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Vector Autoregressive Modeling on Cases Of Malaria Based on The Tribal in Tanah Bumbu District

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ABSTRACT

The number of malaria in this area always has the tendency of the most compared to the city/district in South Kalimantan Province. Behavior is internalisation factor from the level of knowledge, attitudes and actions of a person who influenced by customs, customs and belief in certain things that has been handed down by his ancestors. The behavior of a community group can be different from the other groups so that they formed a group behavior or can be said tribal behavior.The purpose of this research predicts that the number of the prevalence of malaria in Tanah Bumbu tribal based with Y_{1t} : the tribe of Banjar, Y_{2t} : Javanese, Y_{3t} : the tribe of Bugis, and Y_{4t} : other tribes using vector autoregressive (VAR) model. The results of the study showed with Granger Causality approach there is a relationship between the amount of the prevalence of Malaria Javanese with other tribes, Bugis tribe with other tribes. The relationship is strengthened in the VAR model, which is the number of the prevalence of Malaria Javanese influenced by the number of the prevalence of Malaria Javanese at period t-1, and the number of the prevalence of Malaria tribe Bugis at period t-1. While the number of the prevalence of Malaria tribe Bugis influenced by the number of the prevalence of Malaria Other tribes in the period t-2. The Model of divination the prevalence of Malaria based on ethnicity as follows:

$$Y_{1t}-Y_{1t-1}=0.325Y_{1t-1}+0.277Y_{1t-2}+0.198Y_{2t-1}+0.302Y_{2t-2}+0.645Y_{3t-1}-0.955Y_{3t-2}-1.732Y_{4t-1}+0.812Y_{4t-2}$$
$$Y_{2t}-Y_{2t-1}=-0.085Y_{1t-1}+0.347Y_{1t-2}+0.419Y_{2t-1}-0.059Y_{2t-2}+0.844Y_{3t-1}-0.525Y_{3t-2}-0.125Y_{4t-1}-0.501Y_{4t-2}$$
$$Y_{3t}-Y_{3t-1}=-0.041Y_{1t-1}+0.125Y_{1t-2}+0.136Y_{2t-1}-0.181Y_{2t-2}+0.318Y_{3t-1}-0.074Y_{3t-2}-0.399Y_{4t-1}+0.653Y_{4t-2}$$
$$Y_{4t}-Y_{4t-1}=-0.019Y_{1t-1}+0.026Y_{1t-2}+0.101Y_{2t-1}+0.014Y_{2t-2}+0.136Y_{3t-1}-0.096Y_{3t-2}-0.075Y_{4t-1}-0.039Y_{4t-2}$$

The ability of divination number of the prevalence of malaria based on the tribal areas with the criteria MAPE provides good performance of 28.5 percent.

Keywords: Malaria, Tanah Bumbu, VAR, Tribe Banjar, Javanese, Tribe Bugis, Other Tribes

INTRODUCTION

Genesis malaria of course is associated with the existence of contact with the mosquito Anopheles as penular. Some of the factors that related with the possibility of contact between people in a place with the mosquito namely characteristics, climate

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change, behavior, socio-economic conditions and others. Malaria is one of the infectious disease caused by the Plasmodium. However as other communicable disease, infection of malaria is very influenced by many factors. The things that related with the environment, behavior, and mosquitoes usually most discussed in the transmission of malaria in a region. Various researches have been done. Most research related to the mosquito Anopheles [1]. The types of mosquitoes is indeed the gnats penular known to play a role in the transmission of malaria from one person to another. modeling the relevance of these factors in the genesis of malaria on a certain period used vector autoregressive approach (VAR) [2].

VAR model was built in order to catch the phenomenon that is with good. VAR nonstructural is a model of the relations between the variables, while cointegration and Vector Error Correction Models (VECM) is a solution to create a model that has a long and short term are relationships of variables which have the problem of nonstationary [3]. VAR has several benefits such as (1) this method is simple, researchers do not need to determine where the endogenous variable and which exogenous variable because all the variables in the VAR is the endogenous variable; (2) estimation method can use Ordinary Least Square (OLS) and can be done for each equation separately; (3) the result of divination with this method in many cases better than divination with a complex simultaneous equation method [4].

South Kalimantan Province, if reviewed number from the diversity of Genesis Malaria 2011, a province with the number of Malaria sixth largest. The number of Malaria absolutely 2011 in South Kalimantan Province as much as 6663 Genesis [5]. If compared to the year 2007, then the incidence of malaria 2013 in South Kalimantan Province. Tanah Bumbu is endemic areas malaria because in the last 3 years (2011 until 2013) always found cases of malaria. The number of malaria in this area always has the tendency of the most compared to the city/another district in South Kalimantan Province. The discovery of cases of malaria in Tanah Bumbu on 2012 totaled 6044 cases from the total 29212 cases in South Kalimantan [6].

The results of research related to the genesis of malaria are the temperature and humidity in research [7], [8], [9], and [10]. The height of the location in research [7] and [11]. Biological environment in research [12] and [1]. The socio-economic research in the [12], [13], [14] and [1]. The behavior in research [15], [12], [16], [17], [18] and [19]. The status of the population in research [13], [20] and [1]. Research and modeling of divination genesis diseases including done by [21], [22] and [23]. However, model of divination that obtained in the three research is considering only the case of previously according to time and location as the variable wizards (predictors). Based on the need to be examined the predictions of malaria cases in the district of the land of spices that based on ethnicity and behavior with a model VAR.

METHODS

The Unit of analysis in this research is data number of Genesis malaria per month according to the sub-districts which are recorded in the system of recording and reporting on the health of Tanah Bumbu year 2012-2015. The basic concept in epidemiology often termed the trias epidemiology provides the relationship between the three main factors that have a role in a disease and other health problems, namely host, agent, and environment. The three factors is a dynamic unity in the balance (equilibrium) on the healthy. If the balance is disrupted, will cause the status of the sick [24]. Based on the research and theoretical studies description, then the framework of the concept of the research is presented in Figure 1.

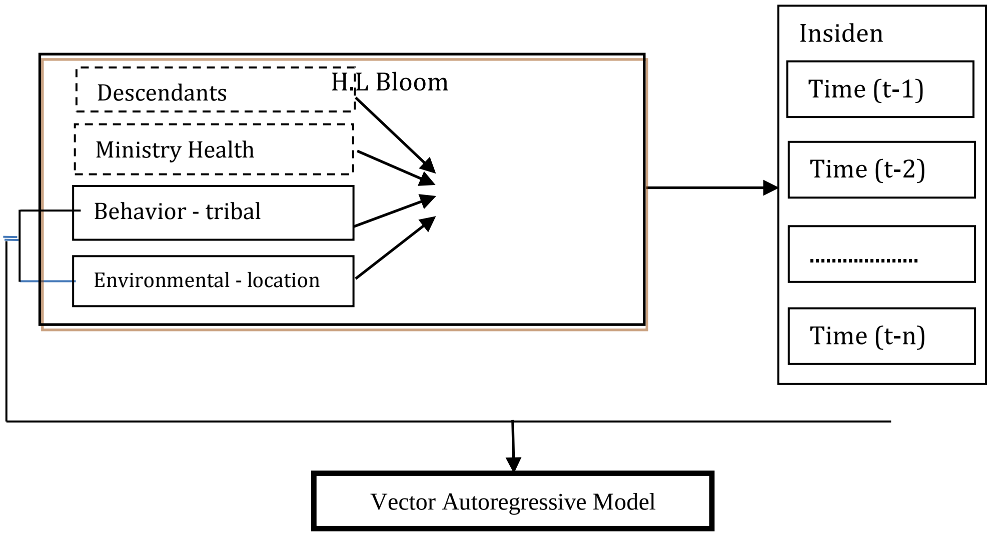


Figure 1. The Conceptual Framework of Genesis Malaria based on the tribal areas with Vector Autoregressive Model [24]

Genesis malaria can had been modeled according to the theory of H.L. 'S taxonomy. In the theory of Genesis a disease can be influenced by 4 (four) factors, factors, descendants of health services, the behavior and the environment. Specific locations have certain environmental factors that can be different from the other locations. So the variables can be used as location) are typical of a genesis pain. Incidents or genesis a disease according to the time will be able to form a specific model. The model can be used to predict the future events that will come. Community groups in Tanah Bumbu become heterogeneous community groups that can have a specific tribal behavior. This tribal behavior patterns will be used in the development of the model VAR in predicting genesis malaria in Tanah Bumbu.

Analysis steps on the modeling VAR as follows [25], [26]:

1. Pre-processing data in the tribal areas of Tanah Bumbu include month and year.
2. Test stationary in variance and the average
   Stationary data is data that is not experience growth or decline. Stationary Data have a horizontal pattern along the time axis, or fluctuations in the data is located around an average value a constant, not depending on time and varians from fluctuations remain constant each time.
3. Do the identification of the model to obtain the Vector Autoregressive order (VAR)
   The first model Identifkasi determine p order from VAR(p), and then q order from X. The determination of the prevailing from VAR(p) used MPACF plots and AIC minimum without involving exogenous variable. While the determination of order X involving exogenous variable. The value of the AIC as follows: (Wei, 2006)
   $$AIC(p) = \ln(|\hat{\Sigma}_p|) + \frac{2m^2 p}{n}$$
   Where:

$\hat{\Sigma}_p = \frac{1}{n}\sum_{t=1}^{n}\hat{\mathbf{u}}_t(\hat{\mathbf{u}}_t)'$ Is based on the model residual kovarian penduga VAR(p),

$\hat{\mathbf{u}}_t$ Is a residual on the time to the t model VAR(p)

M is the number of endogenous variables in the model.

4. Perform the estimation of model parameters VAR used the smallest square method
5. To test the significance of model parameters VAR
6. Checking the assumption of White Noise, Normal Multivariate on a residual
7. Perform data forecasts out sample

RESULTS AND DISCUSSION

Unit will analysis in this research is data number of Genesis malaria per month according to the sub-districts which are recorded in the system of recording and reporting on the health of Tanah Bumbu year 2014-2017. Genesis malaria seen according to each of the tribal areas on all months starting January the year 2014 until May 2017 is shown in Table 1. Genesis plots Timeseries Malaria based on ethnicity served as follows:

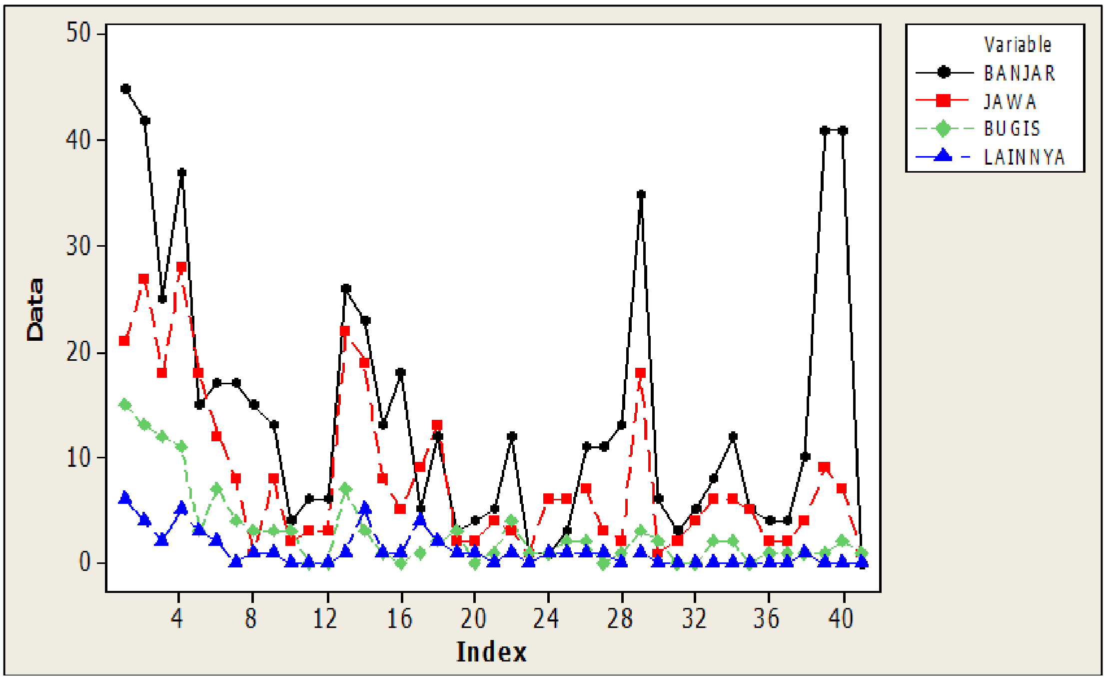


Figure 2. Genesis plots Timeseries Malaria Tribal Based

Figure 2 shows the pattern of the number of the prevalence of malaria from 41 observations on the tribe of Banjar, Java, Bugis and other tribes have the trend is down, although on the other tribes paring losses more entry ramp. This can be in it that the pattern of Genesis malaria tends to be uniform from the four tribes.

In detail is presented in Table 1 below.

Table 1. Cross-tabulation of Genesis Malaria in Tanah Bumbu according to the years, the month and the tribal areas

The Year	The Month	Tribal Areas							
		Banjar		Central Java		Bugis		Others	
		f	%	f	%	f	%	f	%
2014	January	45	51.7	21	24.1	15	17.2	6	6.9
2014	February	42	48.8	27	31.4	13	15.1	4	4.7
2014	March	25	43.9	18	31.6	12	21.1	2	3.5
2014	April	37	45.7	28	34.6	11	13.6	5	6.2
2014	Mei	15	38.5	18	46.2	3	7.7	3	7.7
2014	June	17	44.7	12	31.6	7	18.4	2	5.3
2014	July	17	58.6	8	27.6	4	13.8	0	0.0
2014	August	15	75.0	1	5.0	3	15.0	1	5.0
2014	September	13	52.0	8	32.0	3	12.0	1	4.0
2014	October	4	44.4	2	22.2	3	33.3	0	0.0
2014	November	6	66.7	3	33.3	0	0.0	0	0.0
2014	December	6	66.7	3	33.3	0	0.0	0	0.0
2015	January	26	46.4	22	39.3	7	12.5	1	1.8
2015	February	23	46.0	19	38.0	3	6.0	5	10.0
2015	March	13	56.5	8	34.8	1	4.3	1	4.3
2015	April	18	75.0	5	20.8	0	0.0	1	4.2
2015	Mei	5	26.3	9	47.4	1	5.3	4	21.1
2015	June	12	41.4	13	44.8	2	6.9	2	6.9
2015	July	3	33.3	2	22.2	3	33.3	1	11.1
2015	August	4	57.1	2	28.6	0	0.0	1	14.3
2015	September	5	50.0	4	40.0	1	10.0	0	0.0
2015	October	12	60.0	3	15.0	4	20.0	1	5.0
2015	November	1	33.3	1	33.3	1	33.3	0	0.0
2015	December	1	11.1	6	66.7	1	11.1	1	11.1
2016	January	3	25.0	6	50.0	2	16.7	1	8.3
2016	February	11	52.4	7	33.3	2	9.5	1	4.8
2016	March	11	73.3	3	20.0	0	0.0	1	6.7
2016	April	13	81.3	2	12.5	1	6.3	0	0.0
2016	Mei	35	61.4	18	31.6	3	5.3	1	1.8
2016	June	6	66.7	1	11.1	2	22.2	0	0.0
2016	July	3	60.0	2	40.0	0	0.0	0	0.0
2016	August	5	55.6	4	44.4	0	0.0	0	0.0
2016	September	8	50.0	6	37.5	2	12.5	0	0.0
2016	October	12	60.0	6	30.0	2	10.0	0	0.0
2016	November	5	50.0	5	50.0	0	0.0	0	0.0
2016	December	4	57.1	2	28.6	1	14.3	0	0.0
2017	January	4	57.1	2	28.6	1	14.3	0	0.0
2017	February	10	62.5	4	25.0	1	6.3	1	6.3
2017	March	41	80.4	9	17.6	1	2.0	0	0.0
2017	April	41	82.0	7	14.0	2	4.0	0	0.0
2017	Mei	0	0.0	1	50.0	1	50.0	0	0.0
Total		577	53.9	328	30.6	119	11.1	47	4.4

Table 1 shows that the Genesis Malaria on the tribe of Banjar each month is relatively always higher than genesis malaria on the other tribes. When compared with the other tribes, then genesis malaria on the tribe of Banjar the average range between 11.1 percent to 82.0%.

Now the variables used are:

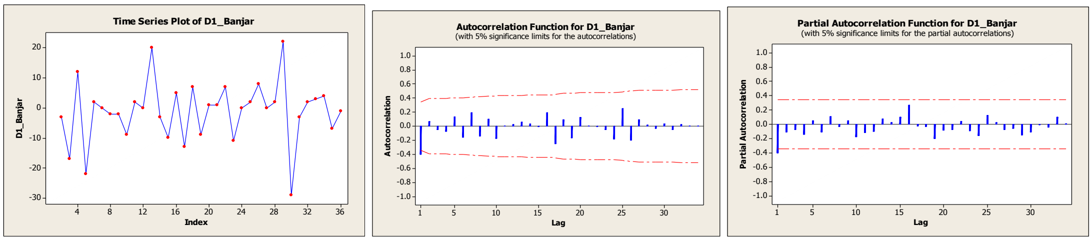
The tribe of Banjar (Y_{1T}): the number of the prevalence of Malaria Tribe of Banjar against all the tribes in Tanah Bumbu

The tribe of Central Java (Y_{2T}): the number of the prevalence of Malaria Javanese against all the tribes in Tanah Bumbu

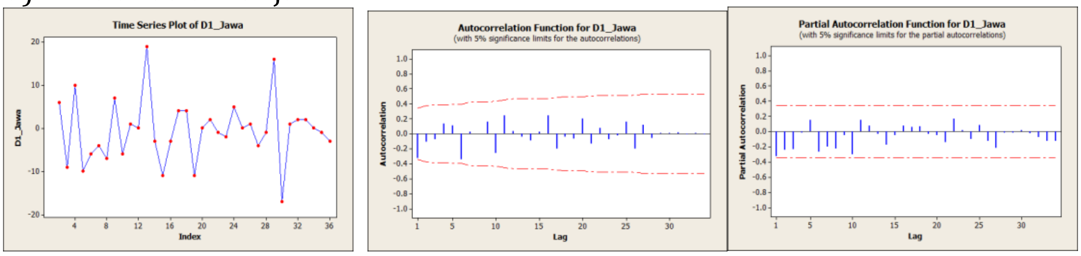
The tribe of Bugis origin ((Y_{3T}): the number of the prevalence of Malaria Tribe Bugis

against all the tribes in Tanah Bumbu
Other tribes (Y_{4T}): the number of the prevalence of Malaria Tribes besides (Banjar, Java, Bugis) against all the tribes in Tanah Bumbu.

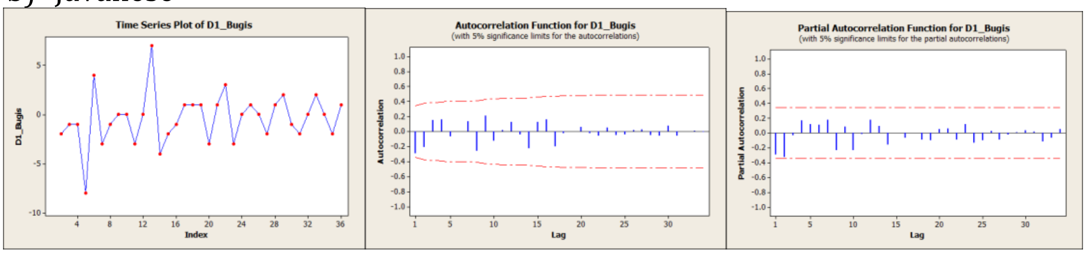
Next time series plots, ACF and PACF each research variables presented in Figure 3.



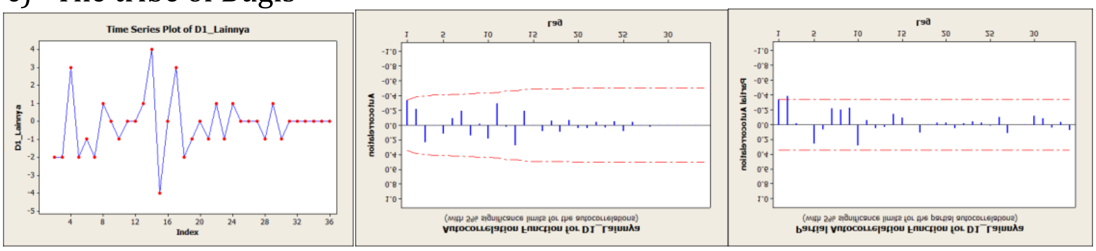
a) The tribe of Banjar



b) Javanese



c) The tribe of Bugis



d) Other tribes

Figure 3. ACF and PACF plots Differencing 1 Prevalence of Malaria based on ethnicity

Based on the Figure 3 shows that the number of patients with Malaria tribes (Banjar, Java, Bugis, others) form the pattern that stationary on timeseries plots, while on the ACF and PACF plots there is a lag that out of bounds. It can be said that the data the number of patients with Malaria Other tribes stationary in the average and variance. The test stationary through Augmented Dickey-Fuller presented in the following table.

Table 2. The value of the Augmented Dickey-Fuller test statistic

The tribe of	T-Statistic	Prob	Decision
Banjar	-3.812047	0.0063	Reject H0
Java	-3.251855	0.0252	Reject H0
Bugis	-3.624860	0.0104	Reject H0
Others	-4.238311	0.0021	Reject H0

Table 2 shows that the Prob. on all tribes (Banjar, Java, Bugis, others) smaller than α=0.05, which means giving the decision Reject Ho. It can be said that the number of the prevalence of malaria on the tribe of Banjar, Javanese, Bugis tribe and other tribes have been stationary in mean and varians. Furthermore, done causalitas granger tests, presented in Table 3.

Table 3. Granger Causality Test

Null Hypothesis	Obs	F-Statistic	Prob.
Java does not Granger Cause BANJAR	34	0.13943	0.8704
BANJAR does not Granger Cause JAVA		0.83067	0.4459
BUGIS does not Granger Cause BANJAR	34	0.86838	0.4303
BANJAR does not Granger Cause BUGIS		0.28776	0.7521
Others does not Granger Cause BANJAR	34	0.76900	0.4727
BANJAR does not Granger Cause OTHERS		1.58712	0.2218
BUGIS does not Granger Cause JAVA	34	1.41222	0.2599
Java does not Granger Cause BUGIS		0.10857	0.8975
Others does not Granger Cause JAVA	34	0.04465	0.9564
Java does not Granger Cause OTHERS		3.03627	0.0635
Others does not Granger Cause BUGIS	34	1.42283	0.2574
BUGIS does not Granger Cause OTHERS		2.74853	0.0807

Table 3. shows that with the level of the significance α=10%, value Prob. smaller than ten percent is the number of the prevalence of Malaria Javanese with other tribes and tribal Bugis with other tribes. This shows that there is the influence between the number of the prevalence of Malaria Javanese with other tribes and the number of the prevalence of Malaria tribe Bugis with other tribes.

Next, done modeling VAR in the tribe of Banjar (Y1T), Javanese (Y2T), the tribe of Bugis origin (Y3T), and other tribes (Y4T), which is presented in the following table.

Table 4. The value of the Estimator, Standard deviation, t-Statistics VAR Model number of the prevalence of Malaria based on ethnicity

	The tribe of Banjar (Y_{1t})	Javaness (Y_{2t})	The tribe of Bugis (Y_{3t})	Other tribes (Y_{4t})
	0.325115	-0.085934	-0.041048	-0.019274
The tribe of Banjar (Y_{1t-1})	(0.33166)	(0.24043)	(0.07731)	(0.04538)
	[0.98027]	[-0.35742]	[-0.53094]	[-0.42472]
	0.277228	0.346611	0.124575	0.026518
The tribe of Banjar (Y_{1t-2})	(0.31300)	(0.22690)	(0.07296)	(0.04283)
	[0.88572]	[1.52756]	[1.70739]	[0.61919]
	0.198695	0.418743	0.136616	0.101222
The tribe of Central Java (Y_{2t-1})	(0.56290)	(0.40807)	(0.13122)	(0.04702)
	[0.35298]	[1.02616]	[1.04115]	[2.15274]
	0.302650	-0.059674	-0.181024	0.013926
The tribe of Central Java (Y_{2t-2})	(0.46587)	(0.33773)	(0.10860)	(0.06375)
	[0.64964]	[-0.17669]	[-1.66691]	[0.21846]
	0.645513	0.843973	0.317533	0.136022
The tribe of Bugis (Y_{3t-1})	(0.90863)	(0.65870)	(0.21181)	(0.06853)
	[0.71042]	[1.28127]	[1.49916]	[1.98485]
	-0.955027	-0.525865	0.074744	-0.096987
The tribe of Bugis (Y_{3t-2})	(0.84783)	(0.61463)	(0.19764)	(0.11601)
	[-1.12643]	[-0.85558]	[0.37819]	[-0.83603]
	-1.731879	-0.124645	-0.399394	-0.074635
Other tribes (Y_{4t-1})	(1.85035)	(1.34139)	(0.43133)	(0.25318)
	[-0.93597]	[-0.09292]	[-0.92596]	[-0.29479]
	0.811660	-0.501651	0.653682	-0.039508
Other tribes (Y_{4t-2})	(1.55322)	(1.12599)	(0.32207)	(0.21253)
	[0.52257]	[-0.44552]	[2.02962]	[-0.18590]
R-squared	0.230273	0.299488	0.585486	0.361856

Table 4 shows that the results of the estimation of VAR models with lag two monthly provide the determination coefficient value for the equation number of the prevalence of Malaria based on ethnicity dimasing of each tribe is the tribe of Banjar (0.230), Javanese (0.299), the tribe of Bugis (0.585), and other tribes (0.362). This indicates that the variables are not yet strong enough to explain the fluctuations in the number of the prevalence of Malaria. This is because the fluctuations in the number of variables the prevalence of Malaria was influenced by many good variables that originate from external and internal, for example the factors behavior. Model VAR based on ethnicity as follows.

$$Y_{1t} - Y_{1t-1} = 0.325Y_{1t-1} + 0.277Y_{1t-2} + 0.198Y_{2t-1} + 0.302Y_{2t-2} + 0.645Y_{3t-1} - 0.955Y_{3t-2} - 1.732Y_{4t-1} + 0.812Y_{4t-2}$$

$$Y_{2t} - Y_{2t-1} = -0.085Y_{1t-1} + 0.347Y_{1t-2} + 0.419Y_{2t-1} - 0.059Y_{2t-2} + 0.844Y_{3t-1} - 0.525Y_{3t-2} - 0.125Y_{4t-1} - 0.501Y_{4t-2}$$

$$Y_{3t} - Y_{3t-1} = -0.041Y_{1t-1} + 0.125Y_{1t-2} + 0.136Y_{2t-1} - 0.181Y_{2t-2} + 0.318Y_{3t-1} - 0.074Y_{3t-2} - 0.399Y_{4t-1} + 0.653Y_{4t-2}$$

$$Y_{4t} - Y_{4t-1} = -0.019Y_{1t-1} + 0.026Y_{1t-2} + 0.101Y_{2t-1} + 0.014Y_{2t-2} + 0.136Y_{3t-1} - 0.096Y_{3t-2} - 0.075Y_{4t-1} - 0.039Y_{4t-2}$$

To view the model stability, used the criteria of the value of the root of modulus less than 1. Modulus values from the VAR model is presented in the following table.

Table 5. Review of the condition of the stability of the VAR

Root	Modulus
0.831296	0.831296
- 0.5344060.338320 i	0.632496
+ 0.5344060.338320 i	0.632496
0.577297	0.577297
- 0.378896-0.371162 i	0.530399
+ 0.378896-0.371162 i	0.530399
-0.521198	0.521198
0.165044	0.165044

Table 5 indicates whether the results of the estimation of the model VAR stable or stationary. If all the roots of has modulus less than one and the model is stable. All root on the table 5 shows that the roots have modulus less than one so that the VAR model has been stable. Because the Model VAR stable then the results of the forecast for out of sample number of the prevalence of Malaria based on ethnicity presented on the following table.

Table 6. The results of the forecast number of the prevalence of Malaria VAR Model tribal based

Year	Month	BANJAR		Javaness		BUGIS		Others	
		actual	forecast	actual	forecast	actual	forecast	actual	forecast
2017	January	4	6	2	6	1	1	0	0
2017	February	10	11	4	15	1	3	1	1
2017	March	41	17	9	9	1	1	0	1
2017	April	41	36	7	4	2	0	0	0
2017	Mei	0	2	1	1	1	1	0	0
MAPE		68%		36%		8%		2%	

Table 6 shows that the forecast of the number of the prevalence of malaria in five next period on the tribe of Banjar MAPE value of 68% (entered in the ability of bad forecasts), on Javanese MAPE value of 36% (entered in the ability of divination enough), in the tribe of the Bugis provides value MAPE is 8% (entered in the ability of divination is very good), and on the other tribes provide a 2 percent MAPE value (entered in the ability of divination is very good). The ability of divination number of the prevalence of malaria on the whole of 28.5 %, so that entered in the category of good.

CONCLUSIONS

Based on the results of the analysis that has been done, it can be concluded that the pattern of the number of the prevalence of malaria tends to be uniform from the four tribes, the number of the prevalence of Malaria Javanese there is a relationship with the other tribes and the number of the prevalence of Malaria tribe Bugis with other tribes. VAR Model tribal based on the prevalence of malaria is strong enough to explain the fluctuations in the number of the prevalence of malaria among the tribe. The number of the prevalence of Malaria Javanese influenced by the number of the prevalence of Malaria Javanese at period t-1, and the number of the prevalence of Malaria tribe Bugis at period t-1. While the number of the prevalence of Malaria tribe Bugis influenced by the number of the prevalence of Malaria Other tribes in the period t-2. The ability of divination number of the prevalence of malaria on the data out of sample with MAPE criteria provide good results, especially in the tribe of the Bugis and other tribes.

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