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Double moving average method for predicting the number of patients with dengue fever in Gorontalo City

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Abstract. Dengue Fever (DF) is an infectious disease caused by the dengue virus which is transmitted by the Aedes Aegypti mosquito. This disease is one of the health problems in Indonesia, especially in Gorontalo City. According to data from the Departement of Health of Gorontalo City, the number of dengue fever patients reached 752 people within 2011 – 2017. Therefore, the related departement keeps predicting the number of patients for future incidence to find a way to prevent increase. The research aimed to create a system that can predict the number of dengue fever patients using the Double Moving Average method. Prediction runs by processing the number of cases of dengue fever patients in 2011-2017 from all sub-districts. Then, The result of prediction found that there would be 116 patients of Dengue Fever in 2018, in which it increased from 2017

1. Introduction

The use of forecasting or prediction has been widely employed in organizational activities to prepare conditions that may occur in the future [1]. Predictions are also the basis for all business decisions even if they are not precise, but the organization can get a picture for future decisions. In made the prediction does not close the possibility of the organization less attention to the pattern of data owned, so finally using predictive methods that are less of the data pattern [1] [2]. The predicted results obtained are not maximal in helping the organization determine the steps in the future, so the understanding of the pattern of data owned is essential [1].

Dengue Fever (DF) is an infectious disease caused by dengue virus which is transmitted by the Aedes Aegypti mosquito, it is still one of the health problems in Indonesia, especially in Gorontalo Province and Gorontalo City is one of the regions in Gorontalo Province with a number of people suffering from dengue fever according to data from the Gorontalo City Health Office from 2011-2017 has reached 752 people with Dengue Fever.

In 2011 the number of sufferers of dengue fever reached 205 patients and in 2012 there was a decline which the number of dengue fever patients reached 88 patients and in 2013 there was a decline in the number of sufferers of dengue fever reaching 67 patients while in 2014 there was an increase over

2012 and 2013 where the number of patients with dengue fever reached 93 sufferers. The decline in the number of dengue fever sufferers occurred again in 2015, the number reached 49 patients, then the number of increases that increased from previous years occurred in 2016 where the number of patients reached 174 patients and in 2017 the number of patients with dengue fever reached 76 sufferers.

The rise and fall of the number of people with dengue fever in Gorontalo City is a problem for the Gorontalo City Health Office to find out the number of people with dengue fever in the following years. For this reason, we need a solution that can predict the development of the number of people with dengue fever in Gorontalo City. In addition to monitoring areas suffering from dengue fever, especially in each subdistrict in Gorontalo City. Therefore we need a system that can predict the development of the number of dengue fever that can function as a source of information to the public and related parties so that it can be taken into consideration in making decisions and policies to eradicate and suppress the number of people with dengue fever in Gorontalo City.

Research on prediction or forecasting using past data has been carried out by several previous researchers including [3] [4] [5] [6] [7] like [8] and [9]. In this study, they used several methods, namely the double weight moving average, single moving average method, single exponential smoothing, and double moving average. This research predicts the number of dengue fever in Gorontalo City using a double moving average.

2. Methodology

The research was conducted at the Gorontalo City Health Office, using data from the last 7 years of dengue fever from each sub-district, from 2011 to 2017. Data processing was done by counting based on the Double Moving Average forecasting formula with n = 3 periods.

2.1 Double Moving Average Method

A way to forecast time series data with a linear trend is to use a double moving average. The technique of this method where one group of moving averages is calculated, and then the second group is calculated as the moving average of results in the first group (Hanke et al, 2003).

Dual moving averages are moving averages of moving averages, and according to symbols are written as MA (k × k), which means moving averages as much as k periods of moving averages as much as k periods [10].

The steps used in calculating a double moving average are as follows:

1. Calculates the first moving average

$$M_t = \frac{Y_t+Y_{t-1}+Y_{t-2}}{n} \quad (1)$$

2. Calculates the second moving average

$$M_t' = \frac{M_t+M_{t-1}+M_{t-2}}{n} \quad (2)$$

3. Determines the amount of constant value, slope and forecasting

$$a_t = 2M_t-M_t' \quad (3)$$

$$b_t = \frac{2}{n-1}\left(M_t-M_t'\right) \quad (4)$$

$$F_{t+1} = a_t+b_t \quad (5)$$

2.2 Accuracy Measurement

To calculate prediction errors, MSE and MAPE calculations are used using the following formula [11] [12]: 1) MSE *(Mean Square Error)* is a method for evaluating forecasting methods. Each error is squared and then summed and added to the number of observations. The formula

$$MSE = \frac{\sum e^2}{n} \quad (6)$$

2. MAPE *(Mean Absolute Precentage Error)* is calculated using absolute errors in each period divided by the real observation value for that period, then the average absolute percentage error. The formula

$$MAPE = \frac{\sum |PEi|}{n} \quad (7)$$

The value of MSE and MAPE aims to test the value of errors from forecasting results. The smallest forecasting method with MSE and MAPE is the best method and will be used to conduct studies and analysis.

3. Result and Discussion

3.1 Result

The results of data collection conducted at the Gorontalo City Health Office and the entire Puskesmas in Gorontalo City, data were obtained regarding the number of people with dengue fever. The data obtained can be seen in table 1.

Table 1. The Number of Patients with Dengue Hemorrhagic Fever in Gorontalo City

Sub District	2011	2012	2013	2014	2015	2016	2017	Amount
Kota Barat	19	11	10	12	11	30	8	101
Kota Selatan	45	8	8	13	4	9	8	95
Kota Utara	20	6	13	13	6	11	10	79
Dungingi	60	4	6	14	4	32	14	134
Kota Timur	26	15	22	21	14	37	9	144
Kota Tengah	35	24	12	4	4	18	19	116
Sipatana	0	16	3	7	2	35	6	69
Dumbo Raya	0	0	0	2	0	2	0	4
Hulondalangi	0	0	0	7	4	0	2	19
Total	205	88	67	93	49	174	76	752

Example calculation using the Double Moving Average for the Kota Barat District area with a value of n = 3 :

Kota Barat District

Table 2. *Double Moving Average* Calculation Table in Kota Barat District

Year	Amount Y_t	M_t	$M_t^{'}$	a_t	b_t	ft	e	e^2

2011	19							
2012	11							
2013	10	13.33						
2014	12	11.00						
2015	11	11.00	11.78	10.22	-0.78			
2016	30	17.67	13.22	22.11	4.44	9.44	-20.56	422.53
2017	8	16.33	15.00	17.67	1.33	26.56	18.56	344.31

From table 2 above can be calculated the prediction of the number of dengue sufferers for Kota Barat District in 2018 are as follows :

$F_{t+1} = a_t + b_t$
$F_{2017+1} = 17{,}67 + (1{,}33) * 1$
$F_{2018} = 19$
With the value of *Mean Squared Error (MSE)* as follow :
$MSE = \frac{766{,}84}{2} = 383{,}42$
And value of $MAPE = \frac{300{,}46}{2} = 150{,}23$

Calculation results The number of DF sufferers from all sub-districts of all sub-districts can be seen in Table 3.

Table 3. The results of the calculation of the prediction of the number of dengue fever patients in all districts

Year/district	Kota barat	Kota Selatan	Kota utara	Dungingi	kota timur	kota tengah	Sipatana	dumbo raya	Hulondhalangi	total
2017	8	8	10	14	9	19	6	0	2	76
2018	19	5	8	22	18	21	21	0	0	114

The results of MSE and MAPE calculations from all sub-districts of all sub-districts can be seen in Table 4.

Table 4. The results of calculation of MSE and MAPE values from all sub-districts

Year/district	Kota barat	Kota Selatan	Kota utara	Dungingi	kota timur	kota tengah	Sipatana	dumbo raya	Hulondhalangi
MSE	383,4	45,7	18,9	686,7	421,1	440,8	831,6	2,8	27,8
MAPE	150,2	54,5	33,9	104,3	145,6	107,2	215,7	NA	NA

Graph of the prediction of the number of sufferers of dengue fever in Gorontalo City can be seen in Figure 4.

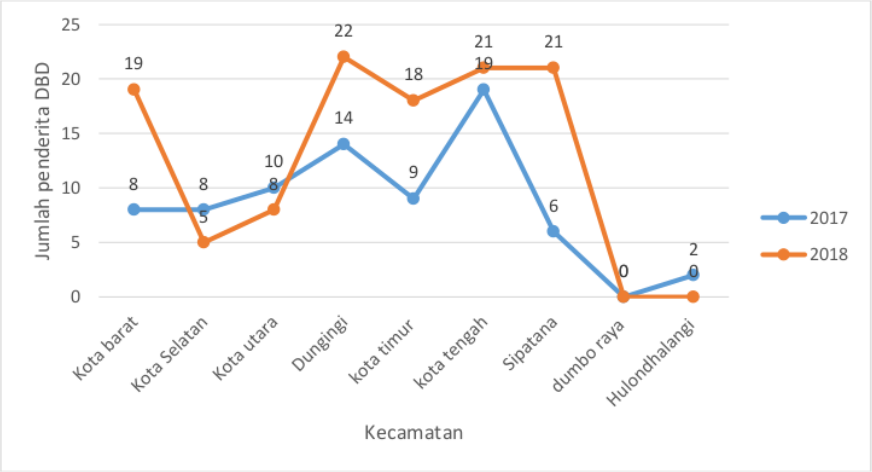

Figure 1. Graphs of 2017 and 2018 prediction results for all sub-districts

3.2 Discussion

If we see the results of the calculation of the prediction above, it shows a very large MAPE value as shown in table 4. The data shows that the Double Moving Average technique used to predict the number of people with dengue fever is less precise. This is different from the research conducted by [8] which shows that the Single Moving Average is the best method because it has a smaller error value. Likewise, with [9], the Double Moving Average method showed a smaller error.

From the comparison of the results of the research conducted, it can be analyzed that this is due to the pattern of data used in predicting the number of dengue sufferers whose values are very fluctuation. The data pattern will have an impact on very large MAPE value used to calculate the percentage accuracy of the predictions made. In contrast to the data pattern of research carried out by Laksana and Ardhiani who have linear trends that will produce very good accuracy values.

4. Conclusion

Based on the results and discussion obtained in this study, conclusions can be drawn as follows : 1) Prediction results in 2018 for Gorontalo reached 116 dengue fever patients with details for Kota Barat Subdistrict 19 sufferers, Kota Selatan Subdistrict 5 sufferers, Kota Utara Subdistrict 9 Sufferers, Dungingi Subdistrict 22 sufferers, Kota Timur District 18 sufferers, Kota Tengah District 22 sufferers, Sipatana District 21 sufferers, Dumbo Raya District 0 patients and Hulonthalangi District 0 patients. 2) Prediction results show a very large MAPE value indicating that the accuracy rate is very low. This means that the Double Moving Average is not suitable for use in fluctuating data patterns.

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