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Untuk
1. Menulis Artikel Ilmiah dengan Judul "FORECASTING OF INDONESIA'S POST-COVID-19 EXPORT VALUE USING SARIMA ", pada tanggal 01 September 2022 s/d 09 Februari 2023 dengan Jumlah Dana Rp.500,000,- .
2. Menulis laporan setelah melaksanakan kegiatan dimaksud.

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FORECASTING OF INDONESIA'S POST-COVID-19 EXPORT VALUE USING SARIMA

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Abstract: The Covid-19 pandemic that entered Indonesia in early 2020 has more or less had an impact on Indonesia's economic growth. One of the important factors that are indicators of the ups and downs of the economy, especially in Indonesia, is export activities. The Covid-19 pandemic has had quite an impact on the total value of Indonesia's exports, especially from 2020 to 2021. The fluctuation in the export value has made researchers interested in forecasting the total export value, especially after the Covid-19 pandemic. Forecasting of the total value of exports can certainly be used as a reference for the government to determine the direction of policies toward export activities to increase Indonesia's economic growth. Export values usually have seasonal patterns. One of the time series analyses that can be applied to data on total export values is the SARIMA model. Especially after Covid-19, no related studies have been found that use the SARIMA model in predicting the total value of exports in Indonesia. Using reference data on the total export value of Indonesia from January 2019 to March 2022, the best model was obtained and met the assumptions of residual normality and residual freedom, namely the ARIMA model (0,1,1)(0,0,1)12 without an intercept with an AICc value of 675.5562. Forecasting the total export value from April 2022 to March 2023 using this model indicates that the export value will increase slowly but decrease in September 2022 and January 2023. For the next research this method can be develop to forecast with longer data period as the reference of the data reseach so the forecasting value can be better.

1. INTRODUCTION

The presence of the Covid-19 pandemic originating from China at the end of 2019 impacted the world economy. The slowdown in the world economy causes a decline in the economic growth of several developing countries. Indonesia is one of the countries that have felt the impact. The Minister of Finance explained that the slowdown in world commerce has significantly impacted Indonesia's economic growth, in addition to having an impact on

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investment and government spending, which also affect to value of exports and imports. Then, China as one of the centers of the world economy has a significant impact on Indonesia's economic growth. Research by Nasution et al [1] found that a slowdown of 1% of the Chinese economy caused a decrease in the economic growth in Indonesia by 0.09%. In BPS data, the economic growth in 2019 occurred a slowdown compared to the previous year, which was 0.15%.

In order to increase the country's economic growth after the issuance of the covid-19 pandemic statement as endemic in Indonesia, a special strategy is needed by stakeholders, especially in the economic sector. The decisions to implementing the Indonesian economy require various sight and overview of opportunities from different points of view. In addition to the investment, government spending, and imports, among the aspects that have a major influence on Indonesia's economic growth are export activities, both oil and gas and non-oil and gas goods. Export is an important benchmark to determine how much a country's economic growth [2]. Export is the sale of commodities to other countries to expect payments in the form of foreign exchange [3].

Previous studies have revealed that in the long term, export and import activities have a significant effect on economic growth [4]. Likewise, research by Mustika et al [5] concluded that crude oil exports affect economic growth in Indonesia. According to Pramudita and Yucha [6], export-import activities in Indonesia and China declined in January and February 2020 and began to improve afterward although it did not recoup the losses suffered by the country and did not cause too high inflation. Nasution et al [1] state that the Central Statistics Agency (BPS) released about the decline in Indonesia's oil and gas and non-oil and gas exports due to the Covid-19 pandemic centered in China, which is the largest importer of crude oil in the world. It means that the increase in international trade activities carried out by the state will indirectly increase domestic economic growth.

An overview of Indonesia's export activities in the future can be made through a forecast obtained based on an overview of current data. Predictions made on the amount of export value can be used as a strategy design for stakeholders and implementers of a national economy to obtain measures that provide a way out for improving the quality and quantity of Indonesia's exports in the future, especially after the Covid-19 pandemic.

Research related to export value forecasting in Indonesia has previously been conducted by Cynthia and Mastur [7] using ARIMA and Bootstrap with model results ARIMA (1,1,2). Gunaryati [8] predicted Indonesian export-import data using the ARIMA-Neural Networks combined method with modeling for the export data obtained, namely ARIMA (1,1,12) with an error value of 0.971 and the combined results of the method with NN resulting in an error of 0.046010. Lailiyah [9] applied the ARIMA model and obtained the best model ARIMA (1,1,0). Furthermore, Dave et al [10] used the ARIMA-LSTM method with the best model criteria using MAPE, which was 7.78% and RMSE of $1.66x10^{13}$.

In forecasting time series data, especially for export data in addition to the methods already used above, you can also use the SARIMA (Seasonal ARIMA) method because the size of the export value can be in the form of a certain seasonal pattern. Research using the SARIMA model for forecasting export data is rarely used, especially in Indonesia. KM et al., [11] used the SARIMA model to forecast leather exports in India. Meanwhile, in Indonesia, the SARIMA model has only been applied to inflation forecasting and export forecasting for certain goods [12].

Based on a review related to the decline of the Indonesian economy after the Covid-19 pandemic and the magnitude of the influence of exports on economic growth, this study will be carried out forecasting the value of Indonesia's exports as a whole in both the oil and gas and non-oil and gas sectors. The model approach taken is SARIMA with forecasting the value of exports that will be expected for April 2022 to March 2023 based on information on Indonesia's export data before the Covid-19 pandemic, namely January 2019 to the covid-19 endemic period, namely March 2022. From the results of this forecasting, it can become a guide in increasing Indonesia's rapid economic growth, especially for stakeholders of the national economy.

2. LITERATURE REVIEW

2.1. ARIMA (Autoregressive Integrated Moving Average)

The ARIMA method is one of the methods in time series analysis for forecasting future data. This method is also called the Box Jenkins method. The ARIMA method is a development of the ARMA (Autoregressive Moving Average) method where if the data is not stationary at the level, then the data must be stationed through a differencing process so that the model becomes an ARIMA model [11]. Data in the ARIMA method must accomplish stationarity, autocovariance, autocorrelation, and partial autocorrelation assumptions. Furthermore, to get optimal forecasting, time series data must achieve the white noise in residual and normal distribution assumptions [7]. ARIMA is formed based on three components, first autoregressive (q), second integrated (d), and third moving average (p). The autoregressive (q) component can be determined based on the PACF (Partial Autocorrelation Function) plot, the integrated (d) component can be determined from the level of data at which level shows stationary data, then the moving average (p) component can be determined from the ACF (Autocorrelation Function) plot [9]. From the three components, the ARIMA model (p,d,q) can be formed as follows:

$$\left(\mathbf{1}-\boldsymbol{B\phi_1}-\boldsymbol{B^2\phi_2}-\cdots-\boldsymbol{B^p\phi_p}\right)(\mathbf{1}-\boldsymbol{B})^{\boldsymbol{d}}\boldsymbol{Z_t}=\boldsymbol{\mu}+\left(\mathbf{1}-\boldsymbol{B\theta_1}-\boldsymbol{B^2\theta_2}-\cdots-\boldsymbol{B^q\theta_q}\right)\boldsymbol{\varepsilon_t} \qquad (1)$$

Each of the above components if detailed is $\left(1-B\phi_1-B^2\phi_2-\cdots-B^p\phi_p\right)$ as an autoregressive component with order p, $(1-B)^d$ as a differencing component with order d, and $\left(1-B\theta_1-B^2\theta_2-\cdots-B^q\theta_q\right)$ as a moving average component with order q.

2.2. SARIMA (Seasonal Autoregressive Integrated Moving Average)

One of the developments of the ARIMA method is SARIMA. Sarima is an ARIMA model applied to data with seasonal trend and non-stationary indication. The form of the SARIMA model compiled by Box and Jenkins in KM et al [11] is

$$\boldsymbol{\Phi_P}(\boldsymbol{B^s})\boldsymbol{\phi}(\boldsymbol{B})(\mathbf{1}-\boldsymbol{B^s})^{\boldsymbol{D}}(\mathbf{1}-\boldsymbol{B})^{\boldsymbol{d}}\boldsymbol{Z_t}=\boldsymbol{\mu}+\boldsymbol{\Theta_Q}(\boldsymbol{B^s})\boldsymbol{\theta}(\boldsymbol{B})\boldsymbol{\varepsilon_t} \qquad (2)$$

The results of the SARIMA model can be written as ARIMA $(p,d,q)(P,D,Q)_s$. The autoregressive component is denoted by the polynomial $\phi(B)$ with the order p. The moving average component is denoted by $\theta(B)$ with the order q. Furthermore, the seasonal components for the autoregressive and moving averages respectively are $\Phi_P(B^s)$ and $\Theta_Q(B^s)$ with orders P

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and Q. While the regular differencing and differencing components of the seasonal components are denoted with orders d and D. Order s indicates the order of seasonal factors on the data.

2.3. AIC (Akaikie's Information Criteria)

AIC is a statistic used to identify and evaluate statistical models [13]. Using these criteria, the model with the minimum AIC value was chosen to be the most suitable model among several possible models [11]. However, AIC does not mean determining the correct model, because the best model does not mean the actual model. The best model among possible models is the one that gives the closest approximation of the actual model [13]. The AIC value is determined by:

$$\boldsymbol{AIC = -2ln\,L + 2K} \tag{3}$$

Where L is the Gaussian likelihood function, K is the number of presumed parameters that include in the model (many variables + 1 intercept).

2.4. AICc (Second Order of Akaikie's Information Criteria)

Mazerolle [14]mentioned that Saigura developed the second order of Akaikie's Information Criteria otherwise known as AICc for a small sample size.

$$\boldsymbol{AIC_c = -2ln\,L + 2K + \frac{2K(K+1)}{(n-K-1)}} \tag{4}$$

The value of n is number of samples. If the sample size increases, then the value $\frac{2K(K+1)}{(n-K-1)}$ will be close to zero so that the AICc value is close to the AIC value.

3. METHODOLOGY

This study used secondary data derived from the official website of the ministry of commerce https://satudata.kemendag.go.id/. The in-sample data used is Indonesia's total oil and gas and non-oil and gas exports monthly from January 2019 to March 2022. Data collection was chosen from 2019 on the grounds of economic conditions before covid-19 until 2022 when the pandemic situation was over and declared endemic.

The procedure to forecast the value of Indonesia's exports using time series data analysis is as follows.

1. Explore data with descriptive analysis to see patterns and trends in the movement of Indonesia's export value from January 2019 to March 2022 based on charts.
2. Testing the stationer of data with the ADF (Augmented Dickey-Fuller) test. The null hypothesis in the ADF test indicates that the export data have unit roots (the data is not stationer). The alternative hypothesis shows that the export data does not have unit roots (the data is stationer). If the data has been stationer then the analysis can be continued. If the data is not stationer then the data is transformed using differencing techniques until stationer data is obtained.

3. The stationer data is applied to the corresponding time series data analysis model. In this study, a model with the SARIMA (Seasonal Autoregressive Integrated Moving Average) was used which is a development of the ARIMA (Autoregressive Integrated Moving Average) model.
4. The selection of the best model uses the AICc criteria which is a development of the AIC (Akaikie's Information Criteria). Some of the best model candidates are collected then the model with the smallest AICc as the best model.
5. The model candidates selected as the best models will be tested for assumptions with a residual normality test and a residual freedom test. If these two assumptions are accomplished then the model is feasible to apply to the data to forecast the value of the export data for the next period.
6. Measures the level of accuracy of the model in estimating which is measured through error values or errors MAE (Mean Absolute Error) and MAPE (Mean Absolute Percentage Error).
7. Export value forecasting will be calculated for the period April 2022 to March 2023 using the best model that already accomplished the model's assumption testing.

4. RESULTS AND DISCUSSION

Exports are one of the important indicators affecting economic growth [15]. Exports can generate foreign exchange that can be used for foreign transactions of a Country. This activity requires mutual cooperation with each other between countries so that natural conditions and political conditions greatly affect, including national disasters that occur in a country.

The export value in Indonesia from January 2019 to March 2022 in Figure 1 shows that the export value in the range of 14,000 from 2019 to 2020 and began to increase until 2022. There was a significant decline in the second quarter of 2019 and 2021 and the first quarter of 2022. The very sharp decline at the beginning of 2020 for approximately three months shows that the COVID-19 pandemic has had a major impact on export activities. Furthermore, Indonesia's exports began to recover and increased from April 2020 to March 2022. There is a seasonal pattern that occurs in the first or second quarter of each year. The pattern of declining export values indicates an indication of non-stationary data.

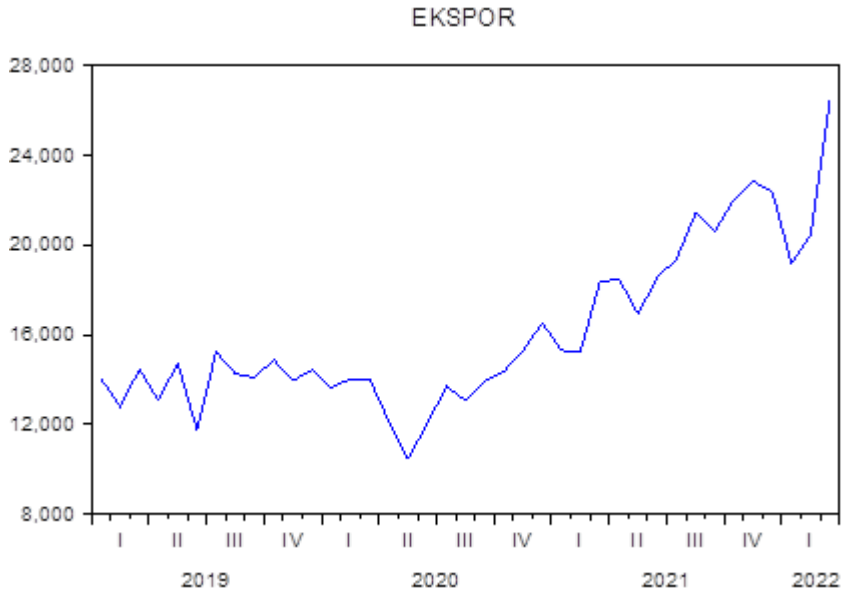


Figure 1. Plot of export value in Indonesia (million US$) period 2019-2022

To examine the stationerity of the export data, an ADF (Augmented Dickey-Fuller) test was performed. Table 1 shows the results of the ADF test of export data with a null hypothesis indicating that the export data have unit roots (non-stationary data). From the test results, a statistical value greater than the critical value or probability value greater than the level of significance (5%). It was obtained in testing without trends and intercepts, without trends with intercepts, and with trends and intercepts. On the ADF test it was concluded that it failed to reject the null hypothesis in other words the export data was not stationary.

Table 1. Result of ADF test for export value

		Without Trends and Intercepts		Without Trends With Intercepts		With Trends And Intercepts	
		t-Statistics	Probability	t-Statistics	Probability	t-Statistics	Probability
Augmented Dickey-Fuller test Statistic		1,722208	0,9773	0,638414	0,9889	-1,333429	0,8631
Test critical values:	1% level	-2,630762		-3,626784		-4,234972	
	5% level	-1,950394		-2,945842		-3,540328	
	10% level	-1,611202		-2,611531		-3,202445	

Probability base on MacKinnon (1996) one-side p-value

Furthermore, to further see the other components contained in the export data, it can be examined through the parsed plot of the export data shown in Figure 2. Based on the results of the export data plot if divided according to the components contained in the data, it can be seen that the data has elements of exponential trends and seasonal trends. Because the data contains trends, seasonality, and also random components, the data is suitable to be modeled with SARIMA.

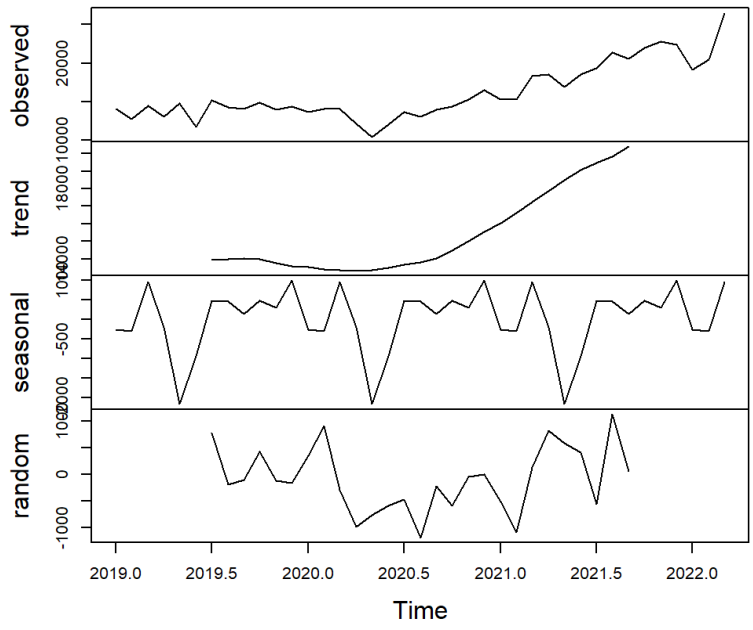


Figure 2. Components from export value in Indonesia period 2019-2022

Non-stationary export data must be transformed with differencing techniques to be stationary before being formed into a model. The results of the first differencing obtained data stationer. So that it can be analyzed to a time series model. The form of the data of the results of the first level of difference can be seen in Figure 3.

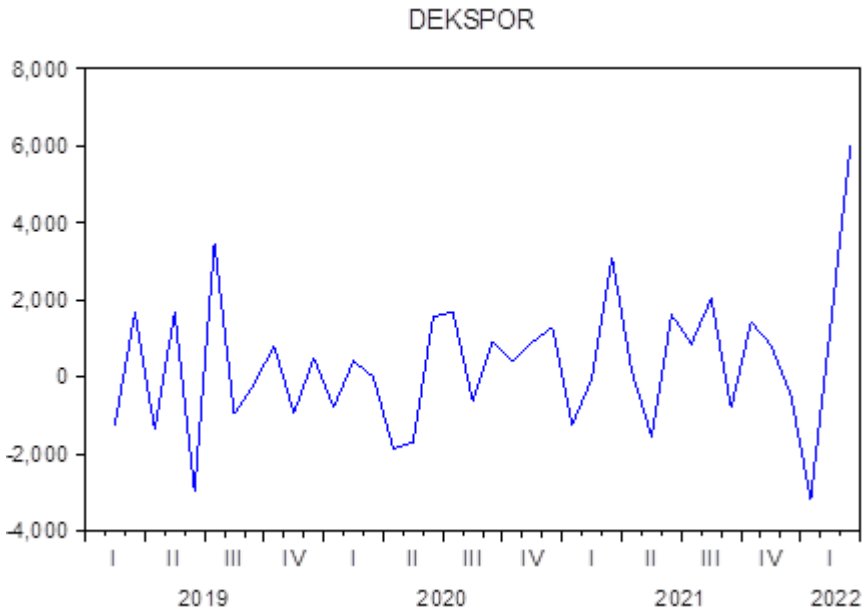


Figure 3. Plot of first differencing of export value

Export data on the first differencing based on the plot looks stationer based on the spread of data that is around zero. For further testing, the first differencing accuracy of the export data can be seen in the ADF test. The ADF test results in Table 2 of the first differencing export data in a statistical value that was smaller than the critical value or probability value less than the level of significance (5%) so it was decided to reject the null hypothesis. In other words, it can be concluded that the export data of the first differencing are already stationer.

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Table 2. Result of ADF test for first differencing of export value

		Without Trends and Intercepts		Without Trends With Intercepts		With Trends And Intercepts	
		t-Statistics	Probability	t-Statistics	Probability	t-Statistics	Probability
Augmented Dickey-Fuller test Statistic		-4,937261	0,0000	-5,278419	0,0001	-5,572950	0,0003
Test critical values:	1% level	-2,630762		-3,626784		-4,234972	
	5% level	-1,950394		-2,945842		-3,540328	
	10% level	-1,611202		-2,611531		-3,202445	

The best model is taken from several possible model candidates and selected values with the smallest AICc. Table 3 lists 16 possible model candidates as the best models. The model with the smallest AICc was obtained on the ARIMA model $(0,1,1)(0,0,1)_{12}$ without interception with an AICc value of 675.5562, so this model was selected as a suitable model for export data. The ARIMA model $(0,1,1)(0,0,1)_{12}$ is the best model for stationary export data at the first differencing, with an autoregressive order 0 and a moving average order 1 while the seasonal component in the 12 months with an autoregressive order 0, first differencing, and moving average order 1.

Table 3. Model candidates of export value

Model Selected	Exogenous Variable	AICc
ARIMA $(0,1,0)(0,0,1)_{12}$	Without Intersept	676,2671
ARIMA $(0,1,1)(0,0,1)_{12}$		675,5562
ARIMA $(0,1,1)(1,0,0)_{12}$		675,8044
ARIMA $(0,1,1)(1,0,1)_{12}$		678,0586
ARIMA $(1,1,0)(0,0,1)_{12}$		676,5589
ARIMA $(1,1,1)(0,0,1)_{12}$		677,9591
ARIMA $(0,1,2)(0,0,1)_{12}$		677,8948
ARIMA $(0,1,0)(0,0,1)_{12}$	With Intersept	677,8507
ARIMA $(0,1,1)(0,0,1)_{12}$		676,1757
ARIMA $(0,1,1)(1,0,0)_{12}$		676,5837
ARIMA $(0,1,1)(1,0,1)_{12}$		678,8091
ARIMA $(1,1,0)(1,0,0)_{12}$		678,2335
ARIMA $(1,1,0)(0,0,1)_{12}$		677,8402
ARIMA $(1,1,1)(0,0,1)_{12}$		678,6855
ARIMA $(0,1,2)(0,0,1)_{12}$		678,5975
ARIMA $(1,1,2)(0,0,1)_{12}$		681,3995

Based on the results of the best model ARIMA $(0,1,1)(0,0,1)_{12}$ testing of model assumptions was carried out. The necessary tests are the residual normality test and the residual freedom test. Figure 4 shows the test results of assumptions for the ARIMA model $(0,1,1)(0,0,1)_{12}$. The residual ACF plot does not cross the line and the residual Q-Q plot indicates the residual spread around the linear line, which indicates the assumption of normality for the residual model has been met. Furthermore, the Ljung-Box test for residual freedom testing (independency residuals) was obtained and the p-value for all lags was above the value of 0.05. It was concluded that the assumption of residual freedom was also met. The ARIMA model $(0,1,1)(0,0,1)_{12}$ already meets both model assumptions, namely the residual normality test and the residual freedom test so this model can be used to estimate the value of Indonesia's

exports in the next few periods. The error rate of the model in estimating values can be measured through MAE (Mean Absolute Error) and MAPE (Mean Absolute Percentage Error). MAE shows the average error of the actual value with the predicted value. The MAE value in this model is 1129.507 means the average error estimates the total export value of US$ 1129.507. The MAPE value is about 7.1084 where the MAPE value < 10% indicates that is a very good prediction.

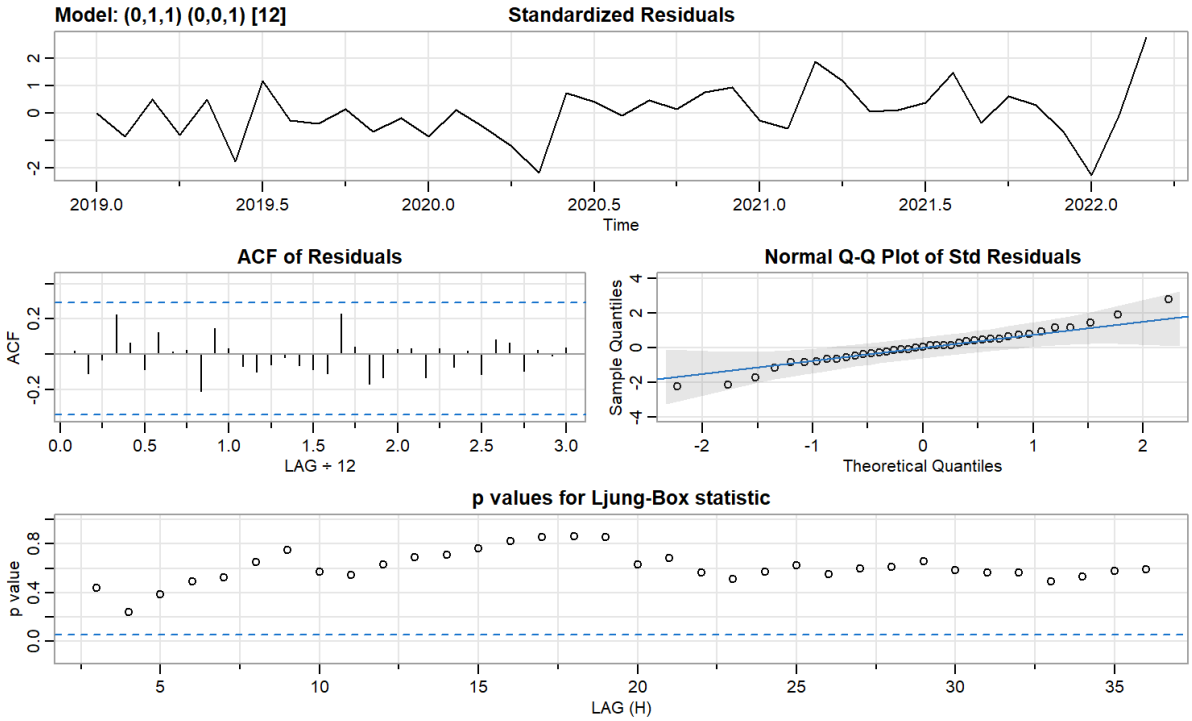


Figure 4. Result of assumption tes for ARIMA $(0,1,1)(0,0,1)_{12}$

The forecasting of Indonesia's exports for 12 periods from April 2022 to March 2023 is shown in figure 5. The value of exports was predicted to increase gradually. But there is a significant decline in September 2022 and January 2023. The lowest estimated export value is predicted in January 2023 at 24930.02 and the highest estimated export is predicted in March 2023 at 28117.30. This downward trend is predicted based on seasonal patterns that occur from 2019 to early 2022 which shows a significant decline in exports in the middle and beginning of the year.

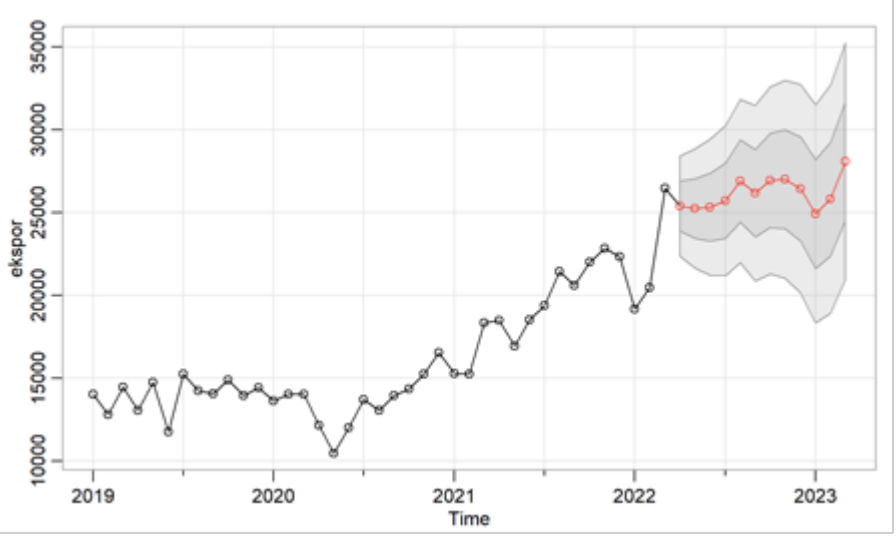


Figure 5. Prediction plot of export value April 2022 - March 2023

If the prediction of export value from April 2022 to March 2023 is shown in the unit number of US$ million, details will be obtained as presented in Table 4. The pattern obtained in the results of the alleged export value in this period is not much different from the seasonal trend that occurred in the previous period. The results of estimating the value of exports in April-June 2022 have a considerable difference when compared to the actual value. However, in July-August 2022, the difference in the prediction of export value is not so significant from the actual export value. It is necessary to conduct further research on what factors caused the difference in the value of conjecture that occurred in the period. Theoretically, this can happen due to unpredictable events such as wars, disasters, special days, and so on.

Table 4. Prediction of export value April 2022 - March 2023

Period	Prediction of export value	Increasing or decreasing	Actual export value*	Increasing or decreasing	Difference between actual and prediction value
March 2022	-	-	26497.48		
April 2022	25409.97	-	27322.28	-	-1912.31
Mei 2022	25251.27	decreasing	21509.83	decreasing	3741.44
June 2022	25321.84	increasing	26150.12	increasing	-3828.85
July 2022	25729.36	increasing	25563.20	decreasing	166.16
August 2022	26915.96	increasing	27862.09	increasing	-946.13
September 2022	26181.70	decreasing	-	-	
Oktober 2022	26947.25	increasing	-	-	
November 2022	27022.71	increasing	-	-	
Desember 2022	26466.32	decreasing	-	-	
January 2023	24930.02	decreasing	-	-	
February 2023	25818.67	increasing	-	-	
March 2023	28117.30	increasing	-	-	

*data update from https://satudata.kemendag.go.id/data-informasi/perdagangan-luar-negeri/ekspor-impor per 24 October 2022

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Furthermore, the results of estimating the export value have decreased which needs to be watched out for in January 2023. This can be used as a guide in making desicion of policy by the government to avoid a more drastic decline in exports for that period through preventive measures from both export policies and other economic policies.

5. CONCLUSION

Export activities are one of the important indicators of economic growth, especially in Indonesia. The Covid-19 pandemic outbreak that occurred in the 2020-2021 period has become a very significant caused of fluctuations in economic growth. For a more mature economic recovery and to set a policy direction for export activities, an estimate of the value of exports in Indonesia will be carried out from April 2022 to March 2023. The best model obtained from export data for the period January 2019 (before covid-19) to March 2022 (post-covid-19) is ARIMA $(0,1,1)(0,0,1)_{12}$ without an interception with an AICc value of 675.5562. From this model, it is obtained to estimate the value of exports which have increased gradually but experienced a significant decline in September 2022 and January 2023. The estimates of decline in the value of exports in September 2022 and January 2023 is expected to be a guideline for the government in setting economic policies, especially export activities to avoid economic deficits that harm the country. From this research it can be suggestion for the next researcher to develop the forecasting with longer data period as the reference of the data reseach so the forecasting value can be better and close to the real value.

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Rencana Anggaran Biaya (RAB)

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2	Olah data	500.000,00
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Bahwa yang bersangkutan telah membuat artikel dengan Judul "FORECASTING OF INDONESIA'S POST-COVID-19 EXPORT VALUE USING SARIMA " dari tanggal 01 September 2022 sampai tanggal 09 Februari 2023.

Demikian surat keterangan ini diberikan untuk dapat digunakan sebagaimana mestinya.

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