Forecasting of Groundwater Tax...

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Forecasting of Groundwater Tax Revenue Using Single Exponential Smoothing Method

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Abstract. Setting the target of groundwater tax revenues for the next year is an important thing for Kutai Kartanegara Regional Office of Revenue to maximize the regional income and accelerate regional development. Process of setting the target of groundwater tax revenue for the next year still using estimation only and not using a mathematical calculation method that can generate target reference value. If the realization of groundwater tax revenue is not approaching the target, the implementation of development in the Government of Kutai Kartanegara can be disrupted. The mathematical method commonly used to predict revenue value is the Single Exponential Smoothing (SES) method, which uses alpha constant value which is randomly selected for the calculation process. Forecasting of groundwater tax revenue for 2018 using groundwater tax revenue data from 2013 to 2017. Single Exponential Smoothing method using alpha constant value consists of 0.1, 0.2, 0.3, 0.4 and 0.5. The forecasting error value of each alpha value is calculated using the Mean Absolute Percentage Error (MAPE) method. The best result is forecasting using alpha value 0.1 with MAPE error value was 45.868 and the best forecasting value of groundwater tax for 2018 is Rp 443.904.600,7192.

Keywords: **Forecasting; Groundwater Tax; Single Exponential Smoothing Method; Mean Absolute Percentage Error.**

1 Introduction

The data realization of groundwater tax revenue is used to estimate the potential of groundwater tax revenue in the next 1 (one) year through the meetings held at the end of every year. But, the target of groundwater taxes revenue that has been determined in recent years is far from the realization. Realization of groundwater tax revenue which is much lower than the target will disrupt the existing development process and the realization which is much higher than the target considered to inhibit the process of acceleration of the development. The revenue target is important to determine the optimal process of development correctly.

Exponential Smoothing is a method that continually improves forecasting by taking the smoothing value of the past value of a data series of time exponentially. Exponential smoothing analysis is one time series analysis and is a forecasting method by giving smoothing values in a series of previous observations to predict future values [1]. Two exponential smoothing methods include Single Exponential Smoothing (SES) and Double Exponential Smoothing (DES) [2]. In this study, the Single Exponential Smoothing method was used as a method of settlement because the realization of groundwater tax revenue data used to estimate the potential of groundwater tax revenue in the next 1 (one) year is stationary data or relatively stable data.

Several kinds of researche on forecasting using SES have been carried out. Prediction of the amount of water in PDAM Malang city [3], drug sales [4], store income retribution [5], prediction of Motor Vehicle Tax Revenue in Pekalongan regency [6]. Single Exponential Smoothing method can be performed to forecast using 1 year period. Based on these, in the research on forecasting groundwater tax using Single Exponential Smoothing method and forecasting process used data from January to December with a period of 1 year has been done.

The groundwater tax revenue in the next 1 (one) year can be estimated through forecasting using the Single Exponential Smoothing method and used the realization data of groundwater tax revenue in previous years. The development of the system aims at making the system able to assist in setting the target of groundwater tax revenue for next year through desktop based system using Single Exponential Smoothing method.

2 Literature Review

2.1. Forecasting

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

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the past. Past data and information are behavior that occurs along with various conditions at that time. In practice, there are several types of forecasting. Types of forecasting relate to others [1]:

Based on perspective:

1. Subjective forecasting is a forecast based on the feelings or feelings of the person who composed it. In this case, the views and experiences of the past from the person who composed greatly determine the outcome of the forecast.
2. Objective forecasting is a forecast based on existing data and information, then analyzed using a particular method. The data used is the data of the past.

Based on the type of forecasting:

1. Qualitative forecasting is a forecast based on qualitative data. Usually this forecast is based on the results of the investigation.
2. Quantitative forecasting is a forecast based on past quantitative data (in the form of numbers).

Based on the period of time:

1. Short-term forecasting is forecasting which is based on 1 period.
2. Mid-term forecasting is a forecast based on a span time of a 1-3 period.

Long-term forecasting is a forecast based on a period of more than 3 periods.

2.2 Groundwater Tax

Definition of Groundwater Tax According to Regional Regulation Number 2 Year 2011 regarding Regional Tax is a tax of collection and or utilization of groundwater. The tax collected by the Kutai Kartanegara Regional Office of Revenue is intended for the utilization of groundwater excludes basic household purposes, irrigation of agriculture and fishery of the people and worship. The tax subject for the tax object is an individual or company that utilizes the groundwater are considered as taxpayers [7].

2.3 Single Exponential Smoothing

Exponential smoothing is a powerful moving average forecasting method, but it's still easy to use and used for short-term forecasting. This method uses a few past data entry [8]. The exponential smoothing forecasting method is a periodic forecasting model (time series) used for forecasting [5, 6]. The exponential smoothing method is the development of moving average method [2]. The Single Exponential Smoothing method is more suitable for predicting fluctuations in random (10).

The equations for a single exponential smoothing method is:

$$S_{t+1} = \alpha X_t + (1-\alpha)S_t \qquad (1)$$

In equation 1, S_{t+1} is the forecasting value generated for the first period using actual data of groundwater tax revenue (X_t), the forecast value in the previous period (S_t) and the alpha constant (α) value in the range $0 < \alpha$

<1. In forecasting using a single exponential smoothing (SES) method, the value of α (alpha) is determined by trial and error until found α (alpha) value which has the smallest forecast error [2]. Single Exponential Smoothing performs a comparison in determining alpha values by Means Absolute Percentage Error (MAPE) method. The best value of α is obtained by comparing error value of forecasting result using a smoothing interval between $0 < \alpha < 1$ [4].

2.4 Mean Absolute Percentage Error

Mean Absolute Percentage Error (MAPE) is calculated using the absolute error in each period divided by the observed values that are actual for that period. Then, averaging those absolute percentages of error [8].

$$MAPE = \frac{100}{n} \times \sum_{t=1}^{n} \left| \frac{Y_t - \overline{Y}_t}{Y_t} \right| \qquad (2)$$

In equation 2 the MAPE error calculation uses the result of the average of the absolute value of each actual data (Y_t) minus the forecast value ($\overline{Y}_t$) in period (t) then all the results are added and multiplied by 100 and divided by the amount of data (n).

MAPE value obtained after the calculation is completed and the accuracy prediction level based on percentage. The accuracy prediction percentage of forecast error can be seen in Table 1 [6, 11].

Table 1. MAPE Value for Prediction Evaluation

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

3 Methodology

Collection of data and related information about groundwater tax revenue through a direct interview to Kutai Kartanegara Regional Office of Revenue. Collected data and information for system development.

The data used for forecasting is the data of groundwater tax revenue for the last 5 years. Record data on each month from year to year is fluctuating. In this research data collected from the Kutai Kartanegara Regional Office of Revenue then the collected data is the data of groundwater tax revenue from January to December for the last 5 years from 2013 to 2017.

Forecasting process to find the value of forecasting for January 2018, the data used is the data of groundwater tax revenue from January 2013 to January 2017, the process repeated until December 2018. The calculation is done by using 5 alpha values 0.1, 0.3, 0.5, 0.7, 0.9. The alpha value is a random value and the range of the alpha value is greater than 0 and smaller than 1.

The alpha value used in this research refers to previous researches that have alpha values in the range of values 0 and 1 and alpha values are used with the purpose of more forecasting results gained to compare the best forecasting results of all alpha values used. The forecasting result will be calculated error value using MAPE method. The error of forecasting results using each alpha value will be compared to get the best forecasting result with the lowest error value.

In the first period of 2013, there is no forecasting result, then the first forecasting starts from the second period using the actual revenue data of the first period and the forecasting results in the first period are determined the same as the actual data in the first period. The codification for forecasting using equation 1 can be seen in Table 2.

Table 2. Forecasting Codification

Forecasting	Explanation
S_2	Forecasting for Period 2014
S_3	Forecasting for Period 2015
S_4	Forecasting for Period 2016
S_5	Forecasting for Period 2017
S_6	Forecasting for Period 2018

In the process of calculating the forecast for the next period requires actual data of groundwater tax revenue in the previous period. The codification for actual data of groundwater tax revenue using equation 1 can be seen in Table 3.

Table 3. Actual Data Revenues Codification

Actual Data	Explanation
X_1	Actual Data for Period 2013
X_2	Actual Data for Period 2014
X_3	Actual Data for Period 2015
X_4	Actual Data for Period 2016
X_5	Actual Data for Period 2017

The flowchart of the system designed explains the operation flow of the groundwater tax forecasting system when used by the user.

Fig. 1 describes the system design starting from the beginning of system usage. User input data of groundwater tax revenue from January to December for 1 year, the data will be used for forecasting process using Single Exponential Smoothing method. The forecasting process uses alpha value 0.1, 0.3, 0.5, 0.7, 0.9 then the result of all forecasting using each alpha value will be calculated for the error value using Mean Absolute Percentage Error method. The alpha value with the lowest MAPE value is the best forecasting result and become the best forecast recommendation for the system user.
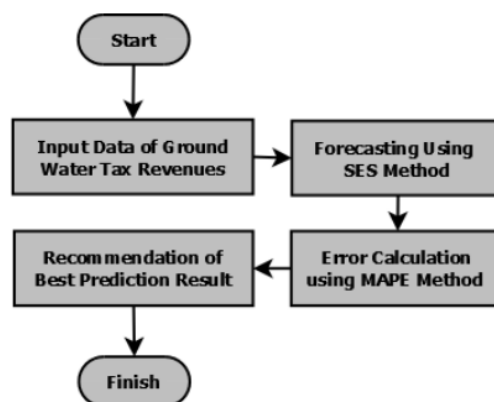

Fig. 1. System Design

4 Result and Discussion

The system generated in this research is a desktop-based application. Several main pages that become important pages of this system, the first is the groundwater tax revenues data form. This page used by the user to manage the data of groundwater tax revenue. The groundwater tax data form can be seen in Fig. 2.

Fig. 2. Groundwater Tax Revenues Data Form

The data inputted into the system will be used on the forecasting form. A forecasting form is a form for doing the forecasting process. There is a choice of years to be predicted and how many years of data used for the forecasting process. 5 tables containing the results of forecasting calculations using different alpha values, then the results of the calculations on the 5 tables will be summarized into the forecasting table and will be used to compare the forecasting results that have been done using the five different alpha values and actual data. The data contained in the forecasting table will be used by the system to calculate the MAPE value to find out the error value of previous forecasting results using the five alpha values, the value of this error will be inserted into the MAPE table. The forecasting form can be seen in Fig. 3.

Fig. 3. Forecasting Form

The best forecasting results of the process in the forecasting form will be launched on the result form. There is information about the forecasted year and the best forecasting result. The result form is shown in Fig. 4.

Fig. 4. Result Form

In the forecasting form, there is a calculation process performed by the single exponential smoothing method and the search for the best forecasting value is done by calculating the error value of each alpha value using mean absolute percentage error method. In the SES method when $t = 1$ as the first year, the value of forecasting S_1 is not available, then set the value of S_1 equal to the value of X_1 on all calculations. Below is presented groundwater tax revenues data from January 2013 to January 2017 in Table 4 with a sample calculation for January 2018 with a value of alpha 0.1.

Table 4. Revenues Data for January 2013 to 2017

Year	Actual Data (Rp)
2013	41,563,923
2014	28,629,594
2015	36,920,720
2016	29,797,534
2017	32,308,535

Forecasting Process for January 2018 using $\alpha = 0.1$:

$$S_2 = (\alpha \times X_1) + (1 - \alpha) \times S_1$$
$$= (0.1 \times 41563923) + (1 - 0.1) \times 41563923 = 41563923$$
$$S_3 = (\alpha \times X_2) + (1 - \alpha) \times S_2$$

$$= (0.1 \times 28629594) + (1 - 0.1) \times 41563923 = 40270490.1$$
$$S_4 = (\alpha \times X_3) + (1 - \alpha) \times S_3$$
$$= (0.1 \times 36920720) + (1 - 0.1) \times 40270490.1 = 39935513.09$$
$$S_5 = (\alpha \times X_4) + (1 - \alpha) \times S_4$$
$$= (0.1 \times 29797534) + (1 - 0.1) \times 39935513.09 = 38921715.18$$
$$S_6 = (\alpha \times X_5) + (1 - \alpha) \times S_5$$
$$= (0.1 \times 32308535) + (1 - 0.1) \times 38921715.18 = 38260397.16$$

The calculation process above is repeated using the same alpha value until December 2018 then the results of forecasting for January 2018 to December 2018 using alpha 0.1 can be seen in Table 5.

Table 5. Forecasting Results for 2018 using $\alpha = 0.1$

Month	Forecasting Value (Rp)
January	38,260,397.1629
February	61,713,066.9732
March	45,129,303.4284
April	6,237,104,.278
May	23,545,600.7065
June	27,983,955.4945
July	71,598,391.8584
August	27,958,699.6516
September	29,961,689.0143
October	40,778,656.6625
November	31,210,744.1704
December	39,526,991.3687
TOTAL	443,904,600.7192

The forecasting calculation then performed using other alpha values. All the forecasting results gained and then calculated MAPE error value. The results of the MAPE values for the 5 (five) alpha values can be seen in Table 6.

Table 6. MAPE Values

Alpha	MAPE Value
0.1	45.868735
0.3	47.076851
0.5	50.291601
0.7	53.830948
0.9	55.533109

In Table 6 the best forecasting result is forecasting using alpha value 0.1 with the amount of forecasting value January 2018 to December 2018 is

443,904,600.7192. The value can be used as a reference to determine the target value of groundwater tax revenue in 2018 because the movement of data in the 1 year period for each month is not stable it is causing the error value based on the literature in table 1 is reasonable with MAPE 45.868735.

5 Conclusion

Based on the results of research and discussion it was concluded that the application of a single exponential smoothing method was used as a calculation method to forecast groundwater tax revenues for the next year by using actual data income from the previous several years as the basis for the calculation. The system using α constant value consists of 0.1, 0.2, 0.3, 0.4 and 0.5 to produce 5 (five) different forecasting results and provide information about the best forecasting of the 5 (five) forecasting results. The best forecasting result for the 2018 period is 443,904,600.7192 earned from the result of the forecast amount for January 2018 to December 2018 using α = 0.1 because it has the smallest error value.

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