritase forecasting process

Analysis of optimum value Golden section

To obtain the optimum value for initial scoring of the overall smoothing (*α*), (smoothing *trend* (*β*) smoothing. as for the following steps are :

1. Determine the lower limit (below_a, under_b, under_c) and upper limit (below_a, above_b, above_c) as well as the iteration cessation

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tolerance (error). Note: since α, β, γ are between 0 and 1 then the lower limit 0 and the upper limit of 1.

2. Calculate the golden ratio.
3. Determining the Initial Value:
   a. α1 = r * below a + (1-r) * above_a;
   b. β1 = r * below_b + (1-r) * above_b;
   c. γ 1 = r * below c + (1-r) * above_c;
   d. α 2 = (1-r) * below_a + r * above_a;
   e. β 2 = (1-r) * below_a + r * above_a;
   f. γ 2 = (1-r) * below a + r * above_a;
4. Find the minimum f (X) between combinations X for:
   a. α 1 = r * below_a + (1-r) * above_a;
   b. β 1 = r * below_b + (1-r) * above_b;
   c. γ 1 = r * below_c + (1-r) * above_c;
   d. γ 2 = (1-r) * below_a + r * above_a;
   e. β 2 = (1-r) * below_a + r * above_a;
   f. γ 2 = (1-r) * below_a + r * above_a;
5. Reduce the interval limit based on the golden section criteria
6. Repeat steps 4 & 5 to α 2 - α 1 │ ≤ error │β 2 - β 1 │≤ error and │γ 2 - γ 1│≤
7. Find the minimum f (X) of the combinations below_a, above_a, α_1, α_2, below_b, above_b, β_1, β_2, below_c, above_c, γ_1, γ_2
8. Output α, β, γ is the optimum
9. Calculating forecasting with exponential smoothing holt winters with an optimum α, β, γ output
10. Determine the value of MAPE, MSD, MAD

Here is the process of each iteration that runs toward an optimum value, as for the explanation as follows:

Optimum value of economic AKAP

In table 1. in the view of the analysis process for the optimum value that obtained in the Economic AKAP, the optimum value for the value of α: 0.9, β: 0.02 and γ: 0.9 which is obtained by using the golden section method. In Table 1, for Economic AKAP based on the specified error value that is 0.01 from the *golden section method*. It will have first iteration process in column 1 which has the value of α is 0.6180, in column 2 the value of β is 0.3820, in column 3, with the value of γ is 0.6180, and in column 4 with the value of MAPE is 0.0737.

Table 1. Optimum analysis of AKAP Economy using the golden section method

Iteration	α	β	γ	MAPE
1	0.6180	0.3820	0.6180	0.0737
2	0.7639	0.2361	0.7639	0.0654
3	0.8541	0.1459	0.8541	0.0597
4	0.9098	0.0902	0.9098	0.0560
5	0.9443	0.0557	0.9443	0.0536
6	0.9656	0.0344	0.9656	0.0521
7	0.9787	0.0213	0.9787	0.0512

In this table when each iteration increases, the MAPE value will always decrease, if it is observed from every iteration 1 to 7 the values in columns 1 (α), 2 (β), and 3 (γ) are fluctuated, but in column 4, the value of MAPE is decreased. It means that, if the value of MAPE smaller, then MAPE value will be better. While in the next iteration the values of columns 1 (α), columns 2 (β), and column 3 (γ) are not shown because they are smaller than the specified error of 0.01. Thus, stopping at the seventh iteration.

Optimum value of non-economic AKAP

In table 2, in the view of the analysis process for the optimum value that obtained in non-economic AKAP, the optimum value for the value α = 0.7, β = 0.02 and γ = 0.9 is obtained by using the *Golden section method*. In Table 2 for the non-economic AKAP based on the specified error value that is 0.01 which obtained by using *golden section method* will have first iteration process, in column 1 which has the value of α is 0.6180, in column 2 the value of β is 0.3820, in column 3 the value of γ 0.6180, and in column 4 is the value of MAPE is 0.0661.

Tabel 2. Optimum value analysis of AKAP non economy with golden section method

Iteration	α	β	Γ	MAPE
1	0.6180	0.3820	0.6180	0.0661
2	0.7639	0.2361	0.7639	0.0617
3	0.8541	0.1459	0.8541	0.0603
4	0.8541	0.0902	0.9098	0.0599
5	0.8197	0.0557	0.9443	0.0596
6	0.7984	0.0344	0.9656	0.0594
7	0.7852	0.0213	0.9787	0.0593

In this table, each iteration are increased and the value of the MAPE are usually decreased. From iterasi 1 to 7 value in column 1 *(α),* column 2*(β),*and column 3*(γ)* are fluctuated. However, in column 4 MAPE value is decreased which means if the value of MAPE decrease then the value of MAPE is also getting better. In the next iteration the values of columns 1 (α), columns 2 (β), and column 3 (γ) are not displayed because they are smaller than the specified error of 0.01. Thus, stopping at the seventh iteration.

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Optimum value of AKDP

In table 3, in the view of the analysis process for the optimum value that obtained in the AKDP, based on the picture, the optimum values of α = 0.02, β = 0.9 and γ = 0.02 were obtained by using the golden section method. In table 3 for AKDP based on the specified error value that is 0.01 from *golden section method*. It will have first iteration process in column 1 which has the value of α is 0.6180, column 2 β is 0.3820, column 3 γ 0.6180, and the column 4 the value of MAPE is 0.0635.

Table 3. Analysis of AKDP optimum value using golden section method

Iteration	α	β	γ	MAPE
1	0.3820	0.6180	0.3820	0.0635
2	0.2361	0.7639	0.2361	0.0581
3	0.1459	0.8541	0.1459	0.0555
4	0.0902	0.9098	0.0902	0.0544
5	0.0557	0.9443	0.0557	0.0539
6	0.0344	0.9656	0.0344	0.0537
7	0.0213	0.9787	0.0213	0.0536

In this table when each iteration increases, the MAPE value will always decreased, if it is observed from every iteration 1 to 7 the values in columns 1 (α), 2 (β), and 3 (γ) are fluctuated, but in column 4, the value of MAPE is decrease. It means that, if the value of MAPE smaller, then MAPE value will be better. While in the next iteration the values of columns 1 (α), columns 2 (β), and column 3 (γ) are not displayed because they are smaller than the specified error of 0.01, thus stopping at the seventh iteration.

Optimum value of KOTA

In table 4, in the view of the analysis process for the optimum value that obtained in KOTA based on figure 3.19. optimum value of α = 0.4, β = 0.8 and γ = 0.4. All values are obtained with *golden section method.* In table 4. for the City based on the specified error value of 0.01 from the golden section method. It will have first iteration process in column 1 with the value of α = 0.6180, in column 2, β = 0.6180, in column 3, γ = 0.6180, and in the 4th column the MAPE value is 0.0281.

Table 4. Optimum value analysis of KOTA using golden section method

Iteration	α	β	γ	MAPE
1	0.6180	0.6180	0.6180	0.0281
2	0.6180	0.7639	0.6180	0.0277
3	0.5279	0.8541	0.5279	0.0248
4	0.4721	0.9098	0.4721	0.0233
5	0.4377	0.9098	0.4377	0.0225
6	0.4164	0.8885	0.4164	0.0221
7	0.4033	0.8754	0.4164	0.0219

When each iteration increases, the MAPE value will always decreased, if it is observed from every iteration 1 to 7 the values in columns 1 (α), 2 (β), and 3 (γ) are fluctuated, but in column 4, the value of MAPE is decrease. It means that, if the value of MAPE smaller, then MAPE value will be better. While in the next iteration the values of columns 1 (α), columns 2 (β), and column 3 (γ) are not displayed because they are smaller than the specified error of 0.01, thus stopping at the 7th iteration. After the optimization values are obtained for *exponential smoothing holt winters.* The overall smoothing commonly referred to as the value (α), the usual trend smoothing is called the value (β) and seasonal (seasonal) or so-called value (γ)

4. RESEARCH RESULTS AND DISCUSSIONS

In this section we will discuss the results of the analysis that obtained from the exponential *smoothing holt winters* and *moving average methods* in generating the *mean absolute percentage error* (MAPE), *mean square deviation* (MSD) , the smallest of *Mean Absolute Deviation* (MAD) and forecasting results in one future period for Economic AKAP, non-economic AKAP, AKDP and KOTA. As for the following explanation are. The obtained results for forecasting in one future period for the *exponential smoothing holt winter* are: 12355.26 .

The forecasting number are used as the source of comparison for forecasts in the next period. The smoothing model used *multiplicative* because the season variation was always changed from January 2013 to December 2015. The value of MAPE is based on predetermined values. It's not exceeding the error rate level of 10%. The obtained MAPE is 4%, the obtained MAD 496, and the obtained MSD is 446841. The results are shown in the figure 3.

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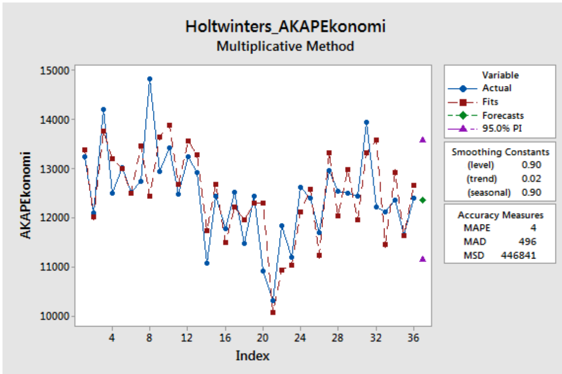

Figure 3. Prediction results of AKAP Ekonomi Exponential smoothing Holt Winters

The obtained results for forecasting in one future period for *moving average* is 12430.42 The forecasting number then used as the source of comparison for forecasts in the next period. The value used is MA (12) to average the effects of the season. The value of MAPE is based on predetermined values. It doesn't exceed the error rate level of 10%. The obtained MAPE is 6%, the obtained MAD is 737, and the obtained MSD is 943207. The results are shown in the figure 4.

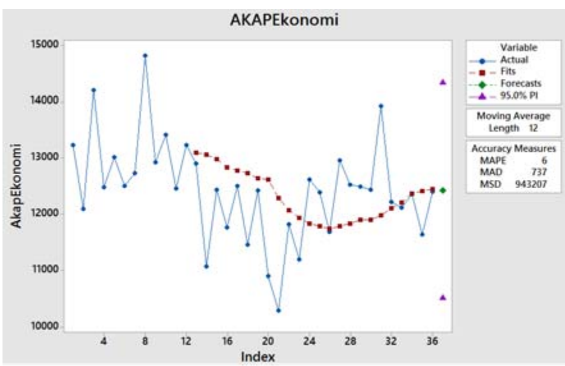

Figure 4. Prediction Results of AKAP Economy moving average

Non Economy AKAP

The obtained results for forecasting in one future period for *exponential smoothing holt winter* is :11759.07. The forecasting number then used as the source of comparison for forecasts in the next period. The smoothing model used *multiplicative* because the season variation was always changed from January 2013 to December 2015. The value of MAPE is based on predetermined values. It doesn't not exceed the error rate level of 10%. The obtained MAPE is 5%, the obtained MAD is 522, and the obtained MSD is 704039. The results are shown in the figure 5.

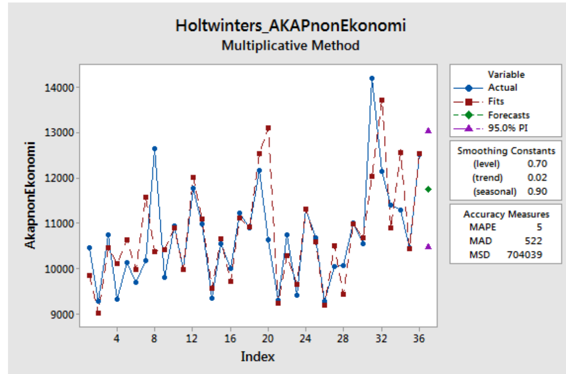

Figure 5. Prediction results of non economy AKAP Exponential smoothing Holt Winters

The obtained results for forecasting in one future period for moving average is 11135.17. The forecasting number then used as the source of comparison for forecasts in the next period. The value used is MA (12) to average the effects of the season. The value of MAPE is based on predetermined values. It doesn't exceed the error rate level of 10%. The obtained MAPE is 5%, the obtained MAD is 522, and the obtained MSD is 704039. The results are shown in the figure 6.

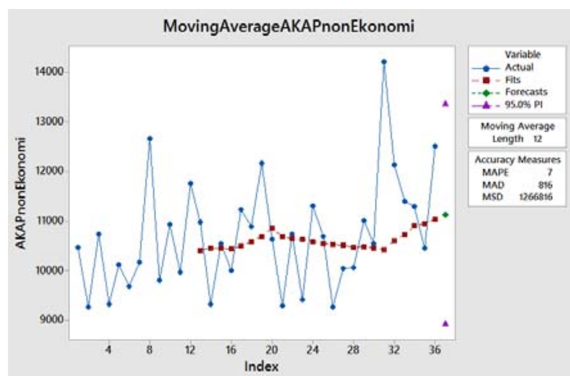

Figure 6. Prediction results of non economy AKAP moving average

The obtained results for forecasting in one future period for *exponential smoothing holt winter* is 11813.47. The forecasting number then used as the source of comparison for forecasts in the next period. The smoothing model used multiplicative because the season variation was always changed from January 2013 to December 2015. The value of MAPE is based on predetermined values. It doesn't not exceed the error rate level of 10%. The obtained MAPE is 4%, the obtained MAD is 506, and the obtained MSD is 390490. The results are shown in the figure 7.

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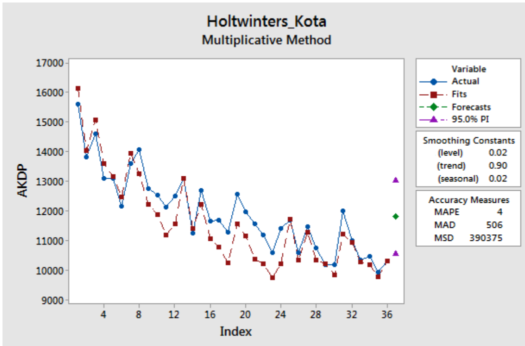

Figure 7. Prediction results of AKDP Exponential smoothing Holt Winters

The obtained results for forecasting in one future period for *moving average* is 10748.83. The forecasting number then used as the source of comparison for forecasts in the next period. The value used is MA (12) to average the effects of the season. The value of MAPE is based on predetermined values. It doesn't exceed the error rate level of 10%. The obtained MAPE is 7%, the obtained MAD is 720, and the obtained MSD is 730490. The results are shown in the figure 8.

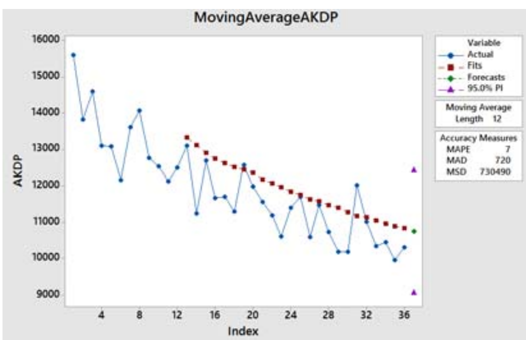

Figure 8. Prediction results of AKDP moving average

The obtained results for forecasting in one future period for *exponential smoothing holt winter* is :133347.9. The forecasting number then used as the source of comparison for forecasts in the next period. The smoothing model used *multiplicative* because the season variation was always changed from January 2013 to December 2015. The value of MAPE is based on predetermined values. It doesn't not exceed the error rate level of 10%. The obtained MAPE is 8%, the obtained MAD is 925, and the obtained MSD is 1391093. The results are shown in the figure 9.

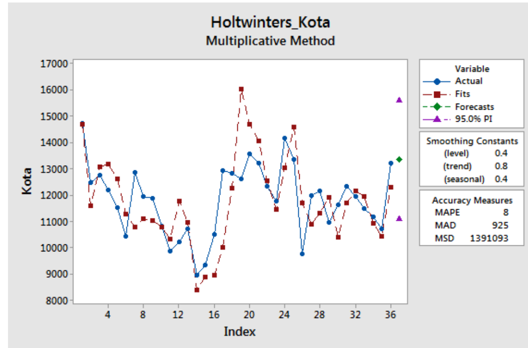

Figure 9. Prediction results of KOTA Exponential smoothing Holt Winters

The obtained results for forecasting in one future period for *moving average* is 11723.75. The forecasting number then used as the source of comparison for forecasts in the next period. The value used is MA (12) to average the effects of the season. The value of MAPE is based on predetermined values. It doesn't exceed the error rate level of 10%. The obtained MAPE is 11%, the obtained MAD is 1291, and the obtained MSD is 2314376. The results are shown in the figure 10.

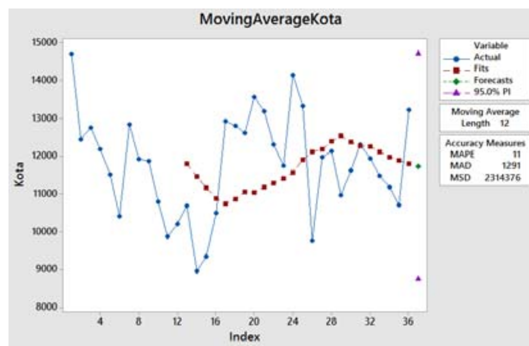

Figure 10. Prediction Results of KOTA moving average

5. CONCLUSION

Based on the results of the study in determining / choosing the time series data forecasting method that is considered as the appropriate to be used in ritase forecasting for UPT Management of Giwangan Terminal Yogyakarta City Transportation Department of two methods *(Moving Average, Exponential Smoothing Holt-Winters),* can be drawn conclusion as follows:

1. By using the *exponential smoothing holt winters method,* which is used for ritase forecasting with *time-series* data from 2013-2015 for the AKAPEkonomy *seasonal chart patterns and trend multiplicative model,* the number of required iterations to obtain the optimum by using the *golden section method*

is the 7th iteration with the same optimum result for α = 0.9, β = 0.02 and for γ = 0.9. For AKAPnonEconomic *seasonal chart patterns and trend multiplicative models*, the number of iterations that required to obtain the optimum using *the golden section method* is the 7th iteration with the same optimum result for α = 0.7, β = 0.02 and for γ = 0.9. For AKDP *seasonal chart patterns and trend multiplicative models,* the number of required iterations to obtain the optimum by using *the golden section method* is the 7th iteration with the same optimum result for α = 0.2, β = 0.9 and for γ = 0.02. For KOTA *seasonal chart patterns and trend multiplicative models,* the number of required iterations to obtain the optimum by using *the golden section* method is the 7th iteration with the same optimum result for α = 0.4, β = 0.8 and for γ = 0.4.

2. By comparing the values of MAPE, MSE and MAD for both methods between *Moving Average* and *Exponential Smoothing Holt Winter*, the smallest value is *exponential smoothing holt Winter*. Hence, forecasting with *exponential smoothing holt winter* method is considered as the best method and it can be used to do the ritase forecasting at the Transportation Department, City of Yogyakarta-Upt Giwangan Terminal Management Unit.

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