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FORECASTING THE AMOUNT OF OIL AND NON-OIL AND GAS EXPORTS IN INDONESIA USING *THE BOX-JENKINS METHOD*

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ABSTRACT

Indonesia is one of the countries in Southeast Asia that has diversity and abundance of natural resources, both oil and gas and non-oil and gas. Export is an international trade activity that is profitable for economic growth in Indonesia. The purpose of this study is to determine the best results and models for oil and gas and non-oil and gas export data. The Box-Jenkins method (ARIMA) is a forecasting method that does not require or ignores independent variables. The stages used in the box-Jenkins method are identification of the model to see whether the model is stationary or not, for a model that is already stationary, a parameter estimation test will be carried out by looking at the significance value of the parameter, then a diagnostic check will be carried out using residual white noise and residual tests. normal distribution. After that, the initial prediction model is obtained and to get the best ARIMA model, it can be done by looking at the smallest MAPE value of each model. The best model obtained in this study to predict the amount of oil and gas and non-oil and gas exports in Indonesia uses the Box-Jenkins or ARIMA method, namely model (5,1,3) with the smallest MAPE of 8.142%. Forecasting results for the number of oil and gas and non-oil and gas exports in Indonesia in January - December 2023, namely: January 22194.9 million dollars, February 22795.6 million dollars, March 24796.0 million dollars, April 24106 million dollars, May 22281.6 million dollars, June 23186.6 million dollars, July 25184.3 million dollars, August 24325.8 million dollars, September 22456.3 million dollars, October 23565.6 million dollars, November 25602.2 million and December 24540.3 million dollars. Actual data or actual data for January – April 2023, namely January 22,323.8 million dollars, February 21,321.3 million dollars, March 23,416 million dollars, April 19,290.5 million dollars. It can be concluded that the results of the forecasting value of the box-Jenkins method are close to the actual value.

Keywords: Export, Oil and Gas, Non-oil and Gas, Box-jenkins Method, Indonesia

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PRELIMINARY

Indonesia is one of the countries in Southeast Asia that has diversity and abundance of resources. One of them is in the form of oil and natural gas (oil and gas) assets as well as non-oil and gas assets which have enormous potential to develop the economy through buying and selling transactions with other countries (Desy, 2022). The success rate of a country's economic development can be seen from how much economic growth has

occurred in that country in a certain period of time. Economic growth is very important for the sustainability of society and the State. For some people, economic growth has a positive impact and will lead to good results for people's welfare. International trade is one of the economic activities that is expected to be able to support national development where in international trade activities there are export-import activities (Tondolambung et al, 2021).

Creating broad market conditions for the development and progress of a country's economy can be done by increasing the number of exports. Prediction or forecasting the number of oil and gas and non-oil and gas exports every month needs to be done to get a policy in increasing the number of exports. Research related to research using the Jenkins box method has been carried out by (Ihwati, et al., 2022) predicting the value of Indonesia's oil and gas exports using the ARIMA method with the results of the analysis stating that the ARIMA model (1,1,0) is the best model in predicting the value of oil and gas exports in Indonesia in 2022. The purpose of this study is to determine the best results and models not only for oil and gas export data but also for non-oil and gas export data so as to assist the government in anticipating a decline in export levels by using the ARIMA method. This method predicts time series data based on statistical theory that has developed to find patterns in the data series and then extrapolate them to the future (Pamungkas, 2019). In addition, the ARIMA method can provide forecasting accuracy that is quite accurate for short-term forecasting (Permaisuri,2022). Building an ARIMA model requires a sufficient number of samples (Nurviana et al., 2022). Box and Jenkins suggest the minimum sample size required is 50 data observations (Hutabarat, 2022)

The objectives to be achieved in this research are as follows:

1. Get the best model for forecasting the number of oil and gas and non-oil and gas exports in Indonesia.
2. Knowing the results of forecasting the number of oil and gas and non-oil and gas exports in Indonesia using the Box-Jenkins method in Indonesia in 2023.

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METHODS

The software used in this research is Minitab version 16 software which is used to find the best ARIMA model to predict the number of oil and gas and non-oil and gas exports in Indonesia. The steps or analysis used are:

1. Collect data on the number of oil and gas and non-oil and gas exports from January 2015 to December 2022.
2. Conduct a descriptive analysis to see an initial overview of oil and gas and non-oil and gas export data from January 2015 to December 2022.
3. Identify the ARIMA model (p,d,q)
    a. See whether the data is stationary or not using time series, box-cox-plot or ACF plot. If the rounded value in the box-cox plot is 1 or the CL-Upper value is 1, then the data can be said to be stationary with respect to variance. However, if the data is not stationary, a Box-Cox transformation is necessary.
    b. The data can be said to be stationary with respect to the mean when the time series plot shows fluctuations or on a line parallel to the time axis (t) or the ACF plot does not experience a sharp/significant decrease. However, if the data is not stationary with respect to the mean, it is necessary to do differencing (Azhari, 2022).
4. Analyze ACF and PACF plots to estimate the appropriate ARIMA (p,d,q) model.
5. Perform parameter assessment.
6. Carry out diagnostic examinations (diagnostic checking).
    a. Parameter significant test
    b. Test the suitability of the model which includes the white noise assumption test using the L-Jung Box test. Test the assumption that the residuals are normally distributed using the Kolmogorov Smirnov test. If the two tests are not met, then the test can be carried out again on other model estimates.
7. If more than one model is obtained, the best model can be selected using the MAPE value. The smaller the MAPE value, the better the model (Oktarini et al., 2018).
8. Make predictions using the best model that has been selected
9. Conclusion

RESULT AND DISCUSSION

Descriptive statistics

In order to understand the research analysis data, the results of the descriptive statistical analysis are presented below.

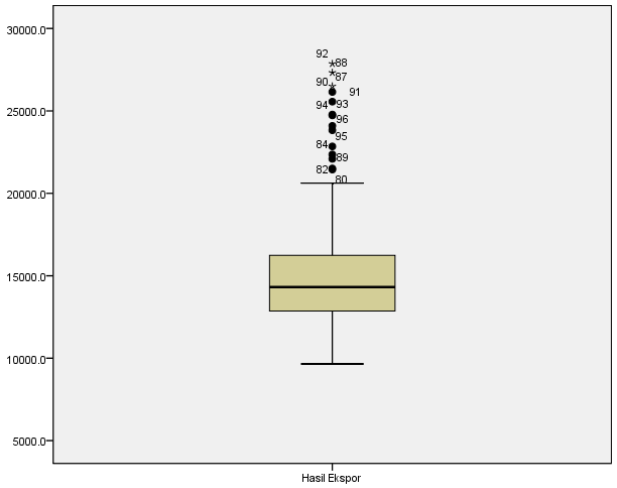

Figure 1. *Box-Cox Plot of* Oil and Gas and Non-Oil and Gas Export Results in Indonesia

Table 1. Descriptive Analysis Of Oil and Gas and Non-Oil and Gas Export Results In Indonesia

Analysis Of Oil and Gas and Non-Oil and Gas Export Results In Indonesia

Statistics		
Export Results		
N	Valid	96
	missing	0
Means		15,612.55
std. Error of *Means*		431.3008
Median		14,312
Mode		9,649.5 [a]
std. Deviation		4.225,8671
Variances		17,860,000
Skewness		1,380
std. Error of Skewness		0.246
kurtosis		1,071
std. Error of Kurtosis		0.488
Range		18,212.6
Minimum		9,649.5

Statistics		
Maximum		27,862.1
sum		1,498,804.7
Deviation Quartile		3,436.22
Percentiles	25	12,826.88
	50	14,312
	75	16.263.1

Based on table 1 above, it can be seen that the descriptive statistics from the data on oil and gas and non-oil and gas exports in Indonesia show that the average (mean) value of exports in Indonesia is 15,612.55 million dollars/month. The skewness value is positive, meaning that there is a lot of overlapping data on values that are small or less than the average value. The kurtosis value is positive so that the data has a sharp peak. It can be seen from the distribution of data that the minimum output of oil and gas and non-oil and gas exports is 9,649.5 million dollars and the maximum export result is 27,862.1 million dollars. So, it can be seen that the data range is 18,212.6. While the variance is 17,860,000 and the quartile deviation is 3,436.22 so that it can be concluded that the distribution of large data and has outliers, for more details, can be seen in the box-cox plot picture.

Time Series Modeling of Oil and Gas and Non-Oil and Gas Exports in Indonesia

Estimates for forecasting the number of oil and gas and non-oil and gas exports can be generated from the data to be analyzed using the Autoregressive Integrate Moving Average (ARIMA) method. The steps used in analyzing this method are:

Initial Model Identification

The thing that needs to be done in the identification of the data model is to look at the stationarity of the data both in the mean and in the variance. Identification is done by looking at the time series and Box-cox transformation. The results of the time series plot obtained are as follows.

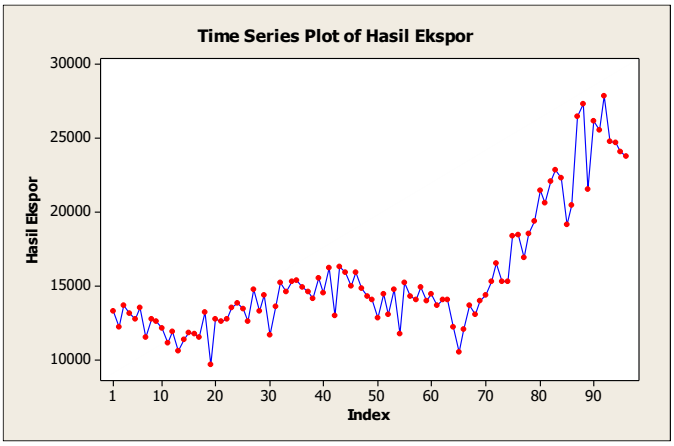

Figure 2. *Time Series Plot of* Oil and Gas and Non-Oil and Gas Export Results in Indonesia

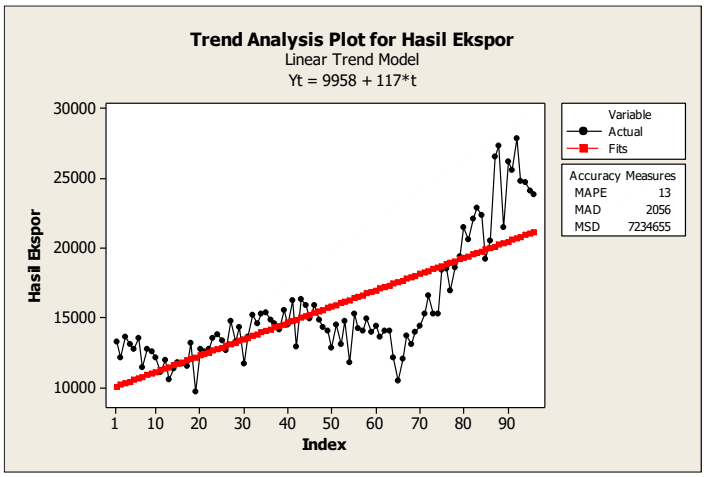

Figure 3. *Trend Analysis Plot of* Oil and Gas and Non-Oil and Gas Export Results

If observed from the results of the time series plot and trend analysis of the export results above, it shows that the number of oil and gas and non-oil and gas exports has an upward trend from January 2015 to December 2022. The plot shows that the data is not stationary in the mean because fluctuations in the number of exports are not is at a constant average value and not yet stationary because it tends to have an upward trend. Before carrying out further checks for stationarity in the mean, a stationary check in variance is carried out using Box-Cox. Consider the following Box-cox plot image:

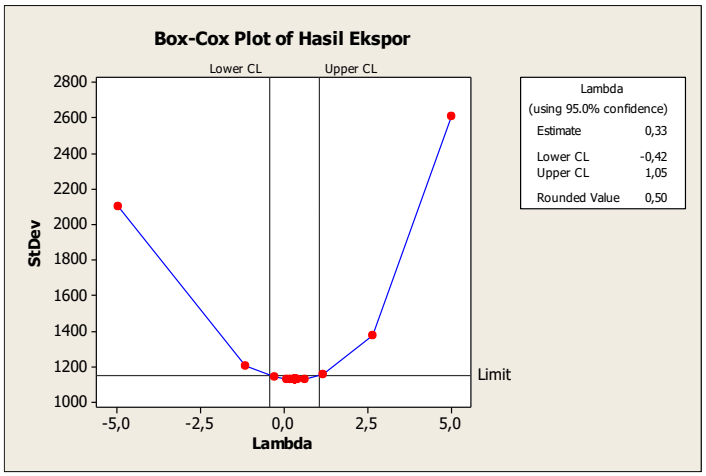

Figure 4. *Box-cox plot* of oil and gas and non-oil and gas exports

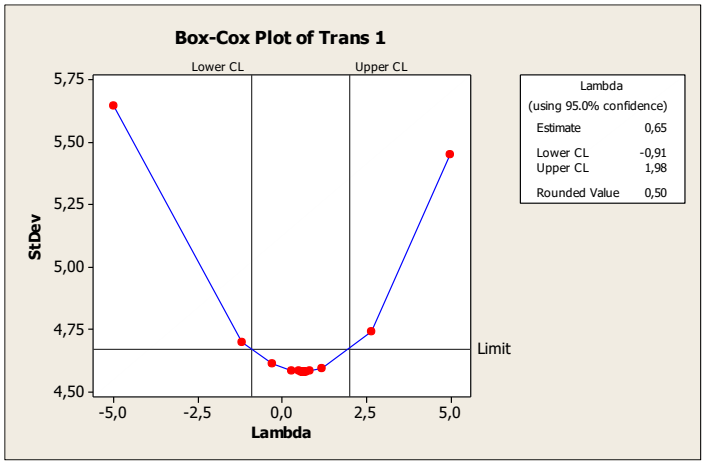

Figure 5. The First Transformation of *Box-cox Plots* of Oil and Gas and Non-Oil and Gas Export Results

From the results of the export box-cox plot and the trans 1 box-cox plot above, it can be seen that the data is not stationary for the variance because it has a rounded value of 0.50, a data is said to be stationary for the variance if the rounded value for the box-cox is 1. So, it is necessary to do a transformation back to the export data.

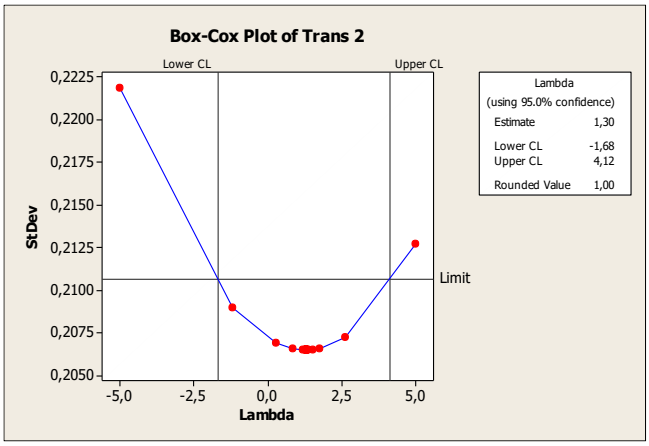

Figure 6 . Transformation of both *Box-cox Plots* of oil and gas and non-oil and gas Export Results

From the output of the box-cox plot of the second transformation, it can be concluded that the data is stationary with respect to the variance because the rounded value is 1. Next, we need to check whether the data is stationary with respect to the mean or not.

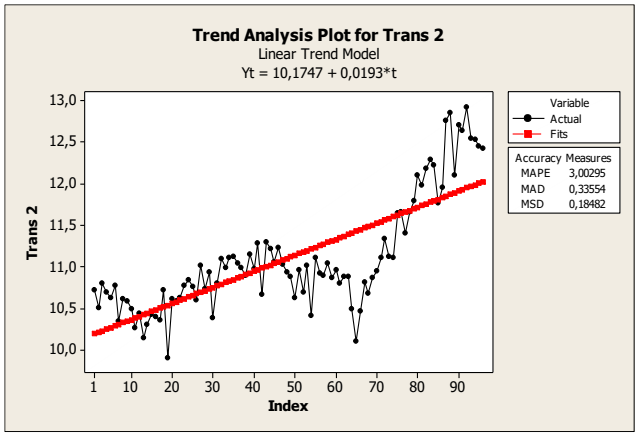

Figure 7. *Trend analysis* plot of the second transformation

From Figure 7 we can see that the data that has been transformed twice is not stationary in the mean because fluctuations in the data on the number of exports are not at a constant average value and are not stationary because it tends to have an upward trend.

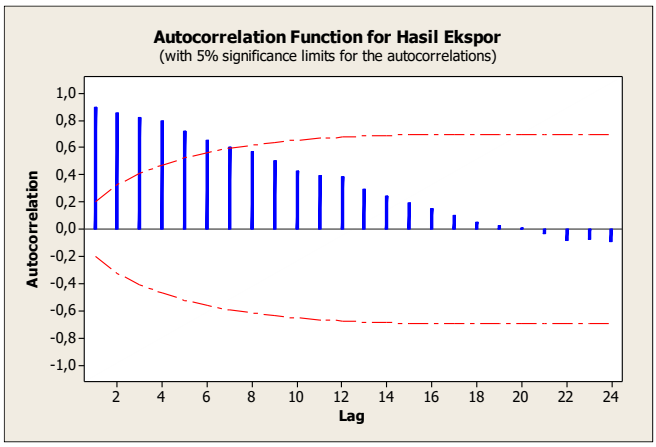

Figure 8. ACF Plot of Oil and Gas and Non-Oil and Gas Export Results

Figure 8 shows that the lag in the ACF plot is still decreasing slowly and there are six successive time lags that are outside the significance limit, so that data on the number of oil and gas and non-oil and gas exports in Indonesia can be said to be not stationary on average and needs to be differentiated.

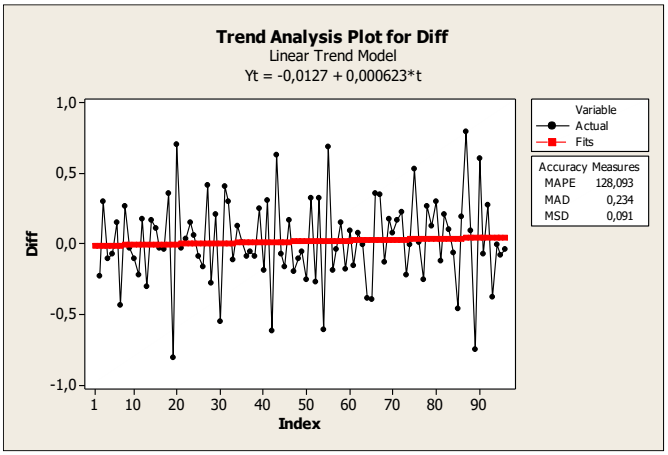

Figure 9. The first *differencing Trend* analysis plot

From plot 9 above, it can be seen that the data is stationary with respect to the mean after differencing once, because the trend line on the horizontal chart means that the average value of export results is fixed. The next step is to determine a provisional predictive model that can be checked using the ACF plot and the PACF plot.

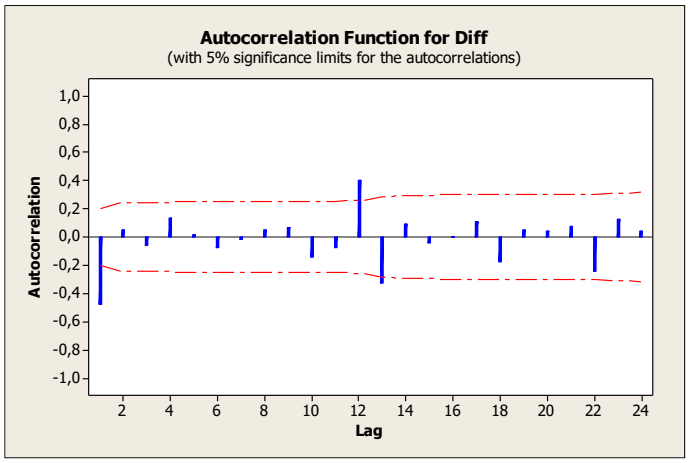

Figure 10. ACF Plot of *Differencing Data*

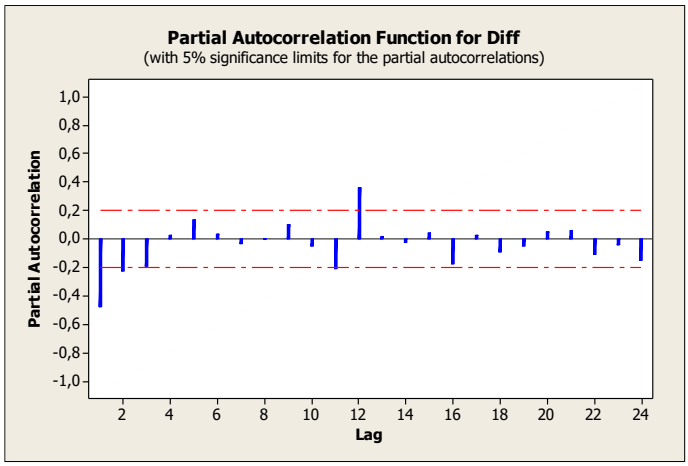

Figure 11. PACF Plot of *Differencing Data*

Based on the ACF plot it can be seen that the significant lines are cut at lags 1 and 12 so that AR has order 12 and based on the PACF plot it can be seen that the significant lines are cut at lags 1 and 12 so that MA has order 12 with differencing once so that several ARIMA conjecture models are obtained. namely ARIMA (1,1,1), ARIMA (2,1,1), ARIMA (4,1,1), ARIMA (5,1,1), ARIMA (1,1,2), ARIMA (2, 1,2), ARIMA (4,1,2), ARIMA (5,1,2), ARIMA (1,1,3), ARIMA (2,1,3), ARIMA (3,1,3), ARIMA (4,1,3), ARIMA (5,1,3), ARIMA (1,1,4), ARIMA (2,1,4), ARIMA (3,1,4), ARIMA (4,1 ,4), ARIMA (5,1,4), ARIMA (1,1,5), ARIMA (2,1,5), ARIMA (3,1,5), ARIMA (4,1,5).

Estimasi Model dan Uji Siginifikansi Parameter

If the significant value is set to ∝, then Reject H0 for |t|>t_(∝\/2);df=n-p or P_value< 0.05. Where n is the number of observations and p is the number of parameters (Nakhe, 2022). From the results of the parameter significance test it can be seen that the significant models are ARIMA (1,1,1), ARIMA (4,1,1), ARIMA (1,1,2), ARIMA (2,1,2),

ARIMA (3,1,2), ARIMA (2,1,3), ARIMA (3,1,3), ARIMA (4,1,3), ARIMA (5,1,3), ARIMA (1,1,4), ARIMA (2,1,4), ARIMA (3,1,4), ARIMA (4,1,4), ARIMA (5,1,4), ARIMA (1,1,5), ARIMA (2 ,1,5), ARIMA (3,1,5), ARIMA (4,1,5).

Check Diagnostics

The results of the residual white noise test can be seen in Appendix 3. The formulation of the hypothesis from the White Noise Test is that it is accepted and meets the assumptions if the significance value or P-Value > ∝ is 0.05 (Haryadi et al., 2022).

There are several models with white noise including the ARIMA (1,1,1), ARIMA (4,1,1), ARIMA (1,1,2), ARIMA (2,1,2), ARIMA (3,1,2), ARIMA (2,1,3), ARIMA (3,1,3), ARIMA (4,1,3), ARIMA (5,1,3), ARIMA (1,1,4), ARIMA (2,1,4), ARIMA (3,1,4), ARIMA (4,1,4), ARIMA (5,1,4), ARIMA (1,1 ,5), ARIMA (2,1,5), ARIMA (3,1,5). The white noise model is feasible for further testing, namely the normal distribution residual test.

Normal Distribution Residual Test

Table 2. Test Results for The Residual Normal Distribution of The ARIMA Model for The Number of Oil and Gas and Non-Oil and Gas Exports

Model	***Kolmogorov-Smirnov***		**Conclusion**
	KS	***P-values***	
(1,1,1)	0.094	0.150	Normal Distribution
(4,1,1)	0.112	0.150	Normal Distribution
(1,1,2)	0.115	0.150	Normal Distribution
(2,1,2)	0.108	0.150	Normal Distribution
(3,1,2)	0.143	0.150	Normal Distribution
(2,1,3)	0.143	0.150	Normal Distribution
(3,1,3)	0.172	0.150	Normal Distribution
(4,1,3)	0.177	0.150	Normal Distribution
(5,1,3)	0.126	0.150	Normal Distribution
(1,1,4)	0.084	0.150	Normal Distribution
(2,1,4)	0.194	0.150	Normal Distribution
(3,1,4)	0.278	0.013	Not Normal Distribution
(4,1,4)	0.213	0.134	Normal Distribution
(5,1,4)	0.162	0.150	Normal Distribution
(1,1,5)	0.118	0.150	Normal Distribution

Model	***Kolmogorov-Smirnov***		**Conclusion**
	KS	***P-values***	
(2,1,5)	0.125	0.150	Normal Distribution
(3,1,5)	0.163	0.150	Normal Distribution

Table 2 explains that there are several models that are normally distributed including ARIMA (1,1,1), ARIMA (4,1,1), ARIMA (1,1,2), ARIMA (2,1,2), ARIMA (3,1,2), ARIMA (2,1,3), ARIMA (3,1,3), ARIMA (4,1,3), ARIMA (5,1,3), ARIMA (1,1,4), ARIMA (2,1,4), ARIMA (4,1,4), ARIMA (5,1,4), ARIMA (1,1,5), ARIMA (2,1,5), ARIMA (3 ,1,5). The ARIMA model is normally distributed because it has a p-value ≥ 0.05 so that it fulfills the assumption that the residuals are normally distributed (Aprilianti et al., 2022).

Best Model Selection

Selection of the best model can be done by looking at the value of the Mean Absolute Percentage Error (MAPE). The best model and the one to be chosen is the one with the smallest MAPE value. Look at the table of MAPE calculation results from the selected ARIMA model below.

Table 3 . Calculation Results for The MAPE Value In The ARIMA Model for Total Oil and Gas and Non-Oil and Gas Exports

Model	**MAPE**
ARIMA(1,1,1)	9.699%
ARIMA(4,1,1)	9.159%
ARIMA (1,1,2)	9.620%
ARIMA(2,1,2)	9.319%
ARIMA(3,1,2)	9.079%
ARIMA(2,1,3)	8.165%
ARIMA(3,1,3)	8.159%
ARIMA(4,1,3)	8.418%
ARIMA(5,1,3)	8.142%
ARIMA(1,1,4)	9.232%
ARIMA(2,1,4)	8.357%
ARIMA(4,1,4)	8.579%

Model	MAPE
ARIMA(5,1,4)	8.435%
ARIMA(1,1,5)	9.350%
ARIMA(2,1,5)	9.449%
ARIMA(3,1,5)	8.455%

Table 3 above explains that the model that has the smallest MAPE value is the ARIMA(5,1,3) model with a MAPE value of 8.142%. If the MAPE value is less than 10% then the ability of the forecasting model is very accurate.

ARIMA Models

ARIMA model was chosen based on the smallest MAPE value, namely model (5,1,3). The following is the model equation for the number of oil and gas and non-oil and gas exports in Indonesia in the following period using model (5,1,3).

.

$$\phi_p B(1-B)^d Z_t = \theta_q(B)\, a_t$$

$$(1-\phi_1 B)(1-B)\, Z_t = (1-\theta_1 B)\, a_t$$

$$(1-B-\phi_1 B+\phi_1 B^2)\, Z_t = -\theta_1 B a_t + a_t$$

$$Z_t - Z_t\, B - \phi_1 B Z_t + \phi_1 B^2\, Z_t = -\theta_1 B a_t + a_t$$

$$Z_t = Z_{t-1} + \phi_1 Z_{t-1} - \phi_1 Z_{t-2} - \theta_1 a_{t-1} + a_t$$

$$Z_t = (1+\phi_1)\, Z_{t-1} - \phi_1 Z_{t-2} - \theta_1 a_{t-1} + a_t$$

Dengan parameter ϕ_1= 0,3168, ϕ_2 = -0,5343, ϕ_3 = 0,4951, ϕ_4= 0,4990, ϕ_5= 0,1144, θ_1 = 0,8893, θ_2= -0,8867, θ_3= 0,9731 adalah

$Z_t = (1+\phi_1)\, Z_{t-1} - \phi_2 Z_{t-2} - \phi_3 Z_{t-3} - \phi_4 Z_{t-4} - \phi_5 Z_{t-5} - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \theta_3 a_{t-3} + a_t$

$Z_t = (1+0{,}3168)\, Z_{t-1} - (-0{,}5343) Z_{t-2} - (0{,}4951) Z_{t-3} - (0{,}4990) Z_{t-4} - (0{,}1144) Z_{t-5} - (0{,}8893) a_{t-1} - (-0{,}8867) a_{t-2} - (0{,}9731)\, a_{t-3} + a_t$

$Z_t = 1{,}3168 Z_{t-1} + 0{,}5343 Z_{t-2} - 0{,}4951 Z_{t-3} - 0{,}4990 Z_{t-4} - 0{,}1144 Z_{t-5} - 0{,}8893 a_{t-1} + 0{,}8867 a_{t-2} - 0{,}9731\, a_{t-3} + a_t$

Forecasting the Number of Oil and Gas and Non-Oil and Gas Exports

The results of total oil and gas and non-oil and gas exports for January 2023 - December 2023 using the ARIMA model (5,1,3) are as follows.

Table 4. Forecasting Results of the Number of Oil and Gas and Non-Oil and Gas Exports in Indonesia in 2023

Month	Total Exports of Oil and Gas and Non-Oil and Gas (Million Dollars)
January	22194.9
February	22795.6
March	24796,0
April	24106.0
May	22281.6
June	23186,6
July	25184,3
August	24325,8
September	22456,3
October	23565.6
November	25602,2
December	24540.3

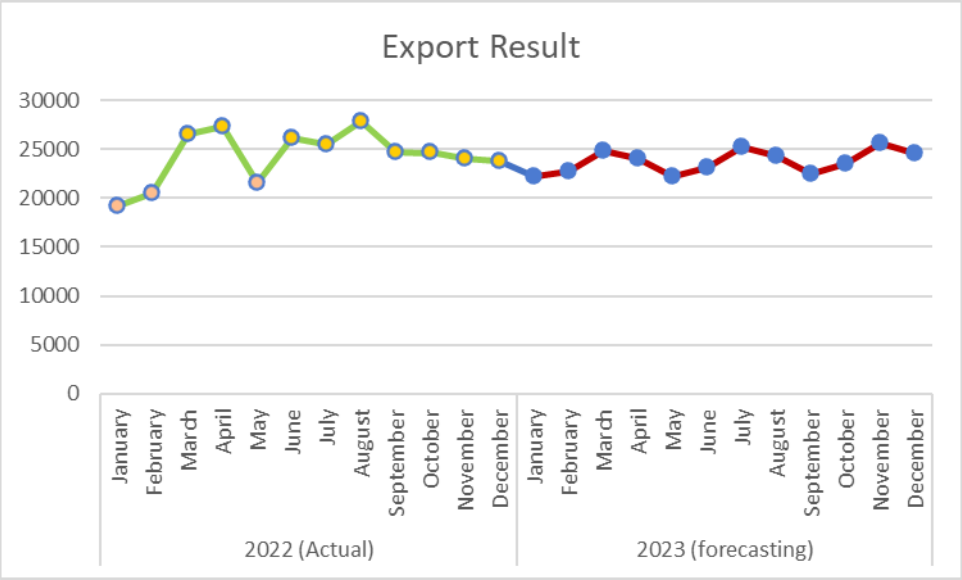

Figure 12. Forecasting Results of the Number of Oil and Gas and Non-Oil and Gas Exports in 2023

Table 4 and figure 12 show that the forecasting results for the number of oil and gas and non-oil and gas exports in Indonesia in January - December 2023 are: January 22194.9 million dollars, February 22795.6 million dollars, March 24796.0 million dollars, April

24106 million dollars, May 22281.6 million dollars, June 23186.6 million dollars, July 25184.3 million dollars, August 24325.8 million dollars, September 22456.3 million dollars, October 23565.6 million dollars, November 25602.2 million dollars and December 24540.3 million dollars. The largest amount of export results was in November 2023, which was 25602.2 million dollars and the smallest amount of exports was in January 2023, which was 22194.9 million dollars. Actual data or actual data for January – April 2023, namely January 22,323.8 million dollars, February 21,321.3 million dollars, March 23,416 million dollars, April 19,290.5 million dollars. It can be concluded that the forecasting value and the actual value are not much different.

CONCLUSION

The conclusions obtained are: The best model that can be used to predict the amount of oil and gas and non-oil and gas exports in Indonesia uses the Box-Jenkins or ARIMA method, namely model (5,1,3) with the smallest MAPE of 8.142%. The ARIMA model (5,1,3) is: Z_t = 1.3168Z_(t-1) + 0.5343Z_(t-2) − 0.4951Z_(t-3) - 0.4990Z_(t-4)- 0.1144Z_(t-5) − 0.8893a_(t-1) + 0.8867a_(t-2) − 0.9731 a_(t-3) + a_t. Forecasting results for the number of oil and gas and non-oil and gas exports in Indonesia in January - December 2023, namely: January 22194.9 million dollars, February 22795.6 million dollars, March 24796.0 million dollars, April 24106 million dollars, May 22281.6 million dollars, June 23186.6 million dollars, July 25184.3 million dollars, August 24325.8 million dollars, September 22456.3 million dollars, October 23565.6 million dollars, November 25602.2 million and December 24540.3 million dollars.

The suggestion that the author wants to convey from research on forecasting the number of oil and gas and non-oil and gas exports in Indonesia is that there is further research to predict the number of oil and gas and non-oil and gas exports in Indonesia using other methods that are better and more accurate.

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