Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

Forecasting the Number of Patient Visits by Arima and Holwinters Method at the Public Health Center

Ilham Basri K.[1)*], David Fahmi Abdillah[2)], Titik Khotiah[3)], Jumain[4)], Abdul Rohman[5)],
[1)2)3)4)5)]Institut Teknologi dan Bisnis Ahmad Dahlan Lamongan,Indonesia
[1)] ilhambasrik@gmail.com, [2)] davidfahmi18@gmail.com, [3)] titikahmaddahlan@gmail.com, [4)]jumain.dj@gmail.com, [5)]rockyrohman@gmail.com

ABSTRACT

As the number of human populations increases and the economy becomes more advanced, people's awareness of health increases. This can increase the number of patient visits if the community will visit for treatment, therefore it is necessary to pay special attention from the health center to carry out readiness in the fulfillment of facilities and service support equipment, such as services in the outpatient registration place where registration documents must be adjusted to the number of existing patients, if the documents are lacking or have not been made, there can be long queues or accumulation of patients which leads to inadequate service. For this reason, the public health center must carry out careful planning activities, one of which is by conducting forecasting activities in order to overcome these problems.This study compares the best method among the 2 time series methods, then the forecasting results will be compared with the actual data to find which forecasting is the best.The final results showed the MAPE value of the arima method for Direct Patient Visits data was worth 22.55% while the Referral Patient Visits were valued at 47.40% with the Moderate/Feasible category, the Holwinters method for Direct Patient Visits data was worth 7.90% while the Referral Patient Visits were worth 11.90% with the excellent category.can be said that the smallest error value is Holtwinters from Direct Patient Visit data with MAPE 7.90% and from Referral Patient Visit data with MAPE 11.90%. Which is where it is said to be an excellent forecasting category

Keywords: Arima, Holtwinters, Forecasting, Direct Patient Visits, Referral Patient Visits, MAPE

1. INTRODUCTION

The Public Health Center is a technical implementation unit that organizes the second strata health efforts, to overcome certain public health problems in an integrated and comprehensive manner in a work area.with the aim of improving the status of public health through the implementation of strata 2 community health efforts according to their fields to the community in their work area (Novitaningsih, 2019).In the rapid development of technology and increasingly fierce competition, health centers are required to improve the quality of their services. Quality is at the core of an institution's survival. The problem that often occurs in the environment of public health centers is the increasing number of outpatient visits, both patients who come directly and referral patients that are increasing so that the health center is often overwhelmed in dealing with patients who visit for treatment in addition to that also in the section where registration of prospective outpatients and referrals there is often a shortage of form documents that can cause long queues or The buildup of patients in addition to the lack of available medical personnel. For this reason, the public health center must carry out careful planning activities, one of which is by conducting forecasting activities in order to overcome the problem of lack of document forms and can also increase the number of medical personnel if needed (Mahfudhoh, 2020).

Forecasting is a prediction of events or events in the future in another sense, namely a prediction to achieve future events systematically using data in the past. There are 2 categories of forecasting models needed in making a decision, namely qualitative models (opinion and judgmental methods) and quantitative models time series (Fiqih Akbari, Ikhwanul Muslimin, 2018).

In this study to determine the accuracy of forecasting results, forecasting was carried out using 2 methods consisting of Autoregressive Moving Averages and Holtwintes the main reason for using these two methods is because they can be used for short-term forecasting by providing complete information about the size of the error (Ilham 2019,

* Corresponding author

Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

n.d.).

Forecasting is carried out for outpatients in the form of direct patient visit (DPV) and referral patient visit (RPV) data. The categories of Direct Patient Visit (DPV) data are in the form of visit data: General, Clinic, BPJS, Non BPJS (SKM), Non BPJS (Gakinda), while the categories of Referral Patient Visit (RPV) data are in the form of visit data: Puskesmas Referrals, Hospital Referrals, Doctor Referrals, Other Place Referrals

.

2. LITERATURE REVIEW

Time Series Model

A time series is a sequence of observations indexed by time, usually ordered in equal intervals of spaces and correlated. In our time, it is already known the importance of time series studies. These studies provide indicators on the economy of a country, the unemployment rate, the level of exports and imported products, etc. The most interesting and ambitious task in time series analysis is to estimate the future value. Models are usually installed to predict future values of time series (Ilham 2019, n.d.).

Autoregressive Integreted Moving Average (ARIMA) Method

The Moving Average forecasting method is a forecasting based on arithmetic averages obtained from past data. Autoregressive Integreted Moving Average (ARIMA) is one of the time series methods part of the quantitative method. ARIMA uses past and present values of dependent variables to produce accurate short-term forecasting, providing complete information on error measures (Pratama, Hidayati, Suroso, & Sartika, 2020).

Holt-Winters Method

A method that can deal with seasonal factors and trends directly. This method is based on three smoothing equations with three parameters, namely one for stationary elements, one for trends,
and one for seasonality (Sungkawa & Megasari, n.d.).

Development of a Forecasting Result Evaluation Model

In the development of the model, applying the stages that need to be carried out, including in evaluating the results of forecasting, it is used to find out the accuracy of the forecasting results that have been carried out on the actual data. There are many methods for calculatingforecasting. Some of the methods used are (Sistem, Genta, Shandi, Adhitama, & Arifa, 2021):

Mean Square Error (MSE)

MSE is the average of the squared differences between the predicted and observed values. The result is that the value of the difference will be divided by the amount of data. The equation used to calculate the MSE value is as follows (Darmawan, Nugraha, & Wahyudi, 2022).

$$MSE = \frac{\sum ei^2}{n} \qquad (1)$$

Root Mean Square Error (RMSE)

A method that is quite often used in evaluating forecasting results is by using the Mean Squared Error (MSE) method. testing the results of the output process, then the process proceeds to see the average error value of the output by using the Mean Squared Error (MSE). This MSE value is calculated based on the completeness of the output value by comparing against a predetermined target. After obtaining the difference between the network output and the target, the result is that the value of the difference will be divided by the amount of data. Here's the MSE formula that can be seen in formula (Yanto, 2021).

$$MSE = X = \frac{\Sigma y - \Sigma yx}{n} \qquad (2)$$

Information:

Σy = Output Value, Σyx = Target, N = lot of data

RMSE is rooted in the value of the previously sought-after MSE. RMSE is used to find the accuracy of forecasting results with historical data using formulas. The smaller the resulting value, the better the forecasting results carried out.

$$MSE = X = \sqrt{\frac{\Sigma(y-yx)^2}{n}} \qquad (3)$$

Mean Absolute Deviation (MAD)

MAD is the absolute error average over a certain period regardless of whether the forecasting result is greater

* Corresponding author

Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

or lesser than in reality, in other words MAD is the rat-mean of the absolute value of deviation (Harini & Wahyuniar, 2021).

$$MAD = \sum \frac{A_t - F_t}{n} \quad (4)$$

Where: At = actual data, Ft = forecasting results, n=total period that actual data and forecasting have

Mean Absolute Percentage Error (MAPE)

This method performs the calculation of the difference between the original data and the forecasting result data. The difference is absolutized, then calculated into a percentage form against the original data. The result of the percentage is then obtained the mean value. A model performs very well if the MAPE value is below 10%, and has a good performance if the MAPE value is between 10% and 20%.

MAPE is a prediction accuracy calculated using the absolute error. It explains that how much error in forecasting data compared with the real values using formula (Razak, 2022).

$$MAPE = \frac{1}{n} \sum_{t=1}^{n} \frac{x_t - F_t}{x_t} \quad (5)$$

Where n is number of data, Xt shows the actual data, Ft indicates the forecasted data [11]

Previous Research

Some journals that have been published are related to forecasting:

in 2021 Dwi Harini conducted a study entitled Estimasi Jumlah Murid Baru Menggunakan Metode Forecasting. This study uses the MAD, MSE, and MAPE approaches. The data used is historical data on the number of students obtained for 9 years starting from the 2013-2014 school year until the 2021-2022 school year. By estimating or forecasting, helping the school, especially the AL-H****h Islamic Junior High School, know the number of new students accepted at the school in the 2022-2023 school year (Harini & Wahyuniar, 2021)

in 2021 Hazriani conducted a study entitled A Comparison of the Smoothing Constant Values Among Exponential Smoothing Methods in Commodity Prices Forecasting. This paper used the alpha (α) value in the range 0,1 to 0,9 and utilized the mean absolute percentage error (MAPE) and Mean Absolute Error (MAE) as the parameter to know the grade of prediction. In data training, the authors used Single Exponential Smoothing (SES) and Brown's Double Exponential Smoothing (B-DES) as methods to compare the results of prediction. It is addressed that forecasting with alpha (α) 0,1 is the most optimal values for Single Exponential Smoothing (SES) in this case with margin error 0,00036 of MAPE and 16,84 of MAE(Razak, 2022)

In 2021 Soffa Zahara conducted a study entitled Multivariate Time Series Based Consumer Price Index Data Forecasting Using Deep Learning. This study developed a CPI forecasting model with a new approach about using several types of deep learning algorithms, namely LSTM, Bidirectional LSTM, and Multilayer Perceptron with architectural variations of the number of neurons and epochs. Furthermore, this study adapt ADDIE model of Research and Development method. Based on the results, the best accuracy is obtained from the LSTM Bidirectional with 10 neurons and 2000 epoch resulting 3,519 of RMSE value. Meanwhile, based on the average RMSE value for the whole test, LSTM gets the smallest average of RMSE followed Bidirectional LSTM and Multilayer Perceptron with the RMSE value 4,334, 5,630, 6,304 respectively (Zahara, 2021).

In 2021 Ika Oktovianti conducted a study entitled Time Series Data Prediction Pattern Analysis using Support Vector Regression, Multilayer Perceptron, and Simple Linear Regression. The result of the study showed for Dataset 1, the ANN-Multilayer Perceptron have a better performance than Support Vector Regression (SVR) with MSE, MAE and RMSE values is 251.09, 11.45, and 15.84. Then for dataset 2, SVR-Linear has better performance than MLP with values of MSE, MAE and RMSE of 1839.93, 32.80, and 42.89. The dataset used to predict the number of permissions is dataset 2. The study also used the Simple Linear Regression (SLR) method to see the causal relationship between the number of licenses issued and licensing service officers. The result is that the relationship between the number of licenses issued and the number of service officers is less significant because there are other factors that affect the number of licenses (Ika Oktavianti, 2021).

In 2020 Is Mardianto conducted a study entitled Comparison of Rice Price Forecasting Using the ARIMA Method on Amazon Forecast and Sagemaker. This study aims to forecast rice prices in the Jakarta area using data held by PT FoodStation during the 2016-2018 data period. Rice price prediction is carried out for the next 30 days using the Auto Regressive Integrated Moving Average (ARIMA) method on the Amazon Forecast and Amazon Sagemaker platforms. The ARIMA model is a form of regression analysis that measures the strength of one dependent variable that is relatively influential on other change variables. The ARIMA model is a special type of regression model in which the

* Corresponding author

Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

dependent variable is considered stationary and the independent variable is the lag or previous value of the dependent variable itself and the error lag. ARIMA is a combination of auto-regressive and moving average processes. The final result obtained in this experiment is that the ARIMA model on Amazon Sagemaker cloud computing is superior when compared to Amazon Forecast. From the experimental results obtained the results of Amazon Sagemaker RMSE (313.379941) are smaller than Amazon Forecast (322.4118029). So it can be concluded that the ARIMA model run at Amazon Sagemaker is more accurate than Amazon Forecast for forecasting the price of rice for 30 days at the Cipinang Rice Main Market (Sistem, Mardianto, Gunawan, Sugiarto, & Rochman, 2021).

In 2018 Ajeng Nur Febriyanti conducted a study entitled The Triple Exponential Smoothing Holt-Winters Method for Forecasting the Number of Train Passengers in Java Island. This study aims to predict the number of train passengers PT. KAI on the island of Java for the next 12 months. The best model obtained for data on the number of train passengers on Java Island in 2013-2019 is Exponential Smoothing Holt-Winters with an additive model for parameters = 0.8991, = 0.0039 and = 0.4668 with MAPE = 3.768534 with very good forecasting ability (Febriyanti et al., 2019).

From the previous studies mentioned above, the difference between the latest and this study is to compare 2 methods consisting of Autoregressive Moving Average (ARIMA), and Holt-Winter's and find the best method from these 2 methods with data from the previous 5 years and predicted for the next 2 years.

3. METHOD

Research Data

The data used is data from the public health center from January 2018 to 2022 (5 years) Forecasting is carried out for outpatients only not for inpatients. Data from outpatients consists of 2 data, namely Direct Patient Visits (DPV) and Referral Patient Visits (RPV). The categories of Direct Patient Visit (DPV) data are in the form of visit data: General, Clinic, BPJS, Non BPJS (SKM), Non BPJS (Gakinda), while the categories of Referral Patient Visit (RPV) data are in the form of visit data: Puskesmas Referrals, Hospital Referrals, Doctor Referrals, Other Place Referrals, here the calculation is carried out only from the total number of visits overall from the category patient visit data.

Table 1
Data Indentification Process DPV and RPV

NO	MOON	2018		2019		2020		2021		2022	
		DPV	RPV	DPV	RPV	DPV	RPV	DPV	RPV	DPV	RPV
1	JANUARY	2236	821	2196	1084	2457	1416	3064	1903	2932	1843
2	FEBRUARY	2285	916	2365	1199	2690	1572	2710	1750	2540	1622
3	MARCH	2399	934	2502	1270	2857	1596	3097	2027	2677	1768
4	APRIL	2734	1174	2556	1230	2849	1667	2903	1752	2896	1976
5	MAY	2576	1101	2237	1123	2789	1656	3170	2123	2748	1768
6	JUNE	2609	1135	2190	1185	2688	1587	2233	1437	1846	1035
7	JULY	2091	1038	2120	1038	2161	1582	3257	2122	2744	1403
8	AUGUST	2358	1063	2157	1190	3025	1582	3281	2219	2617	1122
9	SEPTEMBER	2513	1288	2217	1186	2730	1582	3056	1995	2264	980
10	OCTOBER	2441	1270	2538	1128	2846	1582	3474	2244	2877	1064
11	NOVEMBER	2190	1186	2424	1120	2953	1582	3445	2267	2550	1730
12	DECEMBER	2207	1150	2565	1245	2858	1582	2793	1835	2622	1823

Stages of Research in General:

The research stages that will be carried out are as follows: Collection of historical data on visitor processing at the Public Health Center for the period January 2018 to December 2022, Identify the data patterns indicated by the visitor data, Forecasting the number of visits using the Arima and Holtwinters method,Calculating forecasting results with actual data in 2022, Comparing the smallest average value of visit data against the Arima and Holtwinters method, Results of selected methods used

* Corresponding author

Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

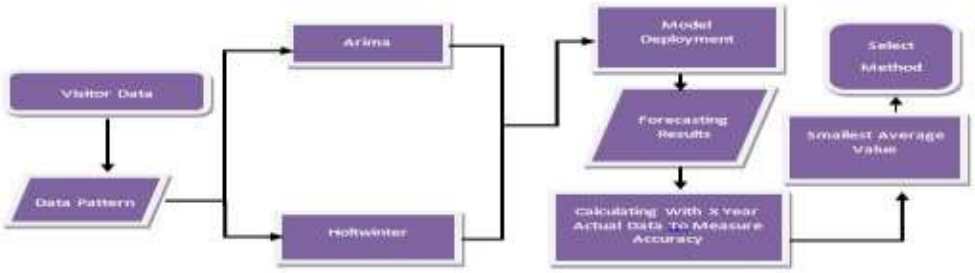
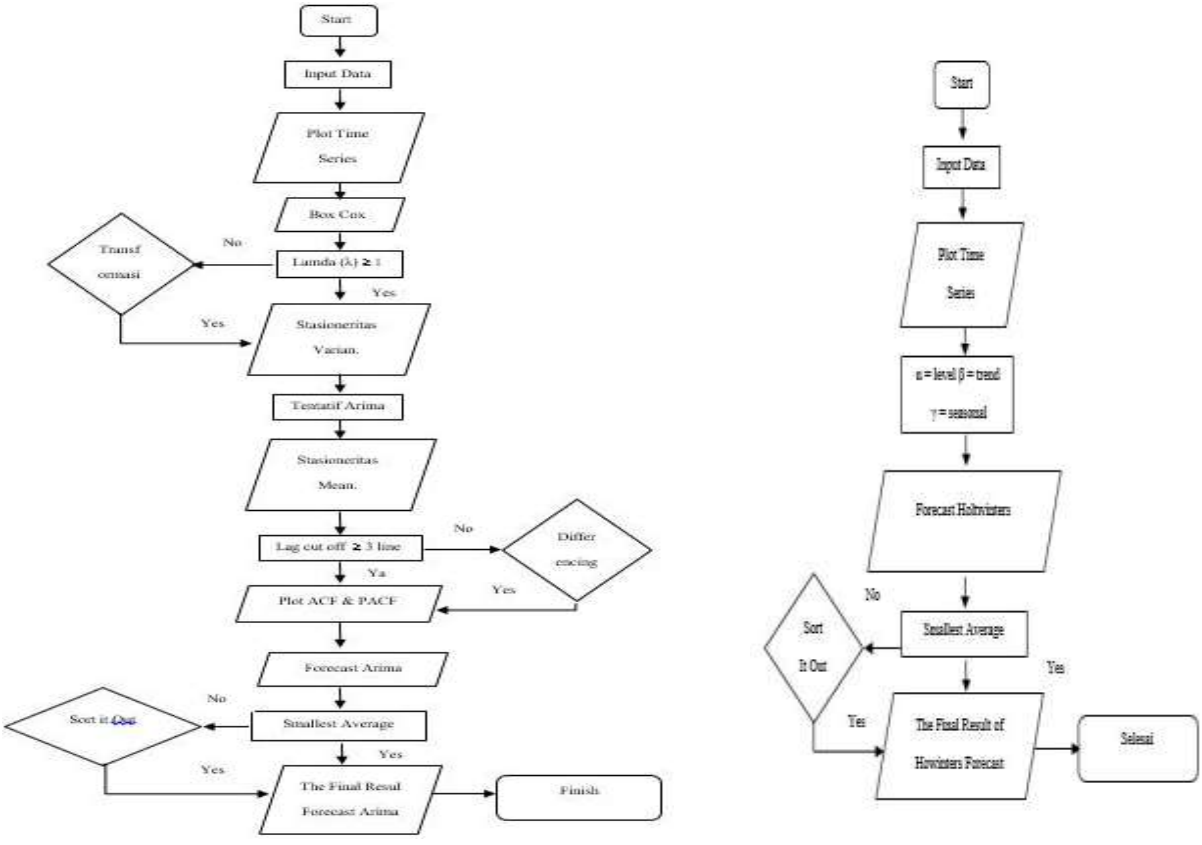


Fig. 1 Flowchart of General Research Stages

Stages of the Process

Arima : Enter the data to be predicted, Time series plot data results, Stationaryity test against variants **(**View lambda value in cox box, If ≥1 then move on to the next stage otherwise perform the transformation) ,Stationaryness test against mean (average), See the pattern of lines on the ACF plot, if lag cut off as much as ≥ 3 lines then do differencing, if not proceed to the next stage, Results of ACF and PACF plots, Input models of tentative arima are arima (1,1,0), arima (0,1,1), and arima (1,1,1). The result of the tentative model of arima, the arima that has the smallest average value that will be used in this model

Holtwinters : Enter the data to be predicted, Time series plot data results, Input the value of α = level β = trend γ = seasonal, Forecasting Process with Holtwinters method.The result of the alpha value model, the alpha that has the smallest average value that will be used in this model.



(a) Arima (b) Holtwinters

Fig. 2 Arima & Holtwinters Forecast Process Flowchart

* Corresponding author

Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

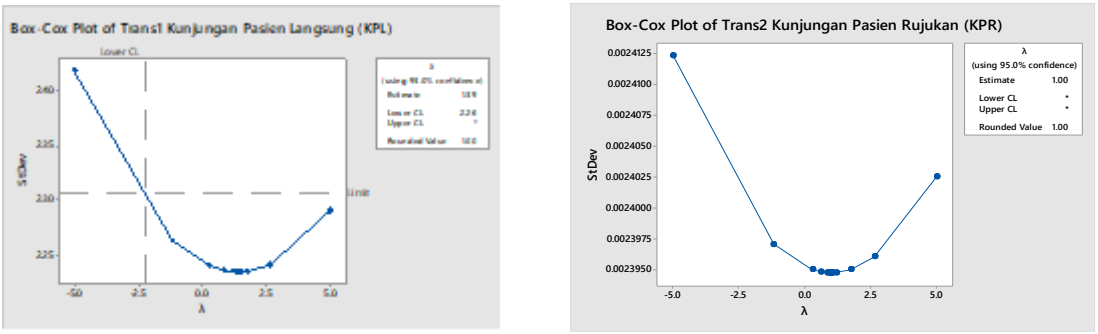
Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

4. RESULT

Forecasting Using the ARIMA Method

To test the variant, you can see the following Box Cox picture.

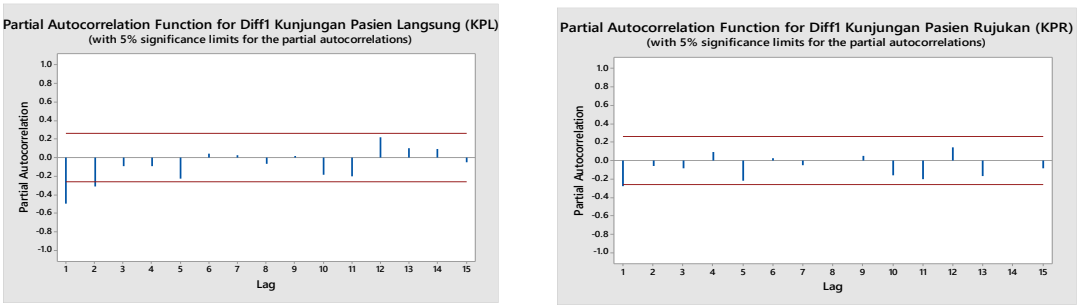
.



(a) (b)

Fig. 3. Box Cox Transformation of DPV and RPV

The result of the transformation from Fig. 3a (DPV) transformation was carried out 1 time while Fig. 3b (RPV) transformation was carried out 2 times to reach number 1, because the rounded value had reached number 1 in the two data, the next process was to see the stasion of the mean (average) by looking at the ACF and PACF tables. The mean is said to be non-stationary if the ACF plot has a lag that cu ts off as much as ≥3 pieces that are out of the red border.



(a) (b)

Fig. 4 Plot of PACF DPV and RPV *differencing* to 1

Fig. 4 shows the PACF plot of the data that the 1st differencing has performed. We can conclude that from the results of this 1st differencing the data has been stationary in the mean. This shows lag that cuts off as much as 2 pieces in Fig. 4a (DPV) while for Fig. 4b (RPV) it does not have a lag that cuts off. We can assume the amount of lag that is cut off to fill in the AR value.After the data analysis process is carried out, the next process is to determine a tentative model. From the results of the analysis, the tentative model ARIMA (p, d, q) must have a significance level close to zero value or have the smallest average, following the explanation of the data processing results:

Table 2
Arima Models

Final Estimates of Parameters											
Arima		Type		Coef		SE Coef		T-Value		P-Value	
DPV	RPV	DPV	RPV	DPV	RPV	DPV	RPV	DPV	RPV	DPV	RPV
1.1.0	1.1.0	AR 1	AR 1	-0.502	-0.343	0.115	0.125	-4.38	-2.75	0.000	0.008
		Constant	Constant	8.9	21.9	41.3	29.6	0.22	0.74	0.830	0.463
0.1.1	0.1.1	MA 1	MA 1	0.7015	0.388	0.0942	0.129	7.45	3.00	0.000	0.004
		Constant	Constant	4.3	14.1	11.7	18.1	0.36	0.78	0.717	0.440
		AR 1	AR 1	-0.066	0.039	0.190	0.365	-0.35	0.11	0.730	0.916
1.1.1	1.1.1	MA 1	MA 1	0.664	0.426	0.142	0.342	4.67	1.24	0.000	0.219
		Constant	Constant	4.6	13.3	13.1	17.2	0.35	0.77	0.728	0.444

* Corresponding author

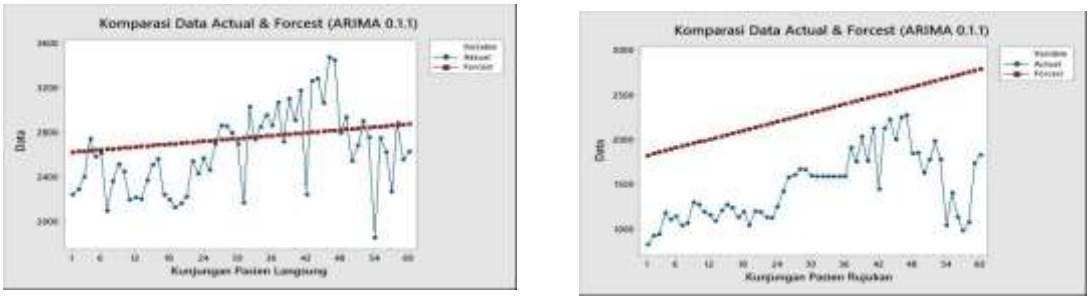
Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

Based on table 2 in the Direct Patient Visit (DPV) arima model above, there are 2 P-Value values with a value of 0.00, namely arima 1,1,0 and 0,1,1, but the value that is suitable for use is arima 0,1,1 because it has a smaller average signification value compared to arima 1,1,0.

Referral Patient Visit (RPV) arima model above the selected tentative arima model is 0,1,1 with a P-Value MA value of 1 0.0.04 because it has a smaller average signification value, just like in the Referral Patient Visit (RPV) arima model using the tentative arima model of 0,1,1.

The last stage carried out is to find the results of the MAPE value from the selected model arima 0,1,1 both from Direct Patient Visits (DPV) and Referral Patient Visits (RPV), the data used to find the ARIMA model, namely data from January 2018 to December 2022 and for test data starting from the 49th period to the 60th period or January 2022 to December 2022 within 1 year.



(a) (b)

Fig. 5 Results of Comparison of Arima DPV and RPV Processes

The results of forecasting direct and referral patient visits from January 2022 to December 2022 can be seen in table 3 and table 4:

Table 3
Arima Forecast Results (0,1,1) Direct Patient Visits (DPV)

Direct Patient Visits (DPV) January 2022 to December 2022						
Period	Actual	Forecast	Error	Absolute Value of Error	Square of Error	Absolute Values of Errors Divided by Actual Values.
T	At	Ft	At -Ft	| At -Ft|	(At -Ft)^2	| (At -Ft)/At|
49	2932	3126.22	-194.22	194.22	37721.4084	0.066241473
50	2540	3130.49	-590.49	590.49	348678.4401	0.232476378
51	2677	3134.75	-457.75	457.75	209535.0625	0.17099365
52	2896	3139.02	-243.02	243.02	59058.7204	0.083915746
53	2748	3143.28	-395.28	395.28	156246.2784	0.143842795
54	1846	3147.54	-1301.54	1301.54	1694006.372	0.705059588
55	2744	3151.81	-407.81	407.81	166308.9961	0.148618805
56	2617	3156.07	-539.07	539.07	290596.4649	0.205987772
57	2264	3160.34	-896.34	896.34	803425.3956	0.395909894
58	2877	3164.6	-287.6	287.6	82713.76	0.099965242
59	2550	3168.86	-618.86	618.86	382987.6996	0.242690196
60	2622	3173.13	-551.13	551.13	303744.2769	0.210194508
Totals	**31313**	**37796.11**	**-6483.11**	**6483.11**	**4535022.875**	**2.705896046**
Forecast Arima 0,1,1			**RMSE**	**MAD**	**MSE**	**MAPE**
			614.751	**540.259**	**377918.573**	**22.55%**

* Corresponding author

Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

In table 3 of the Direct Patient Visit (DPV) can be seen the results of the ARIMA method forecast (0,1,1). Then a calculation is made to get the MAPE value. And the MAPE value obtained is 22.55%, which is included in the category of sufficient / feasible

Table 4
Arima Forecast Results (0,1,1) Referral Patient Visits (RPV)

Referral Patient Visit (RPV) January 2022 to December 2022						
Period	Actual	Forecast	Error	Absolute Value of Error	Square of Error	Absolute Values of Errors Divided by Actual Values.
T	At	Ft	At -Ft	| At -Ft|	(At -Ft)^2	| (At -Ft)/At|
49	1843	2010.14	-167.14	167.14	27935.7796	0.090689094
50	1622	2024.25	-402.25	402.25	161805.0625	0.247996301
51	1768	2038.36	-270.36	270.36	73094.5296	0.152918552
52	1976	2052.47	-76.47	76.47	5847.6609	0.038699393
53	1768	2066.58	-298.58	298.58	89150.0164	0.16888009
54	1035	2080.69	-1045.69	1045.69	1093467.576	1.010328502
55	1403	2094.8	-691.8	691.8	478587.24	0.493086244
56	1122	2108.91	-986.91	986.91	973991.3481	0.87959893
57	980	2123.01	-1143.01	1143.01	1306471.86	1.166336735
58	1064	2137.12	-1073.12	1073.12	1151586.534	1.008571429
59	1730	2151.23	-421.23	421.23	177434.7129	0.243485549
60	1823	2165.34	-342.34	342.34	117196.6756	0.187789358
Totals	**18134**	**25052.9**	**-6918.9**	**6918.9**	**5656568.996**	**5.688380177**
Forcest Arima 0,1,1			**RMSE**	**MAD**	**MSE**	**MAPE**
			686.572	**576.575**	**471380.7497**	**47.40%**

In table 4 of the Referral Patient Visits (RPV) can be seen the results of the ARIMA method forecast (0,1,1). Then a calculation is made to get the MAPE value. And the MAPE value obtained is 47.40%, which is included in the category of sufficient / feasible

Forecasting Using the Holtwinters Method

At this stage, direct patient visit (DPV) and referral patient visits (RPV) data trials were carried out using Holtwinters to determine the MAD, MSE and MAPE values so that the smallest error values were known .

Table 5
Holtwinters DPV and RPV Models

Konstansta Smoothing	Mean Absolute Deviation (MAD)		Mean Squared Error (MSE)		Mean Absolute Percentage Error (MAPE)	
	DPV	RPV	DPV	RPV	DPV	RPV
α = 0:1 β = 0:1 γ = 0:1	249.5	218.5	96328.0	83354.7	9.7%	16.1%
α = 0:1 β = 0:1 γ = 0:2	250.6	224.3	99481.5	88165.2	9.7%	16.5%
α = 0:2 β = 0:3 γ = 0:1	215.0	192.2	71618.3	65262.2	8.4%	13.0%
α = 0:2 β = 0:1 γ = 0:1	213.6	193.2	69932.0	60485.2	8.4%	13.7%
α = 0:2 β = 0:2 γ = 0:2	215.8	198.8	73529.9	66229.5	8.4%	13.7%
α = 0:3 β = 0:2 γ = 0:1	202.0	174.4	66855.0	54608.8	7.9%	11.9%
α = 0:3 β = 0:1 γ = 0:2	203.7	178.2	68448.1	54625.6	8.0%	12.4%
α = 0:3 β = 0:1 γ = 0:1	200.8	175.2	64764.5	51627.4	7.9%	12.2%
α = 0:3 β = 0:3 γ = 0:1	205.0	176.8	69875.4	57016.5	8.0%	11.9%

* Corresponding author

Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

It can be seen in the table above that there are 2 of the same smallest 7.9% MAPE values from the DPV data, but the smoothing constant with a value of α = 0:3 β = 0:1 γ = 0:1 is selected because it has smaller MAD and MSE values, this forecasting means very good categories.

Almost similar to DPV data, data from RPV has the same 2 smallest MAPE values of 11.9%, but a smoothing constant with a value of α = 0:3 β = 0:2 γ = 0:1 which was selected because it has a smaller MAD and MSE value, this forecasting means very good categories.

Table 6
Holtwinters Results α = 0:3 β = 0:1 γ = 0:1 Direct Patient Visits

Direct Patient Visits (DPV) January 2022 to December 2022						
Period	Actual	Forecast	Error	Absolute Value of Error	Square of Error	Absolute Values of Errors Divided by Actual Values.
T	At	Ft	At -Ft	| At -Ft|	(At -Ft)^2	| (At -Ft)/At|
49	2932	3067.49	-135.49	135.49	18357.5401	0.046210778
50	2540	3108.33	-568.33	568.33	322998.9889	0.223751969
51	2677	3364.49	-687.49	687.49	472642.5001	0.256813597
52	2896	3437.08	-541.08	541.08	292767.5664	0.186837017
53	2748	3361.72	-613.72	613.72	376652.2384	0.223333333
54	1846	3049.85	-1203.85	1203.85	1449254.823	0.652139762
55	2744	3027.73	-283.73	283.73	80502.7129	0.103400146
56	2617	3413.89	-796.89	796.89	635033.6721	0.304505159
57	2264	3337.31	-1073.31	1073.31	1151994.356	0.474076855
58	2877	3601.58	-724.58	724.58	525016.1764	0.251852624
59	2550	3521.26	-971.26	971.26	943345.9876	0.380886275
60	2622	3356.88	-734.88	734.88	540048.6144	0.2802746
Totals	**31313**	**39647.61**	**-8334.61**	**8334.61**	**6808615.176**	**3.384082113**
Forecast Hotwinters α = 0:3 β = 0:1 γ = 0:1			**RMSE 254.489**	**MAD 200.800**	**MSE 64764.5**	**MAPE 7.90%**

In table 6 of the Direct Patient Visit (DPV) can be seen the results of the *Holtwinters* method forecast with a value of α = 0:3 β = 0:1 γ = 0:1, then a calculation is made to get the MAPE value. And the MAPE value obtained is 7.90%, which belongs to the excellent category

Table 7
Holtwinters Results α = 0:3 β = 0:2 γ = 0:1 Referral Patient Visits

Referral Patient Visit (RPV) January 2022 to December 2022						
Period	Actual	Forecast	Error	Absolute Value of Error	Square of Error	Absolute Values of Errors Divided by Actual Values.
T	At	Ft	At -Ft	| At -Ft|	(At -Ft)^2	| (At -Ft)/At|
49	1843	2010.08	-167.08	167.08	27915.7264	0.090656538
50	1622	2084.98	-462.98	462.98	214350.4804	0.285437731
51	1768	2217.33	-449.33	449.33	201897.4489	0.254145928
52	1976	2230.09	-254.09	254.09	64561.7281	0.128588057
53	1768	2284.28	-516.28	516.28	266545.0384	0.292013575
54	1035	2059.86	-1024.86	1024.86	1050338.02	0.990202899

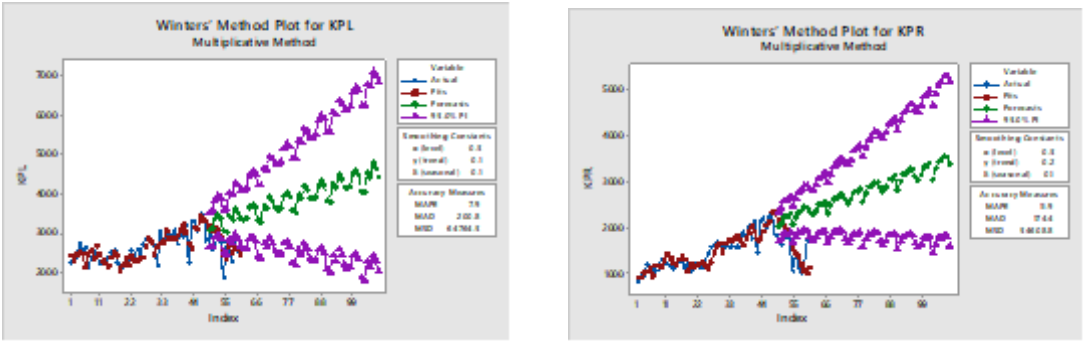
* Corresponding author

Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

55	1403	2210.81	-807.81	807.81	652556.9961	0.575773343
56	1122	2330.02	-1208.02	1208.02	1459312.32	1.076666667
57	980	2358.82	-1378.82	1378.82	1901144.592	1.406959184
58	1064	2432.28	-1368.28	1368.28	1872190.158	1.285977444
59	1730	2419.66	-689.66	689.66	475630.9156	0.398647399
60	1823	2320.46	-497.46	497.46	247466.4516	0.272879868
Totals	**18134**	**26958.67**	**-8824.67**	**8824.67**	**8186443.425**	**7.057948631**
Forecast Hotwinters			**RMSE**	**MAD**	**MSE**	**MAPE**
α = 0:3 β = 0:2 γ = 0:1			**233.685**	**174.400**	**54608.8**	**11.90%**

In table 7 of the Referral Patient Visits (RPV) can be seen the results of the Holtwinters method forecast with a value of α = 0:3 β = 0:2 γ = 0:1, then a calculation is made to get the MAPE value. And the MAPE value obtained is 11.90%, which belongs to the excellent category



(a) (b)

Fig. 6 Plotting Forcest Holtwinters Method DPV and RPV

From the picture above, it shows the results of the graph from *actual, fits* and *forecast* data with a smoothing constant value in the form of α = level β = trend γ = seasonal and accuracy values in the form of MAD, MSE and MAPE from direct patient visits (DPV) and referral patient visits (RPV) data.

Model Analysis

Based on the two models, namely ARIMA, and Holtwinters from direct patient visit (DPV) and referral patient visit (RPV) data, by comparing the average error value of each model, namely

Table 8
10 Results of Calculation of DPV & RPV Error values

	MAPE value		
Type	DPV	RPV	Information
ARIMA	22.55%	47.40%	Sufficient/Feasible
Holtwinters	7.90%	11.90%	Excellent

Based on Table 8 above, it can be said that the smallest error value is Holtwinters from Direct Patient Visit (DPV) data with MAPE 7.90% and from Referral Patient Visit (RPV) data with MAPE 11.90%. Which is where it is said to be an excellent forecasting category.

Analysis of Forecasting Results

Forecasting is carried out after knowing the analysis of several models that have the smallest *error* value where the chosen method is *holwinters*. At this stage, forecasting is carried out for 24 periods as follows:

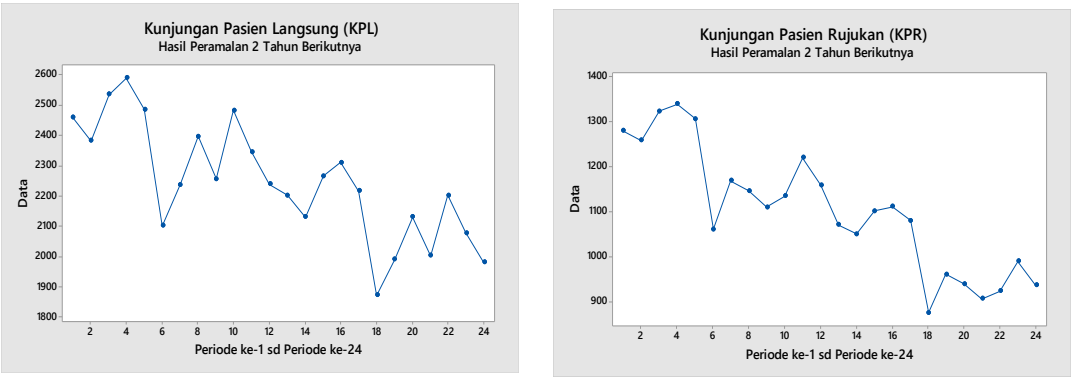
* Corresponding author

Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

Table 9
DPV & RPV 24 Next Period Forecasting Results

Forecast Direct Patient Visits (DPV) & Referral Patient Visits (RPV)						
Period (p)	Forecast		Lower		Upper	
	DPV	RPV	DPV	RPV	DPV	RPV
61	2459.53	1278.19	1967.51	850.829	2951.55	1705.56
62	2382.94	1257.00	1873.28	814.316	2892.60	1699.68
63	2536.77	1322.20	2006.72	861.808	3066.82	1782.59
64	2589.96	1338.27	2037.07	858.040	3142.85	1818.50
65	2486.91	1304.93	1909.03	802.993	3064.80	1806.87
66	2101.57	1059.83	1496.79	534.541	2706.34	1585.13
67	2237.39	1167.41	1604.08	617.327	2870.70	1717.49
68	2397.34	1145.62	1734.05	569.503	3060.62	1721.74
69	2256.37	1109.26	1561.86	506.017	2950.88	1712.49
70	2484.18	1133.27	1757.36	501.967	3211.01	1764.58
71	2346.43	1218.60	1586.34	558.395	3106.52	1878.80
72	2239.02	1158.09	1444.83	468.269	3033.21	1847.91
73	2201.59	1069.46	1372.57	349.390	3030.60	1789.53
74	2130.83	1048.89	1266.35	298.019	2995.31	1799.77
75	2266.00	1100.24	1365.48	318.066	3166.51	1882.41
76	2311.03	1110.42	1373.98	296.519	3248.07	1924.32
77	2216.65	1079.56	1242.63	233.545	3190.68	1925.58
78	1871.10	874.12	859.70	-4.356	2882.49	1752.60
79	1989.76	959.81	940.64	48.570	3038.88	1871.06
80	2129.54	938.84	1042.38	-5.449	3216.69	1883.12
81	2001.95	905.98	876.47	-71.594	3127.43	1883.55
82	2201.41	922.38	1037.35	-88.707	3365.47	1933.46
83	2076.78	988.25	873.91	-56.544	3279.65	2033.04
84	1979.23	935.67	737.34	-143.012	3221.12	2014.36
Total (t)	**53894.2**	**26426.2**	**33967.72**	**9118.452**	**73820.8**	**43734.14**
Rata-rata Perbulan (t/p)	**2245.59**	**1101.09**	**1415.321**	**379.9355**	**3075.866**	**1822.2558**



(a) (b)

Fig. 7 Forecasting Results Over the Next 2 Years

Based on Fig. 7, it shows a forecasting chart for 24 periods or 24 months over a period of 2 years starting from January 2023 to December 2024 using the *holwinters* model from both Direct Patient Visit (DPV) and Referral Patient Visit (RPV) data.

* Corresponding author

Journal of Computer Networks, Architecture and High Performance Computing
Volume 5, Number 1, January 2023
https://doi.org/10.47709/cnahpc.v5i1.2008

Submitted : January 17, 2023
Accepted : January 22, 2023
Published : January 22, 2023

5. CONCLUSION

The forecasting results from patient visits at public health centers using the ARIMA method have a MAPE value in the Direct Patient Visit (DPV) data of 22.55% and a MAPE value in the Referral Patient Visit (RPV) data of 47.40%, and those using the Holtwinters method which have a MAPE value on Direct Patient Visits (DPV) of 7.90% and a MAPE value on Referral Patient Visits (RPV) of 11.90%. of the two forecasting method results described, the chosen method is the Holtwinters method because it has the smallest error value. Then the results of forecasting the total visitors from the selected method, namely holwinters, were maximized in the next 24 months amounting to 53894.2 visitors with an average monthly of 2245.59 visitors.In order for this research to develop, the author hopes that forecasting in public health centers can be predicted also for inpatients and also data from outpatients is not only a combination of the total number calculated as in this article but per subsection such as direct patient visit categories in the form of visit data: General, Clinic, BPJS, Non BPJS (SKM), Non-BPJS (Gakinda) and categories of Referral Patient Visit (RPV) data in the form of visit data: Puskesmas Referrals, Hospital Referrals, Doctor Referrals & Other

6. ACKNOWLEDGMENT

Praise and gratitude I pray for the presence of Allah SWT because for his grace I and the team were able to complete this journal and I as a representative would like to thank crue ITB Ahmad Dahlan a lot of input in making this journal and does not forget also to family, colleagues and friends who have given a lot of motivation.

7. REFERENCES

Darmawan, D. S., Nugraha, A. T., & Wahyudi, R. (2022). *Peramalan Deret Berkala dalam Mengurangi Bullwhip Effect pada Sistem Rantai Pasok Komoditas Sawit pada PTPN VII , Lampung , Indonesia (Forecasting Periodic Series to Reduce the Bullwhip Effect in Palm Oil Commodity Supply Chain System in PTPN VII , Lampu*. *5*(2), 331–341.

Febriyanti, A. N., Azizah, N., Rifai, K., Statistika, P., Matematika, F., & Alam, P. (2019). *Metode Triple Exponential Smoothing Holt-Winters untuk Peramalan Jumlah Penumpang Kereta Api di Pulau Jawa*. 152–158.

Fiqih Akbari, Ikhwanul Muslimin, 2018. (2018). *Optimasi Parameter Pemulusan Algoritma Brown Menggunakan Metode*. *2*(1), 307–314.

Harini, D., & Wahyuniar, L. S. (2021). *Estimasi Jumlah Murid Baru Menggunakan Metode Forecasting*. *2*, 64–70. https://doi.org/10.37640/jim.v2i2.1025

Ika Oktavianti, 2021. (2021). *JURNAL RESTI Analisis Pola Prediksi Data Time Series menggunakan Support Vector*. *1*(10), 282–287.

Ilham 2019. (n.d.). *Comparison of Forecasting the Number of Outpatients Visitors Based on Naïve Method & Exponential Smoothing Comparison of Forecasting the Number of Outpatients Visitors Based on Naïve Method & Exponential Smoothing*.

Mahfudhoh, 2020. (2020). *Pengaruh Kualitas Pelayanan Terhadap Kepuasan Pasien Pada Rumah Sakit Umum Daerah Kota Cilegon*. *8*(1), 39–46.

Novitaningsih, 2019. (2019). *1 Analisis Faktor- faktor…, Novitaningsih, Fakultas Ilmu Kesehatan UMP, 2019*. 1–5.

Pratama, D. A., Hidayati, S., Suroso, E., & Sartika, D. 2020. (2020). *Analisis Peramalan Permintaan dan Pengendalian Persediaan Bahan Baku Pembantu pada Industri Gula (Studi Kasus PT . XYZ Lampung Utara) Analysis Forecasting Dem & Control of Supply Raw Materialsi In The Sugar Industry (Case Study of PT . XYZ North Lampun*. *20*(2), 148–160.

Razak, M. (2022). *JURNAL RESTI A Comparison of the Smoothing Constant Values Among Exponential*. *5*(158), 4–9.

Sistem, R., Genta, M., Shandi, A., Adhitama, R., & Arifa, A. B. (2021). *Penerapan Long Short Term Memory untuk Memprediksi Flight Delay*. *1*(10), 1–3.

Sistem, R., Mardianto, I., Gunawan, M. I., Sugiarto, D., & Rochman, A. (2021). *Perbandingan Peramalan Harga Beras Menggunakan Metode ARIMA pada*. *1*(10).

Sungkawa, I., & Megasari, R. T. (n.d.). *NILAI RAMALAN DATA DERET WAKTU DALAM SELEKSI MODEL PERAMALAN VOLUME PENJUALAN PT SATRIAMANDIRI CITRAMULIA Iwa Sungkawa ; Ries Tri Megasari*. *2*(2), 636–645.

Yanto, M. (2021). *Jurnal resti*. *1*(10), 1–2.

Zahara, S. (2021). *Peramalan Data Indeks Harga Konsumen Berbasis Time Series*. *1*(10), 24–30.

* Corresponding author