

Analysis of Octopus Raw Material Inventory (Octopus sp) on the Production Process (Case Study: PT Kelola Mina Laut Makassar)

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Abstract

Inventory is a company's wealth that has an important role in business operations, so companies need to carry out proactive management, meaning that companies must be able to anticipate conditions and challenges that exist in inventory management to achieve the ultimate goal, namely to minimize the total costs that must be incurred by the company for handling inventory. The production process is the process of processing raw materials into finished products or ready-to-use products. In a production process it is said to be efficient and effective if during the production process it does not produce many losses. The purpose of this study was to analyze the supply of octopus (Octopus sp) raw materials for the production process at PT Kelola Mina Laut Makassar. The results obtained by using ARIMA modeling, obtained the right model to describe the data analysis of octopus (Octopus Sp) raw material inventory at PT Kelola Mina Laut Makassar, namely the ARIMA model (0,1,1) with an MSE of 0.01927 and a MAPE of 16.89%. ARIMA model (0,1,1), with the conclusion that raw material data for octopus at PT Kelola Mina Laut Makassar with data per week over a period of two years for forecasting the next 48 weeks has decreased.

Keywords: Octopus Raw Material, Inventory, ARIMA, Forecasting

INTRODUCTION

Industrial and business competition today can be said to be very tight and quite competitive in an effort to meet the increasing needs of consumers and consumer intelligence in choosing products. Therefore, every company will certainly try to provide

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the best products and services to consumers so that their companies become superior and able to compete and survive in the market.

In improving company operations, one of the companies must monitor inventory levels. Inventory is the main key for the company, because inventory is a very important treasure for business continuity. In a competitive economic climate, inventory accounting systems are a profit improvement tool. A better inventory system can increase profitability, while a bad system can erode profits and make businesses less competitive.

Inventory is a company's wealth that has an important role in business operations, so the company needs to carry out proactive management, meaning that the company must be able to anticipate the circumstances and challenges that exist in inventory management to achieve the final goal, which is to minimize the total costs that must be incurred by the company for inventory handling. In both manufacturing and non-manufacturing systems, the presence of inventory is a factor that triggers an increase in costs. Setting too much inventory will result in a waste of storage costs, but too little will result in lost opportunities for companies to profit if demand is greater than forecast. Controlling raw material inventory is very important in an industry to develop its business because it will affect cost efficiency, smooth production and business profits itself. The existence of inventory is expected to expedite the net production process of a company.

The production process is the process of processing raw materials into finished products or ready-made products. In a production process is said to be efficient and effective if during the production process does not produce much loss. Production activities depend on the needs and income of an enterprise. Production activities are a chain of consumption and distribution that produces goods and services then accepted by consumers. Without production economic activity in the enterprise will stop, in the production process requires tools or means used to carry out production. Production equipment or facilities are the most important factor of production, without these factors, production activities will not run. The function of production is a description of the relationship between the number of inputs and outputs that can be produced at a time. Production, distribution, and consumption are chains of economic activity that influence each other but production is the starting point of these activities, there is no distribution without production while production activities are a response to consumption. In the production process, of course, requires good logistics activities so that the production process can run smoothly in accordance with the goals set by the company.

PT. Kelola Mina Laut Makassar is an international scale company engaged in the seafood industry. This company was originally just a factory established in 1994 that

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produces dried anchovies (Dried Anchovy) and then developed along with the increasing consumer interest in products produced by PT Kelola Mina Laut. Based on the description related to logistics above, every company must certainly have logistics activities to increase profits and achieve company goals. Therefore, the author conducted a research entitled "Analysis of Octopus Raw Material Inventory (Octopus sp) on the Production Process at PT Kelola Mina Laut".

Objectives

The purpose of this study was to analyze the inventory of octopus raw materials (Octopus sp) against the production process at PT Kelola Mina Laut. Sundjaja (2003: 379) in Tuerah (2015), explains that inventory includes all goods or materials needed in the production and distribution process that are used for further processing or sale, while inventory according to Assauri (2004: 169) is an asset that includes goods belonging to the company with the intention of being sold within a normal period of business or inventories of goods which are still in construction or production process, or inventories of raw materials awaiting use in a production process. From this definition of inventory, it can be concluded that inventory is goods or raw materials needed in the production process or used for sale in a certain period.

Heizer & Render (2001: 82), inventory in the company usually consists of four types, namely:

- (a) Raw Material Inventory that has been purchased but not yet processed. A more widely adopted approach is to remove supplier variability in quality, quantity or delivery time so that there is no need for segregation.
- (b) Work In Process Inventory are components or raw materials that have gone through several process changes, but have not been completed.
- (c) MRO (Maintenance, Repairing, Operating Inventory) inventories are inventories devoted to maintenance, repair, operation equipment. This inventory exists because of the need for maintenance and repair of some unknown equipment, so this inventory is a function of the maintenance and repair schedule.

Handoko (2000; 335-336), states that companies carry out inventory storage for various functions, namely:

- (a) Decoupling function

An important function of inventory is to allow internal and external company operations to have freedom (independence). This inventory decouples allows the company to meet customer demand without being disrupted by suppliers.

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(b) Economic Lot Sizing Function

Through inventory storage, companies can produce and purchase resources in quantities that reduce unit costs. With this lot size inventory, savings will be considered

(c) Anticipation Function

Companies often face fluctuations in demand that can be predicted and predicted based on past experience or data. In addition, companies are also often faced with uncertainty over the period for sending goods back, so anticipation must be made for how to overcome them.

Hartati (2017) Autoregressive Integrated Moving Average (ARIMA) models have been extensively studied by George Box and Gwilyn Jenkins (1976), and their name is often symbolized by the ARIMA process applied to time series analysis, forecasting and control. The Autoregressive (AR) model was first introduced by Yule (1926) and then developed by Walker (1931), while the Moving Average (MA) model was first used by Slutsky (1937). However, it was Wold (1938) who produced the theoretical foundations for the ARMA combination process. Wold established ARMA which was developed in three directions namely efficient identification and assessment procedures (for AR, MA and mixed ARMA processes), expansion of the results to include seasonal time series and simple development covering non-stationary processes (non-stationary processes) (ARIMA).

ARIMA is a combination of AR and MA models through a process of differentiation. The autoregressive process can be seen from the PACF plot at a significant lag (cut off), for example in the PACF plot there is a cut off at the 1st lag so that it is called first-order autoregressive with parameter $p=1$ or AR(1). The moving average process is known from the ACF plot at a significant lag (cut off), for example in the ACF plot there is a cut off at the 1st lag, so it is called a first-order moving average with parameter $q=1$ or MA(1). The differentiation process in the ARIMA model aims to obtain stationary data. The differentiation process can be done once or more than once until the data is stationary. Usually this differentiation process is no more than 2 times. The data differentiation process symbol is d .

DISCUSSION

1. Plot Raw Material Data

The data obtained from the fishery company PT Kelola Mina Laut Makassar since the first week of January 2020 – the fifth week of December 2021 are as follows:



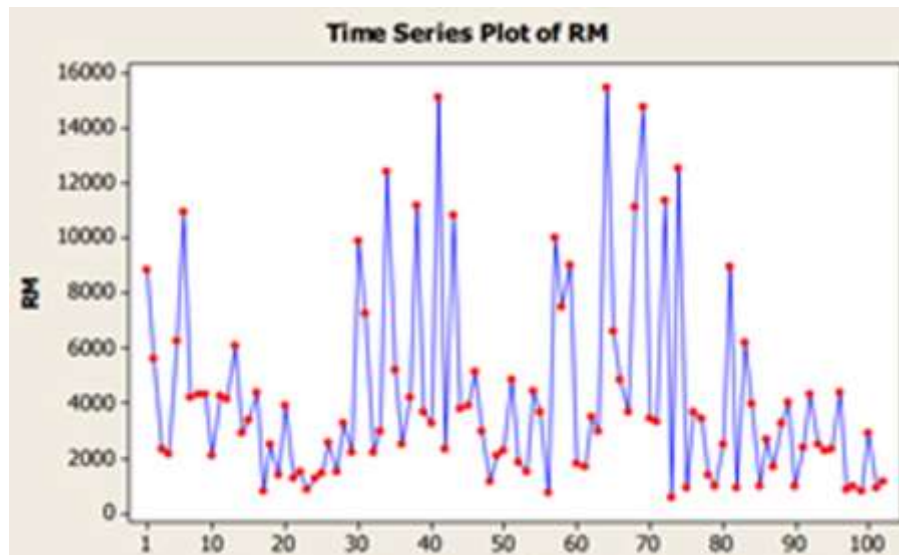


Figure 1. Plot Raw Material data at PT Kelola Mina Laut Makassar
(Source: PT Kelola Mina Laut Makassar)

Based on the raw material data plot in Figure 1, it shows the amount of raw material data per week at PT Kelola Mina Laut Makassar in a period of two years. The plot shows the difference in the amount of octopus raw material with the highest amount in June the 64th week of 2021 of 15,445 tons while the lowest occurred in April the 73rd week of 2021 of 551 kg.

2. Stationary test

Stationarity test is carried out through time series plots, trend analysis plots and Box-Cox. The stationarity test was carried out to test the stationarity of the data. The stationarity of the data to be tested is stationary for variance and mean. Stationary variance is known by looking at the rounded value in the Box-Cox test results which has a value of 1. If the data is not stationary with respect to variance, then data transformation is performed which can be seen in Table 1 below:

Table 1. Box-Cox Transformation

Rounded Value	Transformation
-1,0	$1/Z_t$
-0,5	$1/\sqrt{Z_t}$
0,0	$\ln Z_t$
0,5	$\sqrt{Z_t}$
1	Z_t

Source: Shafira 2018

Data that had been stationary against subsequent variants were tested for stationary against the mean. If the data is not stationary against the average, then a differencing process is carried out to linearize or stabilize the data. Figure 2. The following trend analysis data plot is displayed.

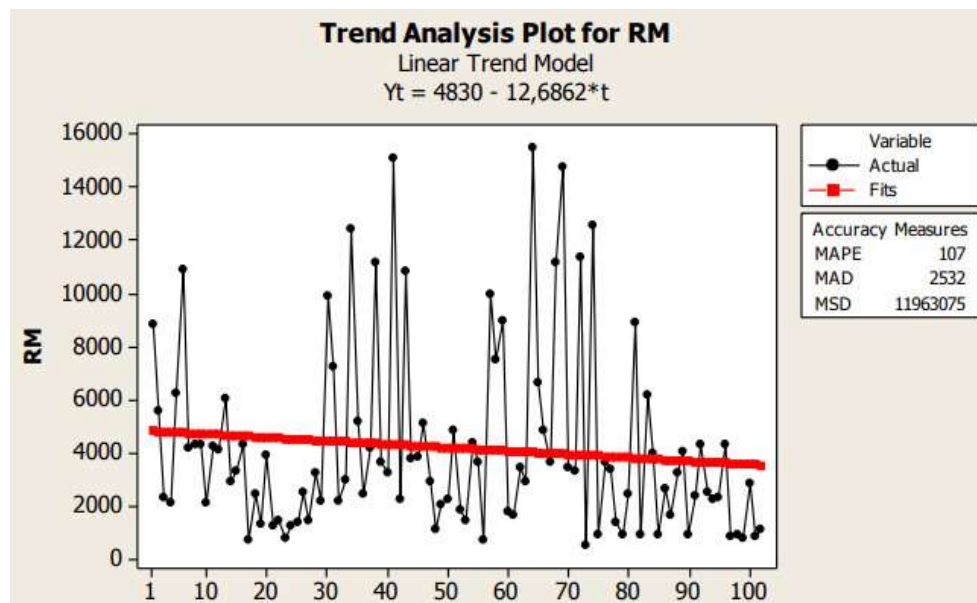


Figure 2. Plot raw material data trend analysis

Based on Figure 2, it shows that the data is not stationary in the average because the raw material data does not fluctuate at the zero point and is not linear, so the first step

that needs to be taken is to test the stationary variance. Stationarity testing of variance using Box-Cox is shown in Figure 3 below.

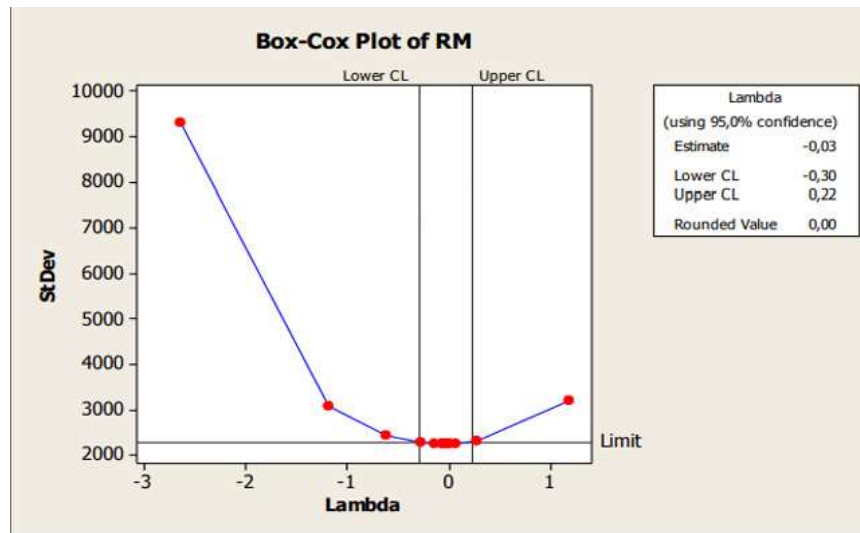


Figure 3. Box-Cox Analysis

Figure 3 is the result of Box-Cox analysis to determine stationary data on variance. The results show that the raw material data obtained a rounded value of 0, so it is concluded that the data is not stationary with respect to variance. Data that is not stationary with respect to variance is transformed using the natural logarithmic (Ln) transformation as shown in Table 1.

The results of the data transformation are shown in Figure 4 below.

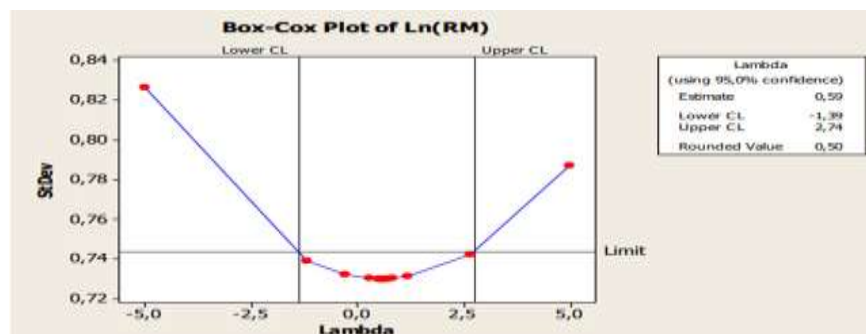


Figure 4. Box-Cox analysis of Ln transformation data.

Figure 4 is the result of Box-Cox analysis on raw material data transformed by Ln. The results show that the rounded value is 0.50. This means that the data is still not stationary with respect to variance because the data requirement is stationary with respect to variance if the rounded value is 1 so that a further transformation is carried out with the type of square root transformation (Table 1).

The results of the square root transformation are shown in Figure 5 below.

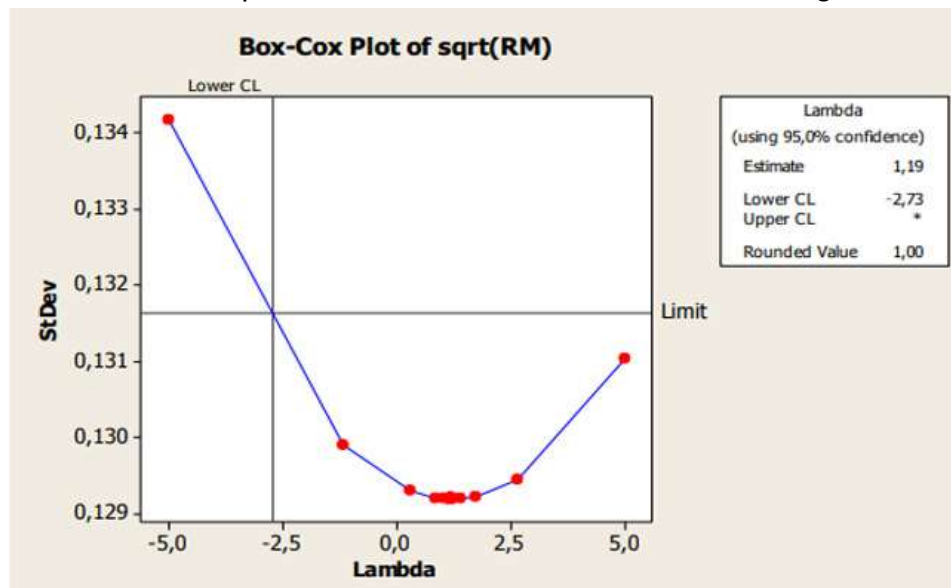


Figure 5. Box-Cox Analysis of Square Root transformation data

Figure 5 is the result of Box-Cox transformation of raw material data with square root transformation. The results show that the rounded value is 1, which means that the raw material data is stationary with respect to variance.

Furthermore, for testing the stationarity of the average, it can be seen by looking at the trend analysis plot as shown in Figure 6 below.

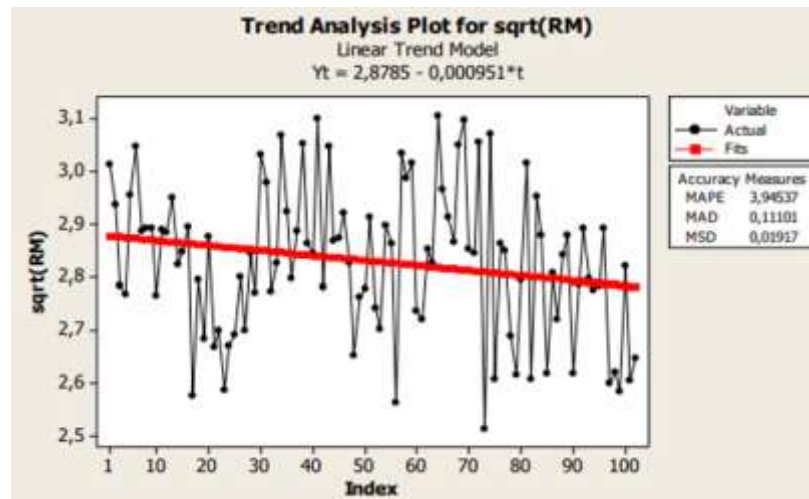


Figure 6. Plot Trend analysis of square root transformation data.

Figure 6 is a plot of trend analysis on the square root transformation data showing that the data is not stationary with respect to the average because the raw material data does not fluctuate at the zero point and is not linear so that in order to stabilize it with the average, differencing is done.

The results of the first differencing are shown in the trend analysis plot of Figure 7 below.

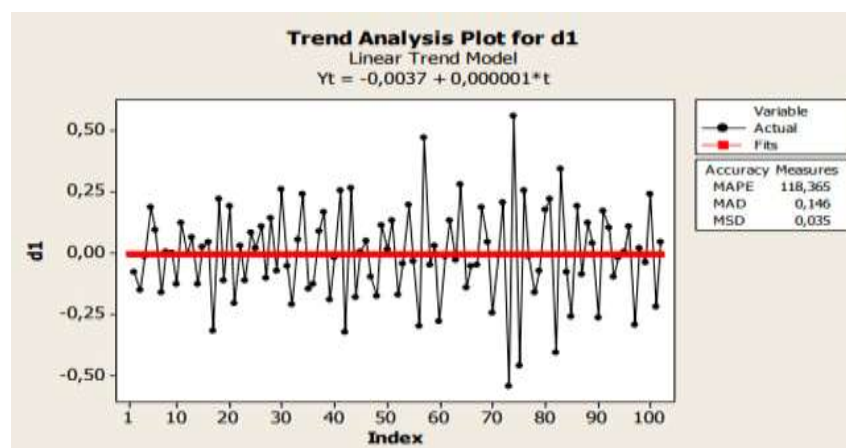


Figure 7 Plot of trend analysis of square root transformation data after differencing

Figure 7 is the result of the trend analysis plot of the square root transformation data after differencing 1 time. The results show that the data is stationary with respect to the average because the raw material data fluctuates at the zero point and is linear. Data that has been stationary with respect to variance and average are then identified by the ARIMA(p,d,q) model where p is a parameter for AR, q is a parameter for MA, and d is a differencing value of 1.

3. Model identification

To obtain AR(p) and MA(q) parameters are identified using ACF plots and PACF plots. Model identification for the AR(q) parameter is shown in Figure 8 below.

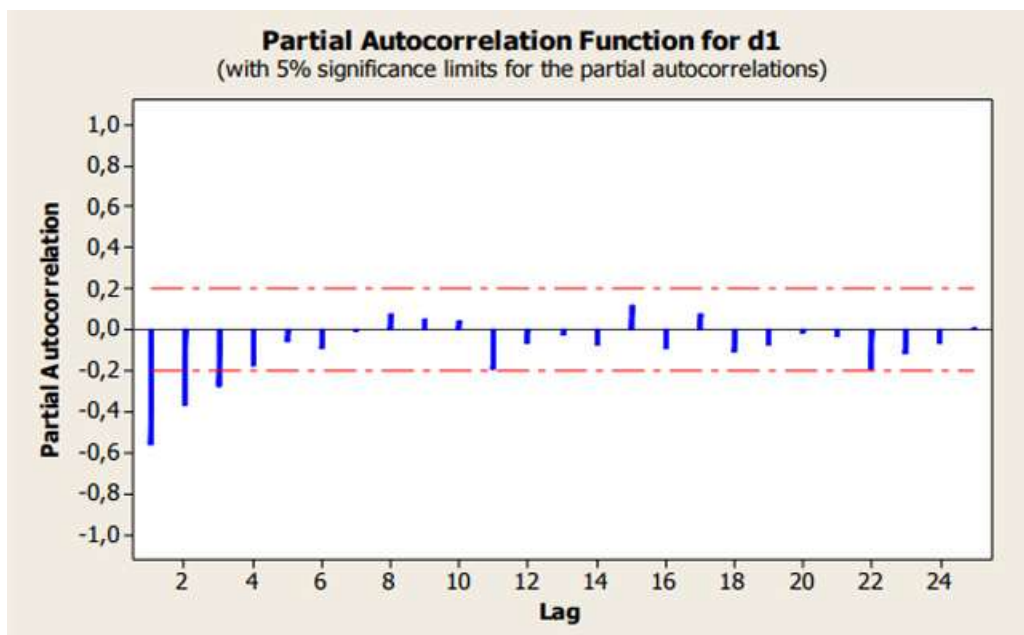


Figure 8 PACF plot

Figure 8 is the result of the PACF data plot for the AR(p) model, there are two lines namely red and blue, the red line is the significant limit and the blue line is the lag. Figure 8 shows that the AR(p) model is cut off until the 3rd lag. So the model obtained is AR(3). Identification of the MA(q) model is shown in Figure 4.9 below.

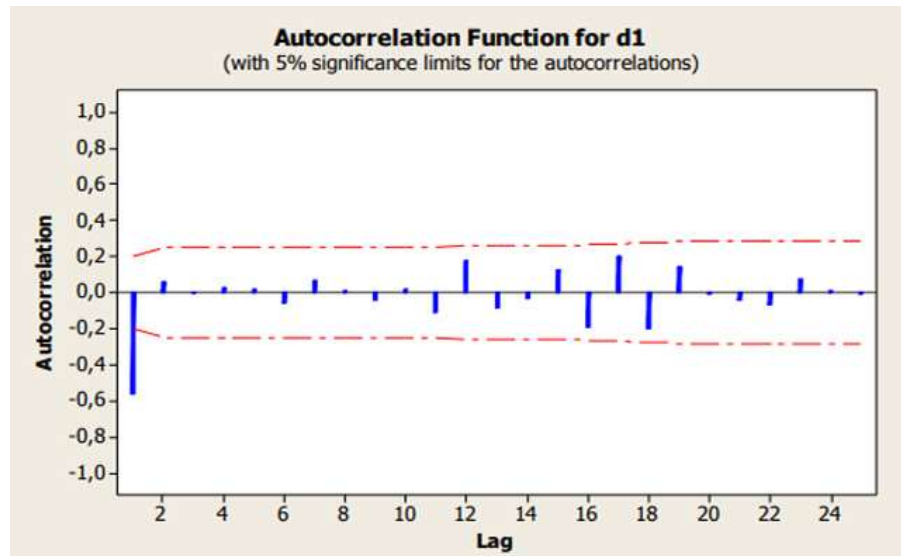


Figure 9. Plot ACF

Figure 9 is the result of the ACF data plot for the MA(q) model. Based on Figure 9, it shows that the MA(q) model is cut off at the 1st lag so that the results of the MA(1) model are obtained. The AR(3) and MA(1) models with $d=1$ are then used to test the significance of the parameters.

4. Diagnostic model and parameter significance test

The AR(3) model and MA(1) model were obtained using the ACF plot and the PACF plot. After estimating the parameter values of the temporarily set ARIMA model, it is necessary to carry out a diagnostic examination to prove that the model is adequate and determine the best model to use for forecasting (Makridakis, 1999).

Table 2. ARIMA model candidate

Model Candidate		Coefficient	p-value	Decision	MSE
ARIMA(3,1,1)	AR(3)	-0,3610	0,000	Significant	0,02193
	MA(1)	-0,9738	0,000	Significant	
ARIMA(0,1,1)	MA(1)	0,8412	0,000	Significant	0,01927
ARIMA(3,1,0)	AR(3)	-0,3040	0,002	Significant	0,01972

Table 2 is a candidate model for determining the best model for forecasting and parameter significance testing. The significant parameter requirement is $p\text{-value} < 0.05$. Based on Table 2, after carrying out the significance test of the three models, namely ARIMA(3,1,1), ARIMA(0,1,1), and ARIMA(3,1,0), it gives results of significant coefficients for all of these models because each -each $p\text{-value} < 0.05$. Furthermore, after obtaining a significant model then the best model is selected based on the smallest Mean Square Error (MSE) criteria.

5. The best models

One of the model selection criteria that can be used to select the best model is based on forecasting errors, the smaller the Mean Square Error (MSE) value, the better the model is to be selected. Selection of the best model is shown in Table 3 below.

Table 3. ARIMA Model Selection Results

Model Candidate		MSE
ARIMA(3,1,1)	AR(3)	0,02193
	MA(1)	
ARIMA(0,1,1)	MA(1)	0,01927
ARIMA(3,1,0)	AR(3)	0,01972

Table 3 is the MSE value of each model, namely ARIMA(3,1,1), ARIMA(0,1,1), and ARIMA(3,1,0). Based on Table 3, the MSE value for the ARIMA(3,1,1) model is 0.02193, the ARIMA(0,1,1) model is 0.01927, and the ARIMA(3,1,0) model is 0.01972. Selection of the best ARIMA model based on the smallest MSE value is ARIMA (0,1,1) with a value of 0.01927 so that the ARIMA model (0,1,1) is used for forecasting raw material data. The best ARIMA model obtained is then forecasted.

6. Forecasting

After getting the best ARIMA model, namely ARIMA(0,1,1) with a Mean Square Error (MSE) value of 0.01927 and a mean absolute percentage error (MAPE) value of 16.89%. The lower the MAPE value, it can be said that the forecasting model has good abilities.

The range of values for MAPE can be seen in Table 4 below.



Table 4. MAPE Value Range

MAPE	SIGNIFICANCE
<10%	Excellent Forecasting Ability
10-20%	Good Forecasting Ability
20-50%	Decent / Adequate Forecasting Ability
>50%	Poor Forecasting Ability

Source, Hutasuht. 2014

The MSE and MAPE values that have been obtained are then forecasted on the raw material data for the next 48 weeks. The forecasting results obtained are the data resulting from the transformation in the modeling so that the transformation is carried out again by squaring and exponentiating the forecasting results to get the actual raw material forecasting data.

Forecasting data for raw materials for the next 48 weeks is shown in Figure 10 below.

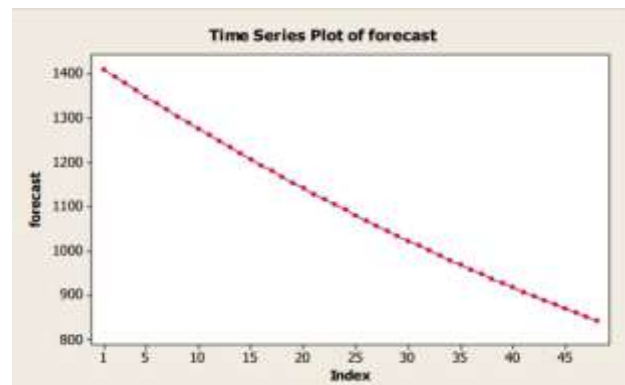


Figure 10. Plot Time Series Forecast

Figure 10 is the result of forecasting the next 48 weeks for octopus raw material data at PT Kelola Mina Laut Makassar. Based on Figure 10, it can be seen that the forecast for the next 48 weeks of raw materials will decrease every week. The highest raw material data in the 1st week was 1,409 tons and the lowest raw material data in the 48th week was 816 kg.

The data used is weekly octopus raw material data at PT Kelola Mina Laut Makassar for a period of two years. Raw material data is then analyzed for raw material inventory using the ARIMA method. Figure 1 is a plot that shows that there are differences in the amount of octopus raw material with the lowest amount in the second week of June

2021 while the highest occurs in the first week of April 2021. The initial stage of estimating the ARIMA model is to check the stationarity of the data against the variance and stationary against the average because the ARIMA model assumes that the data is stationary in variance and mean. Stationary to variance was tested using a boxcox plot while stationary to the average was tested using a time series plot. If the data is not stationary with respect to variance, a Box-Cox transformation is performed. If the data is not stationary with respect to the average then it is done differencing. After testing the time series plot to determine the data of stationary octopus raw materials for variance and average or not. Figure 1 shows that the octopus raw material data is not stationary with respect to the variance and the average, so to stationary the data on the variance, a Box-Cox transformation is performed. Stationary variance can be identified by looking at the rounded value, which is 1. The results of the stationary test for variance can be seen in Figure 3. It shows that the raw material data obtained a rounded value of 0, so it can be concluded that the data is not stationary with respect to variance. Data that is not stationary with respect to variance is transformed by using the natural logarithmic (Ln) transformation as shown in Table 1.

The results of the stationary transformation of the variance can be seen in Figure 4 showing that the rounded value is 0.50. This means that the data is still not stationary with respect to variance, so a further transformation is carried out with the square root type (Table 1). The results of the BoxCox transformation of the raw material data with the square root transformation can be seen in Figure 5 showing a rounded value of 1 so it is concluded that the data is stationary with respect to variance. Furthermore, the stationary test of the average is carried out with a trend analysis plot. Figure 6 is a trend analysis plot which shows that the data is not stationary with respect to the average because the data does not fluctuate at the zero point, so differencing is done to be stationary. The results of differencing can be seen in Figure 7 which shows that the data has been stationary with respect to the average at differencing 1 time. After the data is stationary on the variance and average, we then identify the ARIMA(p,d,q) model where p is a parameter for AR, q is a parameter for MA, and d is a differencing value of 1.

The AR(p) model is obtained on the PACF plot and the MA(q) model uses the ACF plot. The AR(p) model from the PACF plot can be seen in Figure 8 which shows that the AR(p) model is cut off at the 3rd lag so that the model obtained is AR(3). The MA(q) model from the ACF plot can be seen in Figure 9 which shows that the MA(q) model is cut off at the 1st lag so that the model obtained is MA(1). So that the results of the identification of the model obtained are AR(3), MA(1), and differencing models once (d=1). After obtaining

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the next model, it is necessary to carry out diagnostic examinations and significance tests to prove that the model is adequate and determine the best model to use for forecasting (Makridakis, 1999).

Table 2 is a candidate model resulting from the determination of the ARIMA model, there are three candidate models namely ARIMA(3,1,1), ARIMA (0,1,1), and ARIMA(3,1,0). The three models were then tested for significance. The significant requirement is p-value <0.05 and the results show that the three ARIMA models provide significant results because the p-value obtained is <0.05. After the significance test is carried out, it is continued by determining the best model based on the smallest MSE criteria, the smaller the MSE value, the better the model is to be selected. Table 3 is the selection of the ARIMA model with the smallest MSE value for the ARIMA(3,1,1) model of 0.02193, the ARIMA(0,1,1) model of 0.01927, and the ARIMA(3,1,0) model of 0.01972. The selection of the best ARIMA model based on the smallest MSE value is ARIMA (0,1,1) with a value of 0.01927 so that the model is used for forecasting raw material data. After obtaining the best ARIMA model, forecasting octopus raw material data for the next 48 weeks is carried out using the ARIMA(0,1,1) model. The forecasting results obtained are the data resulting from the transformation in the modeling so that the transformation is carried out again by squaring and exponentiating the forecasting results to get the actual raw material forecasting data. Figure 10 is the result of forecasting raw material data for octopus at PT Kelola Mina Laut Makassar for the next 48 weeks, experiencing a decrease in raw materials every week.

Factors causing a decrease in raw materials are delays in the supply of raw materials from suppliers and reduced availability of raw materials from suppliers (Noerprantomo, 2018). Factors that affect the supply of raw materials, (Ahyari, 1999 in Amri, 2018), namely: Estimated use of raw materials Before a company purchases raw materials, management must be able to estimate the raw materials that will be used in the production process in a period, the price of raw materials is the basis for calculating how much company funds must be provided in this raw material inventory. Inventory costs are the costs incurred by the company to carry out raw material inventories which are taken into account in determining the amount of raw material inventories. The amount of raw material inventory to get funds from the company depends on the company's spending policy.

The use of raw materials from past periods is one of the factors that can be used to prepare estimates of raw material needs close to reality, waiting time is the time required between ordering raw materials until the arrival of the raw materials themselves.



This study uses the ARIMA(0,1,1) model with a Mean Square Error (MSE) value of 0.01927 and a MAPE value. Mean Absolute Percentage Error (MAPE) shows forecasting accuracy in percentage form. The MAPE results obtained manually were 16.89%, which means that the MAPE range is in the range of 10-20% indicating that the forecasting ability is good. (Table 4).

CONCLUSION

Based on the results of ARIMA modeling, the right model was obtained to describe the analysis of octopus raw material inventory data (Octopus Sp) at PT Kelola Mina Laut Makassar, namely with the ARIMA model (0,1,1) with MSE 0.01927 and MAPE of 16.89%. The ARIMA(0,1,1) model can be concluded that octopus raw material data at PT Kelola Mina Laut Makassar with weekly data within two years for the next 48 weeks forecast has decreased.

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