Comparison of double exponential smoothing and triple exponential smoothing methods in predicting income of local water company

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D M Khairina[1], Y Daniel[2], P P Widagdo[1]

[1] Department of Information System, Faculty of Engineering, Mulawarman University, Samarinda, East-Kalimantan, Indonesia
[2] Department of Informatics, Faculty of Engineering, Mulawarman University, Samarinda, East-Kalimantan, Indonesia

Corresponding author: dyna.ilkom@gmail.com

Abstract. Local Water Company is a government-owned business entity that has a business scope in the management of drinking water and water facilities to improve the welfare of the community, which includes social, health, and public service aspects and has a very important role for the community in terms of supporting the smooth development of the region so that the company's success must always be sought. This effort certainly needs to be supported also in terms of setting revenue targets at the company. Determination of revenue targets in local water companies is currently using manual calculation methods so that the accuracy and effectiveness of setting revenue targets is less accurate. Forecasting models with mathematical methods are needed to predict future revenue targets so that monitoring of the success of regional development and consideration in decision making can be monitored. Forecasting this revenue target is based on actual data within the previous 5 (five) years, namely from January 2014 until December 2018, by comparing the two forecasting methods, namely the Double Exponential Smoothing (DES) and Triple Exponential Smoothing (TES) methods. The forecasting accuracy method is used the Mean Absolute Percentage Error (MAPE) method to measure the accuracy of the forecasting results from the two forecasting methods used. Forecasting test results are performed using alpha constant values of 0.1, 0.3, 0.5, 0.7, and 0.9 as trial data. Based on the trials conducted, the forecasting results presented show that forecasting results with the Double Exponential Smoothing method provide a more optimal forecasting result at alpha 0.7 with a MAPE value of 9.54%, so that the use of the Double Exponential Smoothing method is recommended in forecasting revenue targets in the Local Water Company because it has an error value under 10%.

1. Introduction

Forecasting is the knowledge and art to predict what will be happened in the future at the present time. In doing the forecasting, it must contain data and information of the past. Past data and information are behavior that occurs along with various conditions at that time [1]. Forecasting methods are various, but in general, there are two types such as: qualitative and quantitative [2]. Forecasting can also be applied to predict the health sector or, in this case, predict the number of dengue fever patients by looking at data and information in the past. From that definition, forecasting has a procedure, namely [3,4]: (1) Problem Analyze; (2) Collecting Data; (3) Analyze the data collected; (4) Selecting the appropriate method; (5) Testing of selected methods; (6) Using the method; (7) Monitor performance

of forecasting methods. From the forecasting procedure that has been described then in this study conducted a comparison test method and forecasting method performance by measuring the accuracy and accuracy of forecasting results.

Forecasting is classified into two general methods, namely qualitative and quantitative, which have their respective properties. Qualitative has an intuitive nature and does not have data of the past, so it can not be solved by mathematical means because more use of certain opinions, contrary to the quantitative that has Previous data, can be calculated by mathematical [5]. Quantitative methods are used more often than qualitative, which is better known as time series, whose data form accumulated over a period of time. Time series has four important components namely, Secular Trends, Seasonal Variations, Cycle Variations, and Ireguler Variations [5]. The use of time series, tends to be used to predict the future as well as made using the detailed data sets generated in the past [6,7].

Exponential smoothing methods are most widely used as a method of forecasting. Exponential formula smoothing as a method of forecasting emerged since 1950 from Brown's original work [8]. Exponential smoothing is the method of many used in time series analysis. The multitude of these uses can be attributed to simplicity, computational efficiency, ease of adjusting response to changes in the forecasting process, and reasonable accuracy [9].

Local Water Company is a government-owned company that has a business scope in managing drinking water and managing dirty water facilities to improve community welfare covering social, health, and public service aspects. Local Water Company at Samarinda City is a Regional Government Business Entity in the field of drinking water services that meet the requirements. Samarinda City is the capital of East Kalimantan Province. At this time, Local Water Company has a very important role for the community in terms of supporting the smooth running of regional development, so the success of the Local Water Company must always be pursued. Local Water Company revenue is obtained from user fees for the use of clean water for the community [10].

One of the most misunderstood aspects of forecasting is uncertainty. The process of forecasting the future itself opens up new possibilities, and this often means more uncertainties that have to be considered. In such cases, the main purpose of forecasting is to make decision-makers and policymakers understand the uncertainties in the future so that the uncertainties and risks that may arise can be considered when making planning or future-oriented decisions. By doing forecasting, planners and decision-makers will be able to consider broader alternative strategies than without forecasting. Thus, various strategies and action plans can be developed to deal with various possibilities that may occur in the future [11].

The research objective is to identify and predict Local Water Company revenue for determining Local Water Company revenue targets in the coming year by comparing the use of the Double Exponential Smoothing (DES) and Triple Exponential Smoothing (TES) methods and analyzing the forecasting results of these revenue targets by testing accuracy using the Mean Absolute Percentage Error (MAPE) is then used in making decisions and knowing the advantages of the best method in prediction or forecasting. The data used are income data for the last 5 (five) years from January 2014 until December 2018. The forecasting results are used in making decisions for planning revenue targets or potential income for the next 1 (one) year.

Several previous studies used the exponential smoothing method, namely research forecasting the demand for electricity in Malaysia and using the Mean Absolute Percentage Error (MAPE) as the level of accuracy [12]. Furthermore, forecasting economic and business sectors such as forecasting milk sales [13] and forecasting the inflation rate in Ghana uses inflation data from January to December of the following year, and the results show that the exponential smoothing method is more suitable for use [14].

Several studies related to forecasting comparing the Double Exponential Smoothing (DES) and Triple Exponential Smoothing (TES) methods include forecasting palm oil real production by measuring the level of accuracy using the Root Mean Squared Prediction Error (RMSE) [15]. Forecasting Grand Watu Dodol tourists which produce an accuracy value of Mean Absolute

Percentage Error (MAPE) for DES with α = 0.1 of 3.8784% and value MAPE accuracy for the TES method with α = 0.1 is 3.3698%, so it can be concluded that the TES method is more recommended [16]. Research on predicting the number of passengers departing for trains in DKI Jakarta that gets the best measurement results with MAPE value of 3.213% in calculations using the TES method so that it gives better results with a percentage value below 10% [17]. Research on cigarette sales forecasting has the final result in the form of a comparison of the level of accuracy between DES and TES, which produces the best forecasting value for each period and in this study, the DES method is more accurate in predicting cigarette sales with a value of α = 0.5 resulting in a MAPE value of 15,262% [18]. Research which also made a comparative model of methods for estimating rice production in Indonesia using exponential smoothing and neural networks then evaluated errors using MAPE and MSE, which resulted in lower MAPE and MSE values of 6.7% and 1.5% compared to statistical methods [19].

2. Research methods

This section discusses the Double Exponential Smoothing (DES), Triple Exponential Smoothing (TES), and Mean Absolute Percentage Error (MAPE) methods used to make comparisons in the prediction results and the accuracy of the prediction results.

2.1. Double Exponential Smoothing (DES)

The DES method was proposed by Brown to overcome the differences that arise between the actual data and the predicted value if there is a trend in the plot. The advantage of this method is that it can model trends and levels from a time series more efficiently than other methods, because it requires less data, and uses one parameter to make it simpler. The algorithm in determining predictions using the Double Exponential Smoothing method uses equation (1) to equation (5).

a. Determine the value S'_t

$$S'_t = \alpha X_t + (1-\alpha)S'_{t-1} \tag{1}$$

b. Determine the value S''_t

$$S''_t = \alpha S'_t + (1-\alpha)S''_{t-1} \tag{2}$$

c. Determine the value a_t

$$a_t = 2S'_t - S''_t \tag{3}$$

d. Determine the value b_t

$$b_t = \frac{\alpha}{1-\alpha}(S'_t - S''_t) \tag{4}$$

e. Determine the value S_{t+m}

$$S_{t+m} = a_t + b_t m \tag{5}$$

From Equation (1) to Equation (5), the smoothing process is done 2 times (double) starting from S't to S"t. Meanwhile, X_t + (1 - α) is the actual value of the time series (periodic series). And the alpha (α) value is the smoothing constant between 0 and 1. And for the value S_{t+m} is the forecast at time $t+1$ [20].

2.2. Triple Exponential Smoothing (TES)

This method is a method of forecasting using quadratic equations. The Triple Exponential Smoothing (TES) method is more suitable for forecasting things that fluctuate or experience tidal waves. The algorithm for forecasting using the TES method is carried out using Equation (6) to Equation (12).

a. Determine the value S'_t

$$S'_t = \alpha X_t + (1-\alpha) S'_{t-1} \tag{6}$$

b. Determine the value S''_t

$$S''_t = \alpha S'_t + (1-\alpha) S''_{t-1} \tag{7}$$

c. Determine the value S'''_t

$$S'''_t = \alpha S''_t + (1-\alpha) S'''_{t-1} \tag{8}$$

d. Determine the value a_t

$$a_t = 3S'_t - 3S''_t + S'''_t \tag{9}$$

e. Determine the value b_t

$$b_t = \frac{\alpha}{2(1-\alpha)^2}[(6-5\alpha)S'_t - (10-8\alpha)S''_t + (4-3\alpha)S'''_t] \tag{10}$$

f. Determine the value c_t

$$c_t = \frac{\alpha^2}{(1-\alpha)^2}(S'_t - 2S''_t + S'''_t) \tag{11}$$

g. Determine the value F_{t+m}

$$F_{t+m} = a_t + b_t m + \frac{c_t m^2}{2} \tag{12}$$

From Equation (6) to Equation (12), the smoothing process is carried out 3 times (triple) starting from S't to S'"t. Meanwhile for X_t + (1 - α) is the actual time series value (periodic series). And the alpha (α) value is the smoothing constant between 0 and 1. And for the value of F_{t+m} is the forecast at time *t+1* [21].

2.3. Mean Absolute Percentage Error (MAPE)

Mean Absolute Percentage Error (MAPE) is a mean or an average number of all error percentages for a given data set. The MAPE method is a measure of the accuracy used in quantitative or forecasting methods. MAPE is calculated as the average of absolute differentiation between the predicted and actual values, expressed as a percentage of the actual value. Mean Absolute % Error is a calculation process used to calculate the absolute average error between the true value and the depth value [22]. If the actual and forecasted values have been obtained for n periods, the MAPE is calculated as:

$$MAPE = \sum_{x=1}^{n} \left| \frac{a_x - \bar{r}_x}{a_x} \right| x \frac{100}{n} \tag{13}$$

In Equation (13) the MAPE error results are obtained from the absolute value of each actual data (a_x) minus the forecast value ($\bar{r}_x$) then divided by the actual data value (a_x) in period *x* then all these results are added and multiplied by 100 and divided by the number of data (*n*). The prediction accuracy of the percentage of forecasting error can be seen in Table 1 [1].

Table 1. MAPE Value for Predictive Evaluation.

MAPE Value	Prediction Accuracy
MAPE ≤ 10%	High
10% < MAPE ≤ 20%	Well
20% < MAPE ≤ 50%	Reasonable
MAPE > 50%	Low

3. Results and discussion

3.1. Data Collection

The Local Water Company revenue target forecasting model is designed to identify and predict Local Water Company revenue for determining Local Water Company revenue targets in the coming year by comparing the use of the Double Exponential Smoothing (DES) and Triple Exponential Smoothing (TES) methods and analyzing the forecasting results of these revenue targets by performing accuracy testing using the Mean Absolute Percentage Error (MAPE) method which is then used in making decisions and knowing the advantages of the best method in prediction or forecasting.

The data used are income data at Local Water Company as PDAM Tirta Kencana Samarinda for the last 5 (five) years, from January 2014 until December 2018. This data then becomes the basis for forecasting the next 1 (one) year. Table 2 presents the data that will be used in forecasting, namely income data from January until December for the last 5 (five) years from January 2014 until December 2014 to January 2018 until December 2018.

Table 2. Income data (Rp).

Month	Year				
	2014	2015	2016	2017	2018
January	15.448.752.330,00	16.770.629.084,75	19.005.612.447,00	23.448.569.785,00	24.664.887.221,00
February	16.510.002.665,00	16.353.096.604,03	18.544.006.600,00	25.697.354.698,00	26.445.881.463,00
March	19.466.164.550,00	15.010.624.569,00	20.485.770.800,05	24.881.662.400,79	29.779.100.237,00
April	20.178.450.046,00	21.490.005.227,03	19.633.560.110,00	23.180.500.462,00	31.012.314.705,00
May	18.231.400.521,00	15.944.621.754,00	18.004.303.640,13	26.447.831.590,51	30.466.528.940,00
June	21.664.528.997,00	18.506.044.779,04	21.970.022.448,17	25.177.148.600,44	28.001.536.488,00
July	21.955.198.000,00	21.109.799.561,04	22.449.710.023,25	29.015.400.158,78	28.454.695.136,00
August	22.005.162.311,00	21.583.552.006,02	20.401.850.114,20	25.448.600.194,17	29.007.566.800,00
September	17.514.751.332,00	19.674.511.900,06	22.445.332.147,00	25.990.480.772,94	28.450.100.231,00
October	16.448.756.100,00	19.709.740.112,00	20.445.663.100,00	27.985.400.678,80	26.900.152.340,00
November	16.200.315.644,00	20.900.461.310,03	22.449.775.612,00	28.446.888.120,00	27.455.879.333,00
December	15.008.544.164,00	18.314.342.110,00	23.775.668.439,05	29.445.500.622,00	26.494.930.626,00

(Source: PDAM Tirta Kencana Samarinda)

3.2. Forecasting Using the Double Exponential Smoothing Method

As a first step, forecasting calculations are carried out using the Double Exponential Smoothing (DES) method to determine the forecasting value, and the results of forecasting calculations are carried out using 5 (five) different alpha (α) values, namely alpha 0.1, 0.3, 0.5, 0.7 and 0.9. Forecasting data is carried out using income data from 2014 to 2018, as in Table 1, to forecast 2019 income. Because when t = 1 is the first year, the forecasting value of S1 is not available, it is determined that the value of S1 is the same as the value of data X1 in the whole calculation. The calculation of monthly income forecasting is carried out using Equation (1) to Equation (5) for forecasting 2015 to 2019. The steps of the calculation process using the DES method for income data are:

1) Calculation to find the value of Single Exponential Smoothing (S't) using Equation (1).
2) Calculation to find the value of Double Exponential Smoothing (S"t) using Equation (2).
3) The calculation looks for the smoothing parameter value using Equation (3).
4) The calculation looks for the parameter value of linear trend smoothing using Equation (4).
5) The final calculation of forecasting results using Equation (5).

The monthly income forecasting calculation is done using 5 (five) different alpha values, namely alpha 0.1, 0.3, 0.5, 0.7 and 0.9. Forecasting results using the DES method for income from 2015 to 2019 can be seen in Table 3, Table 4, Table 5, Table 6, and Table 7.

Table 3. Income forecasting results for 2015 using the DES method.

Month	Forecasting Results (Rp) for 2015				
	α = 0.1	α = 0.3	α = 0.5	α = 0.7	α = 0.9
January	15.448.752.330,00	15.448.752.330,00	15.448.752.330,00	15.448.752.330,00	15.448.752.330,00
February	16.510.002.665,00	16.510.002.665,00	16.510.002.665,00	16.510.002.665,00	16.510.002.665,00
March	19.466.164.550,00	19.466.164.550,00	19.466.164.550,00	19.466.164.550,00	19.466.164.550,00
April	20.178.450.046,00	20.178.450.046,00	20.178.450.046,00	20.178.450.046,00	20.178.450.046,00
May	18.231.400.521,00	18.231.400.521,00	18.231.400.521,00	18.231.400.521,00	18.231.400.521,00
June	21.664.528.997,00	21.664.528.997,00	21.664.528.997,00	21.664.528.997,00	21.664.528.997,00
July	21.955.198.000,00	21.955.198.000,00	21.955.198.000,00	21.955.198.000,00	21.955.198.000,00
August	22.005.162.311,00	22.005.162.311,00	22.005.162.311,00	22.005.162.311,00	22.005.162.311,00
September	17.514.751.332,00	17.514.751.332,00	17.514.751.332,00	17.514.751.332,00	17.514.751.332,00
October	16.448.756.100,00	16.448.756.100,00	16.448.756.100,00	16.448.756.100,00	16.448.756.100,00
November	16.200.315.644,00	16.200.315.644,00	16.200.315.644,00	16.200.315.644,00	16.200.315.644,00
December	15.008.544.164,00	15.008.544.164,00	15.008.544.164,00	15.008.544.164,00	15.008.544.164,00

Table 4. Income forecasting results for 2016 using the DES method.

Month	Forecasting Results (Rp) for 2016				
	α = 0.1	α = 0.3	α = 0.5	α = 0.7	α = 0.9
January	15.713.127.680,95	16.241.878.382,85	16.770.629.084,75	17.299.379.786,65	17.828.130.488,55
February	16.478.621.452,80	16.415.859.028,41	16.353.096.604,03	16.290.334.179,64	16.227.571.755,25
March	19.575.056.553,80	19.792.840.561,40	20.010.624.569,00	20.228.408.576,60	20.446.192.584,20
April	20.440.761.082,20	20.965.383.154,61	21.490.005.227,03	22.014.627.299,44	22.539.249.371,85
May	18.374.044.767,60	18.659.333.260,80	18.944.621.754,00	19.229.910.247,20	19.515.198.740,40
June	21.232.832.153,40	20.369.438.466,22	19.506.044.779,04	18.642.651.091,85	17.779.257.404,67
July	21.786.118.312,20	21.447.958.936,62	21.109.799.561,04	20.771.640.185,45	20.433.480.809,87
August	21.920.840.250,00	21.752.196.128,01	21.583.552.006,02	21.414.907.884,02	21.246.263.762,03
September	17.946.703.445,61	18.810.607.672,83	19.674.511.900,06	20.538.416.127,28	21.402.320.354,50
October	16.900.952.902,40	17.805.346.507,20	18.709.740.112,00	19.614.133.716,80	20.518.527.321,60
November	16.140.344.777,20	16.020.403.043,61	15.900.461.310,03	15.780.519.576,44	15.660.577.842,85
December	15.069.703.753,20	15.192.022.931,60	15.314.342.110,00	15.436.661.288,40	15.558.980.466,80

Table 5. Income forecasting results for 2017 using the DES method.

Month	Forecasting Results (Rp) for 2017				
	α = 0.1	α = 0.3	α = 0.5	α = 0.7	α = 0.9
January	16.384.843.401,70	18.019.087.729,26	19.336.081.635,68	20.335.825.120,96	21.018.318.185,10
February	16.890.129.421,63	17.678.626.025,88	18.504.780.084,75	19.368.591.598,26	20.270.060.566,41
March	19.762.644.003,24	20.257.600.106,30	20.621.885.804,80	20.855.501.098,74	20.958.445.988,12
April	20.892.436.439,57	22.084.329.294,14	22.961.448.905,25	23.523.795.272,92	23.771.368.397,15
May	19.307.228.754,43	21.330.505.399,36	23.182.608.948,38	24.863.539.401,47	26.373.296.758,64
June	21.358.685.370,18	21.135.525.275,77	21.430.401.393,68	22.243.313.723,89	23.574.262.266,42
July	21.910.382.670,02	21.972.923.729,09	22.238.360.413,51	22.706.692.723,27	23.377.920.658,39
August	21.612.826.119,79	20.904.043.592,27	20.296.447.537,95	19.790.037.956,82	19.384.814.848,89
September	18.868.026.791,57	21.185.820.808,46	22.985.272.289,01	24.266.381.233,23	25.029.147.641,12
October	17.632.504.782,04	19.593.025.023,96	21.010.909.103,00	21.886.157.019,16	22.218.768.772,44
November	16.799.232.400,82	18.051.039.694,59	19.374.812.028,50	20.770.549.402,57	22.238.251.816,80
December	15.813.954.669,83	17.369.732.051,21	18.852.117.925,55	20.261.112.292,85	21.596.715.153,11

Table 6. Income forecasting results for 2018 using the DES method.

Month	Forecasting Results (Rp) for 2018				
	α = 0.1	α = 0.3	α = 0.5	α = 0.7	α = 0.9
January	17.843.732.293,57	21.644.481.936,40	24.337.784.814,25	26.177.441.264,01	27.417.251.622,60
February	18.470.659.267,77	22.067.274.965,10	25.205.855.681,75	27.856.275.453,99	29.988.408.318,13
March	21.400.999.425,40	24.943.402.606,18	28.136.563.963,30	31.085.019.820,41	33.893.306.501,15
April	22.585.092.786,14	26.610.207.887,13	29.794.277.978,00	32.389.121.653,50	34.646.557.508,41
May	20.788.784.122,70	24.856.138.359,16	27.641.057.370,29	29.280.479.632,83	29.911.343.623,51
June	22.708.165.077,00	25.310.288.249,33	28.253.521.963,23	31.123.437.248,85	33.505.605.136,34
July	23.329.568.100,49	26.212.481.325,19	29.139.028.164,59	31.946.892.118,41	34.473.756.686,36
August	22.360.574.930,26	23.471.301.484,72	25.047.772.144,97	27.009.037.732,45	29.274.149.068,60
September	20.359.101.480,53	24.590.120.440,94	27.223.125.976,69	28.672.792.116,83	29.353.792.890,44
October	19.361.140.903,48	23.869.567.471,29	26.984.627.428,80	29.140.429.706,30	30.771.083.234,11

November	18.558.859.309,66	22.770.205.390,93	26.259.253.112,00	28.968.430.440,74	30.840.165.345,05
December	17.380.381.486,58	21.365.243.104,49	24.387.281.690,76	26.505.210.451,01	27.777.742.590,89

Table 7. Income forecasting results for 2019 using the DES method.

Month	Forecasting Results (Rp) for 2019				
	α = 0.1	**α = 0.3**	**α = 0.5**	**α = 0.7**	**α = 0.9**
January	19.324.744.158,10	24.313.083.465,88	26.582.224.287,57	27.068.884.102,57	26.455.980.053,32
February	20.162.860.750,44	25.503.536.180,28	28.502.526.100,06	29.520.233.301,57	28.947.186.540,34
March	23.172.361.514,35	28.642.351.914,36	31.848.945.948,51	33.092.444.340,44	32.568.611.490,16
April	24.388.461.352,23	30.158.303.275,23	33.180.855.110,18	34.179.316.584,12	33.625.068.829,33
May	22.849.173.915,58	29.138.169.309,97	32.476.060.380,31	33.916.183.002,20	34.374.934.574,51
June	23.820.811.052,27	27.508.572.270,51	29.764.596.652,48	30.233.109.970,96	28.972.766.968,56
July	24.423.825.615,20	28.205.704.228,64	30.272.583.078,13	30.557.091.971,86	29.154.177.218,29
August	23.708.925.040,54	27.042.594.699,36	29.894.776.914,85	31.876.686.566,66	32.680.487.713,00
September	22.115.109.663,13	27.860.031.365,58	30.434.047.555,73	31.198.503.779,13	31.100.071.552,26
October	21.010.529.091,85	26.704.349.255,88	29.143.001.983,95	29.528.002.350,35	28.626.756.499,08
November	20.454.835.636,53	26.528.892.755,55	29.786.263.347,87	30.793.271.695,21	30.173.814.111,44
December	19.319.724.400,30	25.339.924.699,57	28.585.057.368,87	29.837.123.474,63	29.819.410.877,66

3.3. Forecasting using the triple exponential smoothing method

Forecasting using the Triple Exponential Smoothing (TES) method is carried out with the same steps as the Double Exponential Smoothing (DES) method but uses Equation (6) to Equation (12) to then obtain revenue forecasting for each month 2015 to 2019 using 5 (five) the different alpha (α) values are alpha 0.1, 0.3, 0.5, 0.7 and 0.9. Forecasting data using the DES method is also carried out using revenue data from 2014 to 2018 to forecast 2019 revenue, as in Table 2. The steps of the calculation process using the TES method for income data are:

1) Calculation to find the value of Single Exponential Smoothing (*S't*) using Equation (6).
2) Calculation to find the value of Double Exponential Smoothing (*S''t*) using Equation (7).
3) Calculation to find the value of Triple Exponential Smoothing (*S'''t*) using Equation (8).
4) The calculation looks for the smoothing parameter value using Equation (9).
5) The calculation looks for the parameter value of linear trend smoothing using Equation (10).
6) The calculation looks for the parameter values for the smoothing of the seasonal tren using Equation (11).
7) The final calculation of forecasting results using Equation (12).

Forecasting results using the TES method for income from 2015 to 2019 can be seen in Table 8, Table 9, Table 10, Table 11, and Table 12.

Table 8. Income forecasting results for 2015 using the TES method.

Month	Forecasting Results (Rp) for 2015				
	α = 0.1	**α = 0.3**	**α = 0.5**	**α = 0.7**	**α = 0.9**
January	15.448.752.330,00	15.448.752.330,00	15.448.752.330,00	15.448.752.330,00	15.448.752.330,00
February	16.510.002.665,00	16.510.002.665,00	16.510.002.665,00	16.510.002.665,00	16.510.002.665,00
March	19.466.164.550,00	19.466.164.550,00	19.466.164.550,00	19.466.164.550,00	19.466.164.550,00
April	20.178.450.046,00	20.178.450.046,00	20.178.450.046,00	20.178.450.046,00	20.178.450.046,00
May	18.231.400.521,00	18.231.400.521,00	18.231.400.521,00	18.231.400.521,00	18.231.400.521,00
June	21.664.528.997,00	21.664.528.997,00	21.664.528.997,00	21.664.528.997,00	21.664.528.997,00
July	21.955.198.000,00	21.955.198.000,00	21.955.198.000,00	21.955.198.000,00	21.955.198.000,00
August	22.005.162.311,00	22.005.162.311,00	22.005.162.311,00	22.005.162.311,00	22.005.162.311,00
September	17.514.751.332,00	17.514.751.332,00	17.514.751.332,00	17.514.751.332,00	17.514.751.332,00
October	16.448.756.100,00	16.448.756.100,00	16.448.756.100,00	16.448.756.100,00	16.448.756.100,00
November	16.200.315.644,00	16.200.315.644,00	16.200.315.644,00	16.200.315.644,00	16.200.315.644,00
December	15.008.544.164,00	15.008.544.164,00	15.008.544.164,00	15.008.544.164,00	15.008.544.164,00

Table 9. Income forecasting results for 2016 using the TES method.

Month	Forecasting Results (Rp) for 2016				
	α = 0.1	α = 0.3	α = 0.5	α = 0.7	α = 0.9
January	15.845.315.356,42	16.638.441.409,27	17.431.567.462,12	18.224.693.514,97	19.017.819.567,82
February	16.462.930.846,70	16.368.787.210,12	16.274.643.573,54	16.180.499.936,96	16.086.356.300,38
March	19.629.502.555,70	19.956.178.567,10	20.282.854.578,50	20.609.530.589,90	20.936.206.601,30
April	20.571.916.600,30	21.358.849.708,92	22.145.782.817,54	22.932.715.926,16	23.719.649.034,78
May	18.445.366.890,90	18.873.299.630,70	19.301.232.370,50	19.729.165.110,30	20.157.097.850,10
June	21.016.983.731,61	19.721.893.200,83	18.426.802.670,06	17.131.712.139,28	15.836.621.608,50
July	21.701.578.468,31	21.194.339.404,93	20.687.100.341,56	20.179.861.278,18	19.672.622.214,80
August	21.878.679.219,50	21.625.713.036,51	21.372.746.853,53	21.119.780.670,54	20.866.814.487,55
September	18.162.679.502,41	19.458.535.843,25	20.754.392.184,09	22.050.248.524,92	23.346.104.865,76
October	17.127.051.303,60	18.483.641.710,80	19.840.232.118,00	21.196.822.525,20	22.553.412.932,40
November	16.110.359.343,80	15.930.446.743,42	15.750.534.143,04	15.570.621.542,66	15.390.708.942,28
December	15.100.283.547,80	15.283.762.315,40	15.467.241.083,00	15.650.719.850,60	15.834.198.618,20

Table 10. Income forecasting results for 2017 using the TES method.

Month	Forecasting Results (Rp) for 2017				
	α = 0.1	α = 0.3	α = 0.5	α = 0.7	α = 0.9
January	16.833.060.786,24	19.125.802.067,01	20.784.042.505,50	21.807.782.101,71	22.197.020.855,64
February	17.082.546.390,86	18.284.120.024,55	19.561.008.567,50	20.913.212.019,71	22.340.730.381,19
March	19.902.716.829,57	20.579.815.781,88	20.995.573.925,07	21.149.991.259,14	21.043.067.784,09
April	21.229.756.308,64	22.860.208.968,77	23.861.115.142,00	24.232.474.828,33	23.974.288.027,77
May	19.834.444.552,65	22.783.772.972,09	25.390.755.199,69	27.655.391.235,45	29.577.681.079,37
June	21.238.140.820,04	21.162.418.784,58	22.122.769.173,75	24.119.191.987,54	27.151.687.225,95
July	21.900.655.981,62	22.095.915.382,89	22.696.966.034,87	23.703.807.937,55	25.116.441.090,92
August	21.422.982.178,76	20.410.401.624,08	19.600.194.015,80	18.992.359.353,90	18.586.897.638,39
September	19.512.268.112,83	22.729.787.870,00	24.910.622.554,50	26.054.772.166,33	26.162.236.705,49
October	18.190.464.362,88	20.859.926.644,32	22.444.116.600,00	22.943.034.229,92	22.356.679.534,07
November	17.103.188.594,24	19.016.882.054,97	21.074.505.596,00	23.276.059.217,33	25.621.542.918,97
December	16.212.072.953,55	18.509.043.272,10	20.659.230.576,57	22.662.634.866,96	24.519.256.143,27

Table 11. Income forecasting results for 2018 using the TES method.

Month	Forecasting Results (Rp) for 2018				
	α = 0.1	α = 0.3	α = 0.5	α = 0.7	α = 0.9
January	18.953.500.577,98	24.048.026.589,54	27.118.009.323,81	28.797.949.623,05	29.722.348.329,56
February	19.424.557.067,71	24.596.739.365,81	28.830.257.229,74	32.049.795.750,24	34.180.040.018,03
March	22.338.966.808,85	27.456.172.267,43	31.953.296.321,43	36.091.679.779,96	40.132.663.452,15
April	23.717.487.070,55	29.282.175.009,73	33.353.636.874,74	36.561.419.152,48	39.535.068.329,83
May	21.977.338.624,71	27.408.623.517,41	30.377.741.817,01	31.227.039.715,35	30.298.863.404,26
June	23.281.521.304,90	27.441.600.702,90	31.973.079.456,65	35.839.885.141,52	38.005.945.332,91
July	24.031.315.829,81	28.411.318.411,76	32.756.850.847,91	36.662.121.887,54	39.721.340.279,96
August	22.573.292.790,77	24.489.119.087,55	27.275.721.712,00	30.730.727.717,71	34.651.764.158,30
September	21.651.164.067,81	27.112.295.373,37	29.688.405.351,39	30.416.179.074,55	30.332.301.615,51
October	20.698.594.115,92	26.674.111.302,00	30.188.476.965,20	32.326.963.431,28	34.174.843.026,00
November	19.697.185.455,66	25.665.049.570,82	30.145.137.941,49	32.993.520.487,37	34.066.267.128,14
December	18.501.842.537,15	23.985.491.530,35	27.587.529.364,50	29.454.739.053,65	29.733.903.611,91

Table 12. Income forecasting results for 2019 using the TES method.

Month	Forecasting Results (Rp) for 2019				
	α = 0.1	α = 0.3	α = 0.5	α = 0.7	α = 0.9
January	21.005.651.106,81	26.901.686.308,45	28.135.887.745,73	26.796.248.780,17	24.209.361.762,57
February	21.818.890.989,91	28.587.743.210,15	30.934.739.764,68	29.791.013.596,75	26.178.075.540,71
March	24.854.342.240,62	31.851.999.966,49	34.578.580.264,42	33.680.298.619,92	29.489.761.547,52
April	26.250.338.400,08	33.349.312.306,41	35.569.552.922,05	34.467.240.969,85	30.843.101.388,40
May	24.886.647.449,11	32.608.026.095,00	35.257.138.388,53	35.330.385.541,97	34.913.353.337,42
June	24.866.168.798,48	29.807.865.459,60	31.498.382.661,57	29.462.713.806,16	24.469.139.204,71
July	25.567.911.275,13	30.417.554.332,48	31.739.327.905,49	29.527.123.014,91	24.261.780.182,32
August	24.565.070.301,97	29.415.946.615,93	32.988.649.025,88	34.392.163.909,52	32.978.325.180,22
September	24.087.065.866,73	30.783.547.755,29	32.280.174.370,23	31.565.635.546,36	30.384.599.031,27
October	22.968.138.126,69	29.576.705.397,99	30.702.689.207,75	28.915.768.311,43	25.483.294.673,57
November	22.369.031.170,26	29.960.985.864,10	32.327.518.873,11	30.942.012.933,78	27.450.566.878,90
December	21.240.494.259,76	28.713.004.854,13	31.239.005.673,36	30.714.786.177,91	28.860.496.211,36

3.4. Comparison of forecasting results with the double exponential smoothing method and the triple exponential smoothing method

The comparison of forecasting results from the two methods is made by calculating the accuracy of the forecasting results as a step to see the errors made in forecasting. Getting the accuracy value is used the Mean Absolute Percentage Error (MAPE) method as a consideration in supporting the decision to determine revenue targets. The calculation of the accuracy value is done by means of the actual data minus the forecasting results then divided by the actual data, the result of the calculation is in the form of an absolute number and is carried out repeatedly until all forecasting results using one alpha value have been calculated then all absolute values are added and the result is multiplied by 100 and divided by the number of forecast results. The calculation of MAPE values is carried out on data ranging from 2015 to 2018 as actual data are obtained. The process of calculating the MAPE value for the DES and TES methods for alpha 0.1 is as follows:

$$MAPE\ DES(\alpha = 0{,}1) = \frac{100}{n} \times \sum_{t=1}^{n} \left|\frac{Y_t - \overline{Y_t}}{Y_t}\right| = \frac{100}{48} \times 8{,}800954758 = 18{,}33532241$$

$$MAPE\ TES(\alpha = 0{,}1) = \frac{100}{n} \times \sum_{t=1}^{n} \left|\frac{Y_t - \overline{Y_t}}{Y_t}\right| = \frac{100}{48} \times 8{,}228033373 = 17{,}14173619$$

The result of the MAPE error calculation for the DES method with α = 0.1 is 18.33532241, while the result of the MAPE error calculation for the TES method with α = 0.1 is 17.14173619. Then the calculation for other alpha (α) values, namely alpha 0.3, 0.5, 0.7, and 0.9, the results of the MAPE error calculation for each alpha of the two methods can be seen in Table 13.

Table 13. MAPE value of DES and TES methods.

Alpha (α) Value	MAPE Value	
	DES Method	TES Method
0.1	18,33532241	17,14173619
0.3	13,92723122	10,88730803
0.5	10,35686218	9,855918446
0.7	9,535615069	10,97322543
0.9	9,838956654	12,53790315

From Table 13, it is obtained that the alpha value that has a good MAPE value is α = 0.7 in the calculation using the DES method with a MAPE value of 9.535615069% or 9.54%.

4. Results and discussion

The results of forecasting using the Double Exponential Smoothing (DES) and Triple Exponential Smoothing (TES) methods are presented using income data for the last 5 (five) years, from January 2014 until December 2018, and the calculation is carried out using 5 (five) values different alpha, namely alpha 0.1, 0.3, 0.5, 0.7 and 0.9, then measuring the level of accuracy using the Mean Absolute Percentage Error (MAPE) for each alpha value which indicates that the forecasting result at α = 0.7 is the best forecasting value with a MAPE value of 9.54 % because it has high predictive accuracy with a MAPE value ≤ 10%. Based on this, it is recommended to use the Double Exponential Smoothing (DES) method as an approach to forecast future income as a follow-up to planning policy decision makers in predicting the next year's revenue target.

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