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Forecasting of Dengue Hemorrhagic Fever and Climate Influences Using the Linear Regression Model at Tabanan Hospital

Made Wahyu Aditya[1]

[1]*STIKes Wira Media, Bali, Indonesia*

Correspondence should be addressed to:
Made Wahyu Aditya
wahyuaditya@stikeswiramedika.ac.id

Abstract:
Forecasting is the science of predicting future events using final data. DHF is an infectious disease caused by mosquitoes carrying the dengue virus. Based on data from the Ministry of Health for 2020, there were 95,893 cases, with 661 cases dying. This study aimed to determine the number of patient cases in the future and the influence of climate factors on DHF in Tabanan Hospital. Prediction analysis in this study using the Linear regression method. Evaluation of measurement measurements using MAPE and significance tests, namely the F test and t-test to determine the magnitude of the influence of the independent variables on the dependent variable. This study resulted in a prediction of DHF at Tabanan Hospital in the 65th period of May 2022, totaling 74 DHF cases with an accuracy of the MAPE forecasting error rate of 16.99% in the good category. The F test shows a significance value of 0.31, more significant than the value of α (0.05), and the variable's rainfall, air temperature, and air humidity do not significantly affect DHF cases. The results of the regression test with the t-test showed that the t-count Rainfall is -1,615 with a significance value of 0.11 > 0.05 where the t-count is a negative value which means that if rainfall increases, then the risk of DHF will decrease, the t value counts Temperature air is 0.278 with a significance value of 0.78 > 0.05, the t value for air humidity is 1.845 with a significance value of 0.07 > 0.05. With accurate prediction results, it is hoped that Tabanan Hospital management can improve hospital services and services.

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INTRODUCTION

In an effort to improve health status, one type of disease that is given intensive treatment is an infectious disease. Dengue Hemorrhagic Fever (DHF) is a type of infectious disease caused by the bite of a mosquito carrying the Dengue virus (Ministry of Health RI, 2020). Dengue Hemorrhagic Fever (DHF) is an acute infectious disease caused by the dengue virus. Although this disease is common, it is even more dangerous for children (Tansil et al., 2021).

DHF cases are mostly found during the rainy season when a lot of stagnant water appears from the container/media that collects rainwater which becomes a breeding ground for mosquitoes (Arisanti, & Suryaningtyas, 2021). In addition to climate and environmental conditions, several studies have shown that DHF is related to mobility, population density, and people's behavior (Anggraini et al., 2021). Dengue fever is caused by various factors, namely environmental cleanliness, immune system and climatic factors, namely rainfall, air humidity and air temperature (Mayasari et al., 2020). Physical environmental factors associated with the incidence of DHF such

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as temperature, rainfall, and humidity. Several studies have shown that at temperatures of 28-32oC with high humidity, Aedes sp. will survive for a long time (Oroh et al., 2020).

Dengue fever is still one of the most serious health problems in the world. Based on data from the World Health Organization (WHO), it is estimated that around 2.5 billion or 40% of the world's population in tropical and sub-tropical countries has a high risk of contracting the Dengue virus. It is reported that there are 50 to 100 million cases of Dengue worldwide, 500,000 cases of DHF with a total death of 22,000 people each year (Ciptono et al., 2021).

Forecasting is a variable based on known values to predict future or future events (Makridakis et al., 2019). One approach used for forecasting is the Time Series method. The time series method is a forecasting method assuming that the future is part of the past. The goal is to determine patterns in historical data series and translate these patterns into the future (Husna, 2017).

Subsequent research conducted by Juwita et al. in 2015 explains that forecasting uses the Naïve method, Simple Averages, Moving Averages, Exponential Smoothing, Holt's, ARIMA and a combination of Holt's and Bayesian Network. The best forecasting model is Moving Averages k = 2, producing MSE values of 4.1, MAD 1.3, and MAPE 33.33% with the Fair category. Based on these research deficiencies, the authors used the linear regression method to see the causal relationships that occur between variables and to be able to identify the influence exerted by predictors and predict DHF cases in the future. Based on the problems above, the authors propose a study entitled "Forecasting Of Dengue Hemorrhagic Fever Cases And Climate Influences Using The Linear Regression Model At Tabanan Hospital." decision making and with the aim of research to determine the number of patient cases in the future and the influence of climate factors on DHF in Tabanan Hospital.

METHOD

This research uses the linear regression method. This research was carried out at the reporting unit of the Tabanan Hospital and BMKG Region III Denpasar in June 2022. This study's data collection started from submitting letters and research proposals to finding data by interviewing and using secondary data. Data analysis in this study determines the accuracy of DHF case predictions.

RESULT

The results of this study explain the results of forecasting DHF cases with past data from 2017-2022 and look at the variables that affect DHF cases at Tabanan Hospital.

Data description: This study uses the independent variables, namely rainfall (VCH), air temperature (VSU), and air humidity (VKU) and the dependent variable, namely DHF cases (VDBD). The data obtained are monthly data on dengue cases at BRSUD Tabanan Regency and rainfall data on air temperature and humidity from BMKG Region III from 2017 -2022.

The time series plot in this study is plotted based on monthly time to produce a seasonal pattern. The VDBD, VCH, VSU, VKU variable data plots for 2017-2022 are shown in the figure below.

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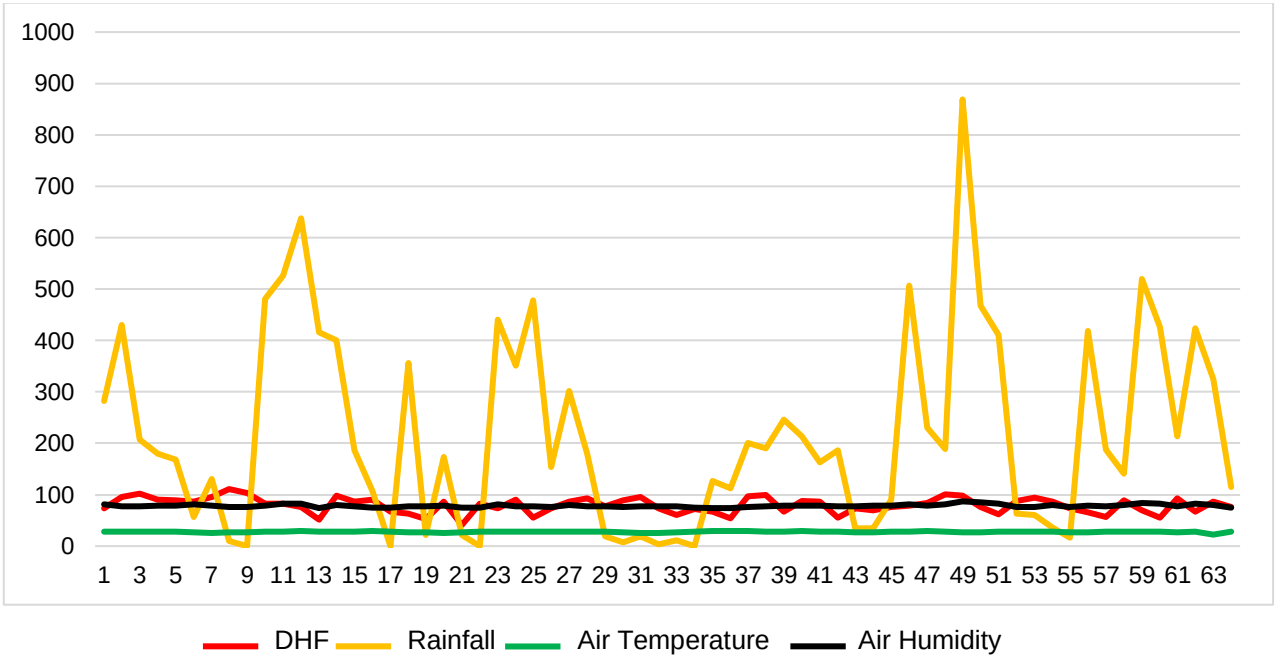

Figure 1. Time Series Plot VDBD, VCH, VSU, VKU in 2017-2022

Pre-Processing Data

The data obtained is in monthly units, so there is no need to change the data unit time and it is directly processed with Minitab and SPSS software.

Hypothesis testing

In this study, to test the truth of the hypothesis made by knowing:

1. H_0 : There is no significant (x) influence of the variable (x) rainfall, air temperature, and air humidity on the variable (y) of DHF cases.
2. H_1 : There is a significant (significant) influence of the variable x) rainfall, air temperature, and air humidity on the variable (y) of DHF cases.

Significance Test

1. Data Normality Test

   The data normality test in this study used the Kolmogorov-Smirnov test based on the Exact Sig significance value. (2-tailed) of 0.787 is greater than 0.05. So according to the basis for deciding on the Kolmogorov-Smirnov normality test, it can be concluded that the data is normally distributed. The assumption of normality in the regression model is fulfilled. More complete data can be seen in the table below.

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Table 1. Kolmogorov-Smirnov Data Normality Test

		Unstandardized Residual
N		64
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	14.79183073
Most Extreme Differences	Absolute	.079
	Positive	.048
	Negative	-.079
Test Statistic		.079
Asymp. Sig. (2-tailed)		.200[c,d]
Exact Sig. (2-tailed)		.787
Point Probability		.000

[a]Test distribution is Normal.
[b]Calculated from data.
[c]Lilliefors Significance Correction.
[d]This is a lower bound of the true significance.

2. Regression Test
   a. Entered/Removed variables

   The Entered/Removed variable results explain the variables entered, variables not used, and the method used. In this study, the variables included were the variable values of rainfall, air temperature, and air humidity as predictors or independent variables, and the method used was the enter method. The Enter method is a method used to form estimates of the regression equation. More complete data can be seen in the table below.

Table 2. Entered/Removed Variable

Model	Variables Entered	Variables Removed	Method
1	Air humidity, air temperature, forecast rainfall[b]	.	Enter

[a]Dependent Variable: DHF
[b]All requested variables entered

   b. Summary models

   The results of the Summary Model to find out the magnitude of the correlation/relationship (R) value of 0.240 with a weak relationship category, and explained the large percentage of influence of the independent variable on the dependent variable which is called the coefficient of determination which is the result of R. This study obtained the value of the coefficient of determination (R Square) equal to 0.058, which means that the effect of the independent variables (rainfall, air temperature, air humidity) on the dependent variable (DHF) is 5.8%. In comparison, other variables influence the remaining 94.2% (1 - 0.058). More complete data can be seen in the table below.

Table 3. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.240[a]	0.058	0.010	15.15712

[a]Predictors: (Constant), VKU, VSU, VCH

c. F test (ANOVA)

The F-test (ANOVA) explains whether the independent variable has a real (significant) effect on the independent variable. The results of this study showed that the significance value of 0.31 was greater than the value of α (0.5) for all independent variables (rainfall, air temperature, and air humidity) and had no significant effect on the dependent variable (DHF case). More complete results can be seen in the table below.

Table 4. F Test (ANOVA)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	841.647	3	280.549	1.221	0.310[b]
	Residual	13784.290	60	229.738		
	Total	14625.937	63			

[a]Dependent Variable: DHF
[b]Predictors: (Constant), VKU, VSU, VCH

d. t-test (Partial)

The t (partial) test explains each independent variable CH (negative) SU (positive) KU (positive), showing results where positive values can affect the dependent variable and negative values have no effect. The sigification value is the value that affects the dependent variable with the smaller the value the more significantly it affects the dependent variable VCH: 0.112, VSU: 0.782, VKU 0.070, then Ho is accepted and H1 is rejected, which means that there is no significant influence from the independent variables (rainfall, air temperature, air humidity) on the dependent variable (DHF cases).

The t (partial) test in this study shows the results of the regression equation:

VDBD = -79 - 0.0240 VCH + 0.52 VSU + 1.90 VKU

Information :

1) A constant of -79 states that if there is no value on the independent variable then the value of the dependent variable is -79.
2) The regression coefficient X is -0.0240 for rainfall, 0.52 for air temperature, 1.90 for air humidity states that for every 1 addition of the value of the independent variable, the value of the dependent variable increases by -0.0240 for rainfall, 0.52 for air temperature, 1.90 for air humidity. More complete results can be seen in the table below.

Table 5. t-test (Partial)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-79.137	106.319		-0.744	0.460
	VCH	-0.0240	0.015	-0.300	-1.615	0.112
	VSU	0.52	1.881	0.037	0.278	0.782
	VKU	1.90	1.032	0.343	1.845	0.070

[a]Dependent Variable: DHF

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Forecasting Results

The results of forecasting DHF cases with data for 2017-2022 in this study using the regression method can be seen in the image below.

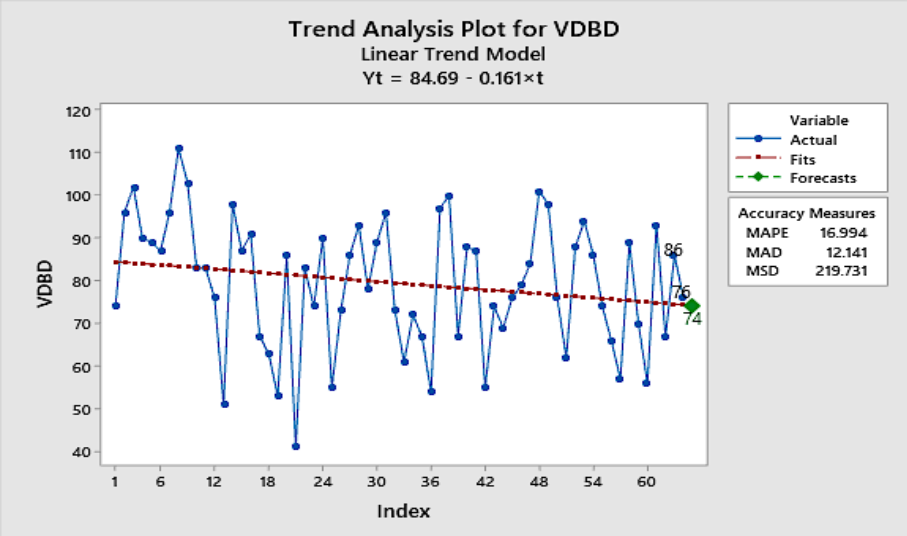

Figure 2. DHF Forecasting

The model used to predict using data from DHF cases. The picture above shows the results of forecasting DHF cases for the 65th period or May 2022, namely 74 DHF cases with an accuracy of the MAPE forecasting error rate of 16.99% with forecasting results in the good category.

DISCUSSION

Based on machine learning analysis, this study was able to determine the effect of the independent variable on the dependent variable, obtaining a coefficient of determination (R Square) of 0.058, which means that the effect of the independent variables (rainfall, air temperature, air humidity) on the dependent variable (DHF) is equal to 5.8% while other variables influence the rest.

The F test shows a significance value of 0.31 greater than the value of α (0.05) together with the Independent variables (rainfall, air temperature and air humidity) have no significant effect on the dependent variable (DHF case). The results of the regression test with the t test to determine the significance of the effect of each independent variable on the dependent variable with a regression coefficient X of -0.0240 for rainfall, 0.52 for air temperature, 1.90 for air humidity states that each addition of 1 independent variable value , then the value of the dependent variable increases by -0.0240 for rainfall, 0.52 for air temperature, 1.90 for air humidity. It is known that the t-count Rainfall value is -1.615 with a significance value of 0.11 > 0.05 where the t-count value is negative, which means that if rainfall increases, the risk of DHF will decrease, the t-count air temperature value is 0.278 with a significance value of 0, 78 > 0.05 where the t calculated value is positive which means if the air temperature increases, then the risk of DHF will increase, the t calculated air humidity value is 1.845 With a significance value of 0.07 > 0.05 where the t calculated value is positive which means if As the air temperature increases, the risk of dengue will increase. Then Ho is accepted and H1 is rejected, meaning there is no significant effect of the independent variables (rainfall, air temperature, and air humidity) on the dependent variable (DHF

cases). Still, air humidity has a moderate effect on DHF cases. Based on the results of interviews with epidemiologist Dr. dr. I Wayan Artawan Eka Putra, S.KM., M.Epid and Ika Setya Purwanti, SKM., M.Epid who stated that environmental factors, one of which is climate, have an indirect influence, rainfall, and humidity, can affect the growth and development of mosquitoes. In contrast, temperature can affect the development of mosquito eggs, hot temperatures will damage mosquito eggs, but other factors are more influential, namely the immune system and environmental cleanliness.

The author performs data processing with machine learning, producing predictions of DHF cases at Tabanan hospitals in the 65th period or May 2022, totaling 74 DHF cases with an accuracy error rate (error) in MAPE forecasting of 16.99% with forecasting results in the good category.

CONCLUSION

Based on the results of tests carried out in the research on predicting the number of dengue fever in Tabanan Hospital using the linear regression method, it can be concluded as follows:

The results of the test resulted in predictions of DHF cases at BRSUD Tabanan Regency in the 65th period or May 2022, totaling 74 DHF cases with an accuracy error rate (error) in MAPE forecasting of 16.99% with forecasting results in the good category.

The F test shows a significance value of 0.31, greater than the value of α (0.05) together with the independent variables (rainfall, air temperature, and air humidity) that have no significant effect on the dependent variable (DHF case).

The t-test (Partial) shows the results of the regression coefficient X of -0.0240 for rainfall, 0.52 for air temperature, 1.90 for air humidity, states that for every 1 addition of the value of the independent variable, the value of the dependent variable increases by -0, 0240 for rainfall, 0.52 for air temperature, 1.90 for air humidity. It is known that the t-count Rainfall value is -1.615 with a significance value of 0.11 > 0.05 where the t-count value is negative, which means that if rainfall increases, the risk of DHF will decrease, the t-count air temperature value is 0.278 with a significance value of 0, 78 > 0.05 where the t calculated value is positive which means if the air temperature increases, then the risk of DHF will increase, the t calculated air humidity value is 1.845 With a significance value of 0.07 > 0.05 where the t calculated value is positive which means if As the air temperature increases, the risk of dengue will increase.

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