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Forecasting of Motorcycle Product Sales in Indonesia Using the ARIMA Method

Eko Afrianto
Institute Technology and Science Mandala
Jember, East Java
082329319788, 68121
eko.afrianto@itsm.ac.id

Ferry Wiranto
Institute Technology and Science Mandala
Situbondo, East Java
08991087383, 68121
ferry@itsm.ac.id

Muhammad Rijalus Sholihin
Institute Technology and Science Mandala
Jember, East Java
081559852272, 682166
muhammadrijalus@itsm.ac.id

ABSTRACT

This research aims to analyze selling of motorcycle products when economic growth slowed down and effected of Covid 19 using the ARIMA method problems causing the downturn of motorcycle market in 2023. The study used a quantitative approach with secondary data sourced by The Indonesian Motorcycle Industry Association (AISI) from January until December 2020 to January until December 2022. The data were analyzed using the ARIMA method and Minitab aplication to calculate, identify and predict the patterns and trends with time series for sales of motorcycle products in the following years in 2023. The results show that predictable using ARIMA method and Minitab aplication is affected by sale of motorcycle market in 2023. The ARIMA method was able to capture the patterns and trends of the sale motorcycle products and predict its future sale. The study found that the based on data from the Indonesian Motorcycle Industry Association (AISI) domestic motorcycle sales is expected to experience fluctuations in the short term but will likely trend upward in the long run for motorcycle companies and can predict purchasing power by consumer.

Keywords : Forecasting; ARIMA Method; Motorcycle Products Sale; Minitab.

1. INTRODUCTION

The company purpose' is to obtain maximal profit and to get selling target in accordance with the company's growth in the long term, so as to ensure the survival of the company. Products inventory has a very important role because the operation of the company depends on the availability of products (Farosanti, 2022). Motorcycle industry and marketing prospects in Indonesian has developed very rapidly, especially with Indonesia's population of more than 250 million people living on more than 230 islands, becoming an extraordinary market potential. Motorcycle Industry in Indonesia as a consequence of demand of motorcycle by costumer has to fulfill requirement product. This industry is very vulnerable to domestic economic turmoil, eventhough the motorcycle industry is growing rapidly. How could it not be in 2015 when economic growth slowed down and effected of Covid 19, which caused high domestic interest rates and weakening of the rupiah, the purchasing power of motorbikes also decreased. Based on data from the Indonesian Motorcycle Industry Association (AISI) domestic motorcycle sales in the last two years have declined sharply, finally the motorcycle industry was also affected.

Finally, the motorcycle manufactures reduced production, while stocks in warehouse and dealers piled up. This condition became even more difficult when the government issued Government Regulation (PP) Number 60 of 2016 concerning types and rates of Non-Tax State Revenue (PNPB), which clearly increasing the price of motorcycles. The Indonesian Motorcycle Industry Association (AISI) identified three main problems causing the downturn of motorcycle market. The first is due to the increase in the price of consumer goods or daily necessities which affecting purchasing power of people. The second cause is the increase in transportation costs as a result of the release of the price of fuel oil (BBM) follwing the market mechanism. The third because commodity prices have fallen and have had an impact, especially outside Java, which so far have relied on commodity-based industries, such as plantations and mining.

Forecasting calculations with Minitab software are expected to be able to predict the need for sales of motorcycle products in the following years. In this way, companies that produce motorcycles will determine the supply chain for each region in Indonesia so that they can make efficient and predictable products that meet the needs and purchasing power of the people.

This forecasting is useful for increasing the efficiency of capital expenditures or the cost of procuring motorcycle products so that they do not accumulate in warehouses due to reduced consumer purchasing power. The method used to perform time series analysis is to use ARIMA (Auto Regressive Integrated Moving Average). A statistical analysis model that uses time series data to either better understand the data set or to predict future trends is the meaning of autoregressive integrated moving average, or ARIMA. A statistical model is autoregressive if it predicts future values based on past values (Fattah et all., 2018). For example, an ARIMA model might seek to predict a stock's future prices based on its past performance or forecast a company's earnings based on past periods.

In this paper, we have mainly focused on the amount of accuracy of forecasting stock values for various sectors which will help motorcycle company understand the market and make a decision to supply product in the stock market. The organization of the paper is as follows. In section II, we discuss about the previous paper using ARIMA model. In section III, we provide details about the dataset on which we have conducted our experiment. In section IV, we discuss about methodology. Section V shows the experimental results and conclude.

2. RELATED WORKS

A time series is a set of well-defined data items collected at successive points at uniform time intervals. Time series analysis is an important part in statistics, which analyzes data set to study the characteristics of the data and helps in predicting future values of the series based on the characteristics. Forecasting is important in fields like finance, industry, etc. (Mondal et all., 2014). ARIMA models considered one of the most models extensively used in economics and finance fields, as well as stock forecasting. However, the prediction of the stock market in time series considered one of the most challenging issues because of it volatile and noise features. Where the change of stock price considered as non-linear and non-stationary, which makes getting reliable and accurate prediction quite challenging. In view of the critical play role of forecasting stock to setting a trading strategy, determining the actions for appropriate timing to buy or sell stocks and to study future investment opportunities as well as the importance of developing and improving time series forecasting models and study its effectiveness and success (Khan & Alghluaiakh, 2020). Data processing to complete Modeling and quantitative forecasting was aided by some software, among others, SPSS, Minitab, and Microsoft Excel. Analysis of forecasting time in this research, used software minitab because computer software has full facilities for problems of ARIMA (Sidiq, 2018).

3. DATASETS

We have taken historical data of from the Indonesian Motorcycle Industry Association (AISI) domestic motorcycle sales in the last three years. We have taken thirty-six months of training data from January 2020 to December 2022 and predicted next months and year' data. We have also divided our dataset into three different time periods, one is of twelve months from January to December 2020, another is of twelve months from January to December 2021 and the other is of twelve months from January to December 2022. This research is used in determining models, forecasting, and determining more accurate software in the data identification stage is the Box-Jenkins ARIMA time series method using Minitab version 17 software. This study to predict sale of motorcycles in Indonesia by companies will determine the supply chain for each region in Indonesia.

4. METHODOLOGY

ARIMA model is derived by general modification of an autoregressive moving average (ARMA) model. This model type is classified as ARIMA(p,d,q), where p denotes the autoregressive parts of the data set, d refers to integrated parts of the data set and q denotes moving average parts of the data set and p,d,q is all non- negative integers. ARIMA models are generally used to analyze time series data for better understanding and forecasting. Initially, the appropriate ARIMA model has to be identified for the particular datasets and the parameters should have smallest possible values such that it can analyze the data properly and forecast accordingly. First, to ensure that the time series data is stationary before fitting into the ARIMA model is used to test for the existence of unit root. The significance level used in this study is 0.05. If the data is stationary, the data will be fitted into ARIMA model and the model with the lowest Akaike information criterion (AIC) will be chosen as the best model. The p-value of greater than 0.05 will imply that there is not The Akaike Information Criteria (AIC) is a widely used measure of a statistical model (Hong et all., 2021). It is used to quantify the goodness of fit of the model. When comparing two or more models, the one with the lowest AIC is generally considered to be closer with real data. AICc is AIC with a correction for finite sample sizes.

According to Box-Jenkins method, in ARIMA (p, d, q) the value of p and q should be 2 or less or total number of parameters should be less than 3. In doing forecasting of time Series data using ARIMA (p, d, q) methods, there are called steps or phases (Ahmar et all., 2018). Therefore, for checking AICc of the model we have only checked for p and q values 2 or less. The model with the least AICc value is selected. We are showing our experimental results for model selection for stock of the company. We have used minitab software for conducting our experiments.

The following is a flowchart of framework for describing the steps in the ARIMA procedure in Figure 1, adoption of the development of previous research (Wawale et all., 2022).

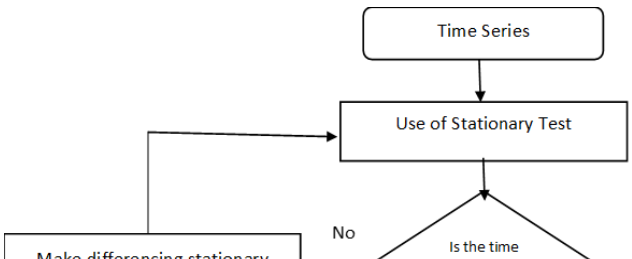

Figure 1 Framework procedure

5. RESULTS AND DISCUSSION

Forecasting the sale amount of the motorcycle product using the ARIMA method is carried out by the following ARIMA steps:

5.1 Identification of Time Series Models

The heading of subsections should be in Times New Roman 12-point bold with only the initial letters capitalized. (Note: For subsections and subsubsections, a word like *the* or *a* is not capitalized unless it is the first word of the header.) The application of the ARIMA method for forecasting is applied to the sale of the motorcycle product data close to the monthly data, starting from January 2020 to December 2022. The sale of motorcycle data pattern is shown in Figure 2.

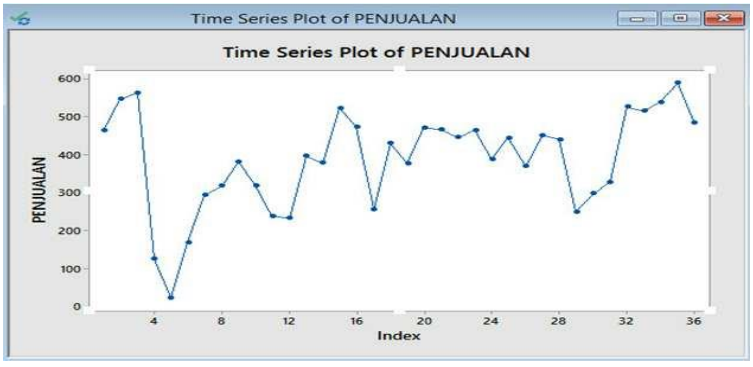

Figure 2 Plot of close data for motorcycle sale from January 2020 to December 2022

In Figure 2 it can be seen that the motorcycle sale close data is not stationary (there is still an element of trend), so it must be stationary. For a series to be classified as stationary, it should not exhibit a trend. Moving on to the second plot, we certainly do not see a trend in the series, but the variance of the series is a function of time. As mentioned previously, a stationary series must have a constant variance. In time series forecasting, a time series, which has constant statistical properties (mean, variance, and covariance) and thus is independent of time, is described as stationary. Because of the constant statistical characteristics, a stationary time series is easier to model than a non-

stationary time series. Thus, a lot of time series forecasting models assume stationarity. Stationarity can be checked either by visual assessment or by a statistical approach (Mohan et all., 2022). To see the stationarity in the variance, it can be seen through the Box-Cox transformation. A Box Cox transformation is a transformation of non-normal dependent variables into a normal shape. if data isn't normal, applying a Box-Cox means that we are able to run a broader number of tests. Normality is an important assumption for many statistical techniques (Fang et all., 2022).

Trend plots in statistical software such as Minitab are used to visualize trends or patterns in data over time. The main function of trend plots is to help users identify changes or trends in time series data and observe any patterns that may exist. Through these trend plots, you can gain a better understanding of changes and patterns in time series data over a given period, and make better decisions based on this analysis. Trend plot sale close data pattern is shown in Figure 3.

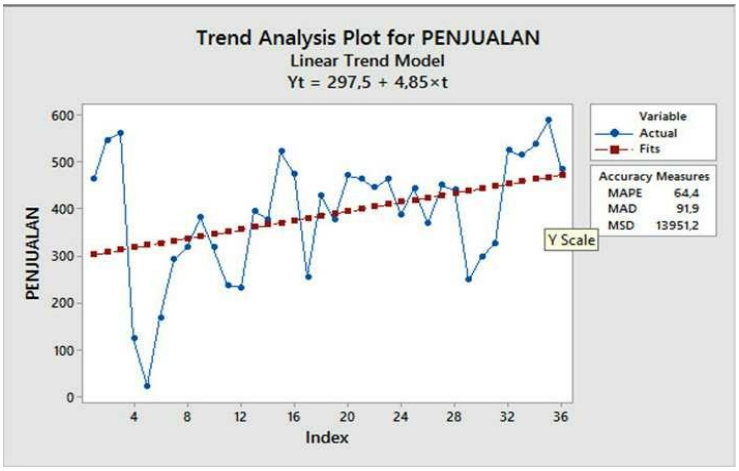

Figure 3 Trend Plot of Motorcycle Sale from January 2020 to December 2022

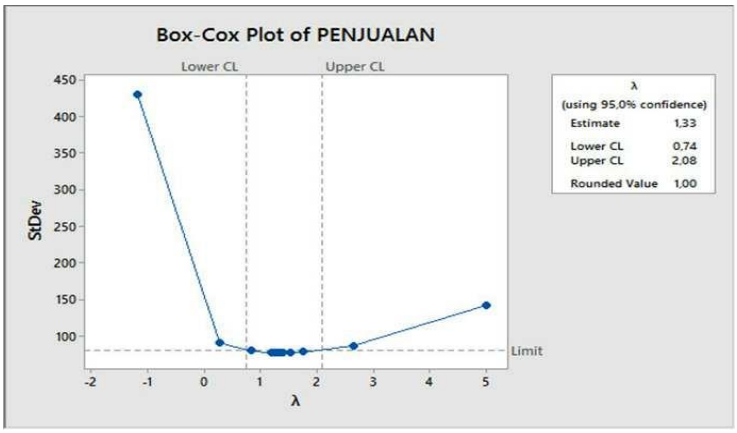

Figure 4 Box-Cox Plot Motorcycle Sale

Figure 4 shows if the data is stationary in variance if the value of the rounded value (λ) is 1. This shows that the motorcycle sale close index data is stationary in variance. Meanwhile, to see stationarity in averages (means) can be seen through time series plots or ACF plots. If in the time series plot there is no trend element in the data or in the ACF plot it drops to near zero quickly, generally after the second or third lag, then it can be said that the data is stationary on average.

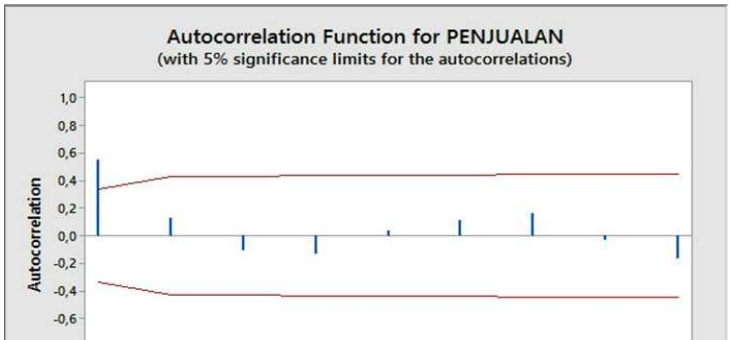

Figure 5 graph of the results of the first differencing Autocorrelation function data sale

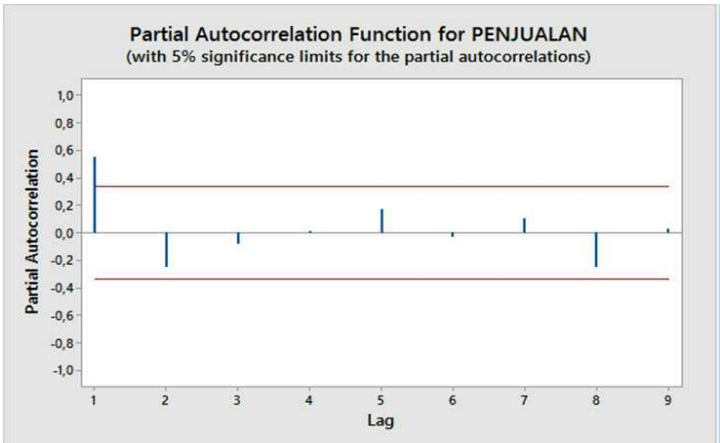

Figure 6 graph of the results of the first differencing Partial Autocorrelation function for sale data

Based on Figure 5 it can be seen that in the ACF plot the autocorrelation value at lag 1 is outside the significant limit or outside the dotted line, while in Figure 6 it can be seen that the PACF plot the partial autocorrelation value at lag 1 is outside the significant limit. Indicating an Autoregressive (AR) process of order 1 and Moving Average (MA) of order 1. From the information, we have ARIMA models like this.

Table 1. Explaining about ARIMA Model

1.	Model 1 : ARIMA (1,0,1)
2.	Model 2 : ARIMA (1,0,0)

Final estimates of parameters we can see at figure 7 and 8, the estimation is consisting of AR, MA, Constant and Mean. From the results we can get not significant and significant of ARIMA model.

Final Estimates of Parameters

Type	Coef	SE Coef	T-Value	P-Value
AR 1	0,349	0,272	1,28	0,208
MA 1	-0,331	0,274	-1,21	0,234
Constant	253,7	24,1	10,52	0,000
Mean	389,8	37,1		

Figure 7 ARIMA model not significant

Final Estimates of Parameters

Type	Coef	SE Coef	T-Value	P-Value
AR 1	0,568	0,143	3,98	0,000
Constant	169,9	18,2	9,31	0,000
Mean	393,0	42,2		

Figure 8 ARIMA model is significant

Table 2. ARIMA estimation model

No	ModelEstimation	Parameters	P.Value	SignificanceTestResults
1	ARIMA(1,0,1)	MA(1)	0,234	Not Significant
2	ARIMA(1,0,0)	AR(1)	0,000	Significant

If the p-value is 0.05 or lower, the result is as significant, but if it is higher than 0.05, the result is non-significant. P-value > 0.05 would be interpreted by many as "not statistically significant," meaning that there was not sufficiently strong evidence to reject the null hypothesis and conclude that the groups are different. P-value of less than 0.05 implies significance and that of less than 0.01 implies high significance. Therefore p=0.0000 implies high significance.

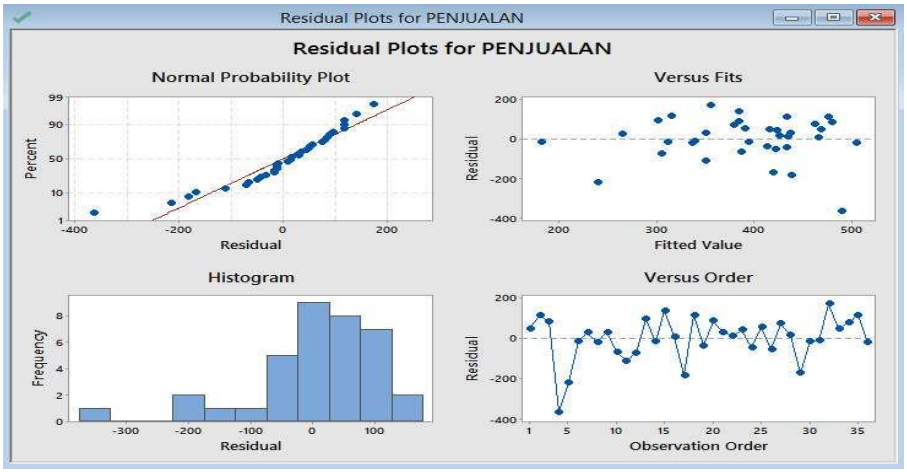

Figure 9 Minitab Normal Probability Plot Sale

Figure 9 The data is around the center line shows that the residuals are normally distributed, so the criteria can be used for forecasting motorcycle sale using ARIMA model (1,0,0).

5.2 Forecasting Data Motorcycle Sale

The data sale from two years before at January 2020 to December 2022 can be used ARIMA model (1,0,0). Its explained by formula

$$Yt = Yt - 1 + (0{,}568) - 0{,}143\varepsilon t{-}1$$

$$Yt = Yt - 1 - 0{,}568 - 0{,}143\varepsilon t{-}1$$

Table 3 results of forecasting sale of motorcycle in Indonesia, Period January to December 2023

No	Month	Forecasting
1	January	444,259
2	February	422,121

3	March	409,554
4	April	402,419
5	May	398,369
6	June	396,069
7	July	394,764
8	August	394,023
9	September	393,602
10	October	393,363
11	November	393,228
12	December	393,151
1 Year		**4,834,922**

From the calculation data from the table using the minitab application with the ARIMA method for forecasting the number of products that will be purchased by consumers. The number of motorcycle products sold each month will appear with a total estimated product sold within 1 year of around 4,834,922. So that forecasting the number of products sold will be known, where later the company selling motorcycle products will provide the number of motorcycles according to consumer demand. From this forecast, the company will not lose with the number of motorcycle products piled up in the warehouse.

6. CONCLUSION

ARIMA, which is used as a method for forecasting sales of motorcycle products in Indonesia, is a combination of the moving average method and the autoregressive method, which is a time series data forecasting method that utilizes historical data and current data to produce accurate short-term forecasts. So it is appropriate to use the forecasting method from previous years' sales data, to estimate the number of sales of motorcycle products in the years to come. Calculations with the Minitab application can also provide accurate results, through curves and forecasts that are used after going through the data calculation process. This will streamline the number of product stocks that will be provided by motorcycle companies and the purchasing power of consumers in each period so that they do not accumulate in warehouses due to limited consumer purchasing power.

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