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Autoregressive Integrated Moving Average (ARIMA) Simulation Methods In Product Inventory 9969B Printable Splicing Tape

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Abstract - Simulation is applied to the 9969B Printable Splicing Tape product. The ARIMA (Autoregressive Integrated Moving Average) method, which is a method that is based on the values of changes that have occurred in the past, is then used to determine historical data patterns. This research aims to simulate forecasting inventory control needs for Printable Splicing Tape stock. The temporary ARIMA model is p = 8 (PACF dying down plot), d = 2 (one differencing), and q = 1. So, the temporary ARIMA model obtained is (8, 2, 1). The sales forecast for all Printable Splicing Tape products type 9969B on average per month during June-December 2023 is estimated that the average forecast for the company's Inventory Control must stock 608 rolls with a tracking error of -1 (e < 4) so it is very permissible because it is less than quaternion.

Keywords: *Inventory, ARIMA, Moving Average*

I. INTRODUCTION

Control of products as inventory is carried out by the Inventory Control (IC) section. This section organizes procurement and inventory control to support sales activities. One of the activities of this section is providing product quantity data to the purchasing department to order from PT 3M Indonesia[1]. Product orders are based on the number of requests determined by the Inventory Control (IC) section and the marketing department by calculating the amount of inventory in the warehouse. All products purchased by PT. ACA from PT 3M Indonesia is an imported product imported by PT 3M Indonesia from its factories in the Americas, Europe, Asia, and Australia. The business world is currently faced with competitive conditions, so the need for forecasting for production handling must be good [2].

Ordering activities are divided into 2, namely regular orders and emergent orders. Regular orders are product orders that are made regularly every month with a lead time of 5 working days for products available in the PT 3M Indonesia warehouse and 3 months if there is no inventory at PT 3M Indonesia and must be imported from factories abroad. successful business, a fairly large amount of capital is required [3]. Delivery of products from PT 3M factories abroad to PT 3M Indonesia is carried out by sea transportation mode (ship) or by air transportation mode (air freight). Meanwhile, emergency orders are carried out as an action against an increase in demand from customers. The form is in the form of additional (additional) order quantities [4]. Additional order activities require additional product procurement costs. In emergency orders, product delivery with an accelerated delivery lead time uses air transportation mode (air freight) [5].

The ARIMA (Autoregressive Integrated Moving Average) method, which is a method that is based on the values of a variable that has occurred in the past, is then used to determine historical patterns of data and then to extrapolate these patterns into the future [6]. The concept of applying ARIMA is by plotting time series data (time series plot), ACF, and PACF [7]. Test data stationarity by looking at time series data plots, ACF plots, and Box-cox plots, and carrying out unit root tests using the ADF test [8].

Carrying out data transformation is done by using the Box-Cox transformation method if the data used is not stationary in variance. Perform differentiation on data if the data used is not stationary on average. Next, check the stationarity of the data that has been transformed or differentiated. This stage is carried out until the data is stationary [9].

Determine the temporary prediction model. Determine the model order by looking at the ACF and PACF plots of stationary data. Estimating the parameters and then testing the

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significance of the model parameters using the t-test or looking at the p-value [10].

Based on existing historical data, the most frequent shortages and overstocks are adhesive and double-sided tape. This condition occurs due to quite large fluctuations in changes in demand estimates, without any method that can anticipate changes that occur by paying attention to possible demand patterns that were formed in the previous period. This shortage and overstock situation occurs in imported materials with a long lead time (3 months), certainly not a good forecast for a very large company [11].

To overcome these fluctuations, proper inventory control is needed. Inventory shortages can cause PO cancellations and customers switching to using competitor products so that customers do not cancel POs and switch to using PT competitor products. ACA [12]. This research aims to simulate forecasting inventory control needs for Printable Splicing Tape stock.

II. METHODOLOGY

The ARIMA model itself is a combination of the AR (Autoregressive) model, which is a method for seeing the movement of a variable through the variable itself, and MA (Moving Average), which is a model for knowing the movement of a variable with its residuals in the past [13]. Seasonal ARIMA (SARIMA) is a development method of the ARIMA method for forecasting patterned data. These two methods were chosen because they have good forecasting accuracy for short-term forecasting. The ARIMA method is used for data with constant data patterns, while the SARIMA method is generally used for data with seasonal patterns.

The equipment used in this research is SPSS version 26.0 software which is used to create forecast models using the ACF and PACF methods, as well as model forecasts using the ARIMA method, and Microsoft Excel is used to calculate correlation and RMSE (Root Mean Square) values. Error) between the output results of the two methods. Sample data was obtained from requests from two companies, namely PT. TJ Mojokerto and PT. SP Sidoarjo, data taken in 2023 for product type 9969B.

III. RESULT AND DISCUSSION

PT ACA receives orders from consumers in the form of purchase orders (PO). Consumers issue a PO every month for one delivery or a PO forecast for delivery in the next 2-3 months, with a maximum lead time of 5 working days from the delivery date determined by the consumer, if this is not met there could be cancellation of the PO because the consumer does not use one brand for double tape.

Figure 1. 9969B *Printable Splicing Tape*

Based on this data, there is a difference between demand and stock provided by the company, where a stock reaches 7.450 rolls and demand reaches 6,470 rolls, resulting in a difference of 980 rolls or around 15.1%.

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Table 1. Demand and Stock for Product Type 9969 B

No	Month	*Customer Quantity*		Qty Total	Amount Stock
		PT. TJ	PT. SP		
1	January	0	0	0	800
2	February	700	325	1025	800
3	March	0	400	400	1000
4	April	0	0	0	200
5	May	800	300	1100	200
6	June	200	100	300	600
7	July	900	370	1270	800
8	August	0	300	300	400
9	September	0	450	450	500
10	October	125	0	125	400
11	November	800	600	1400	1750
12	December	0	100	100	0
			Total	**6470**	**7450**
			Difference	**980**	
			%	**15.1%**	

Suorce : PT ACA, 2023

Bearing in mind that in 2023 the double tape product type 9969 B will experience a stock difference of 980 rolls or around 15.1%, so to reduce this, linear trend forecasting is used which is based on demand and stock for January - June 2023 to forecast demand and stock for July - December 2023

Table 2. Percentage Of Stock Difference For Double Tape Product Type 9969B

No	Month	Stock	Forecast (*MAV*)	Demand
1	January	800	800	0
2	February	800	800	1025
3	March	1000	1000	400
4	April	200	200	0
5	May	200	200	1100
6	June	600	600	300
7	July	800	604	1270
8	August	400	605	300
9	September	500	605	450
10	October	400	606	125
11	November	1750	607	1400
12	December	0	607	100
	Total	**7450**	**7234**	**6470**
	Difference	**980**	**764**	
	Difference (%)	**15.1**	**11.8**	

Based on this forecast, the number of rolls of double tape type 9969B during 2023 required 7234 rolls with a demand of 6470 rolls so the difference is smaller, namely 764 rolls or around 11.8% from the initial stock (original) of 15.1%, there is an estimated decrease in the stock of around 3.3%.

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1. Average Stationarity

Stasioneritas rata-rata dilakukan untuk mengetahui apakah data penjualan selama berbulan-bulan pada kedua perusahaan yang membutuhkan produk perusahaan PT ACA, stasioner terhadap rata-rata. Stasioneritas rata-rata menggunakan plot ACF dan PACF untuk menunjukkan autokorelasi data pada ARIMA

Average stationarity was carried out to find out whether sales data for months at the two companies that needed PT ACA company products were stationary relative to the average. Average stationarity uses ACF and PACF plots to show data autocorrelation in ARIMA.

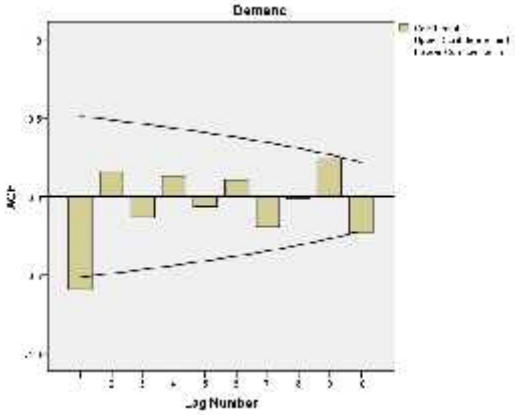

Figure 2. ACF (Autocorrelation Function)

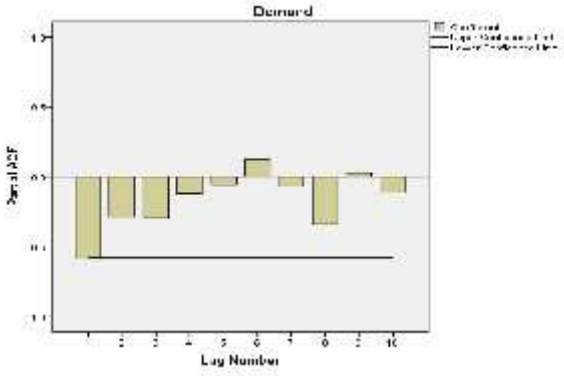

Figure 3. PACF (Partial Autocorrelation Function)

Figure 2 shows the ACF data plot after one differencing, as well as Figure 3 shows the PACF plot after one differencing. One differentiation carried out in ARIMA will determine the order d in the ARIMA model.

Based on Figure 3 and Figure 4, it can be seen that the PACF plot is more dying down than the ACF plot, so the data tends to be AR (Autoregressive). Because the data tends to be AR of order p in the ARIMA model

1. Identify the ARIMA Model

The ARIMA model has the notation (p, d, q). Where the order p is Autoregressive (AR), d is a difference, and q is Moving Average (MA). Based on Figure 2 and Figure 3, the temporary ARIMA model obtained is p = 8 (PACF dying down plot), d = 2 (one differencing), and q = 1. So, the temporary ARIMA model obtained is (8, 2, 1)

One way to evaluate forecasting techniques is to use a measure of the level of difference between forecast results and actual demand which is often used, namely MAD. This is the average absolute error over a certain period without paying attention to whether the forecast results are greater or smaller than reality. Mathematically, MAD is formulated as follows:

2. *Mean Absolute Deviation* = MAD

$$\text{the th MD} = \sum \left| \frac{\text{At} + \text{Ft}}{\text{n}} \right|$$

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Calculating of MAD

$$\text{Period I (0,1)} = \frac{-0.78 - 1.31 - 1.78 - 2.20 - 2.58 - 2.92}{6} = -11.56/6 = -1.93$$

$$\text{Period 2 (0,2)} = \frac{-0.76 - 1.21 - 1.57 - 1.86 - 2.08 - 2.27}{6} = -9.75/6 = -1.63$$

$$\text{Period 3 (0,5)} = \frac{-0.70 - 0.95 - 1.08 - 1.14 - 1.17 - 1.19}{6} = -6.22/6 = -1.04$$

3. *Mean Square Error* = MSE

MSE is an alternative method in a forecasting method. This approach is important because this technique produces moderate errors rather than a forecast that produces very large errors. MSE is calculated by adding the squares of all forecast errors in each period and dividing it by the number of forecasting periods, and the calculation results are as follows:

$$\text{MSE} = \sum \left[\frac{A + F}{n}\right]^2$$

Calculating of MSE

$$\text{Period I (0,1)} = \frac{-(0.78)^2 - (1.31)^2 - (1.78)^2 - (2.20)^2 - (2.58)^2 - (2.92)^2}{6} = 25.48/6 = 4.25$$

$$\text{Period 2 (0,2)} = \frac{-(0.76)^2 - (1.21)^2 - (1.57)^2 - (1.86)^2 - (2.08)^2 - (2.27)^2}{6} = 17.44/6 = 2.91$$

$$\text{Period 3 (0,5)} = \frac{-(0.70)^2 - (0.95)^2 - (1.08)^2 - (1.14)^2 - (1.17)^2 - (1.19)^2}{6} = -6.62/6 = 1.10$$

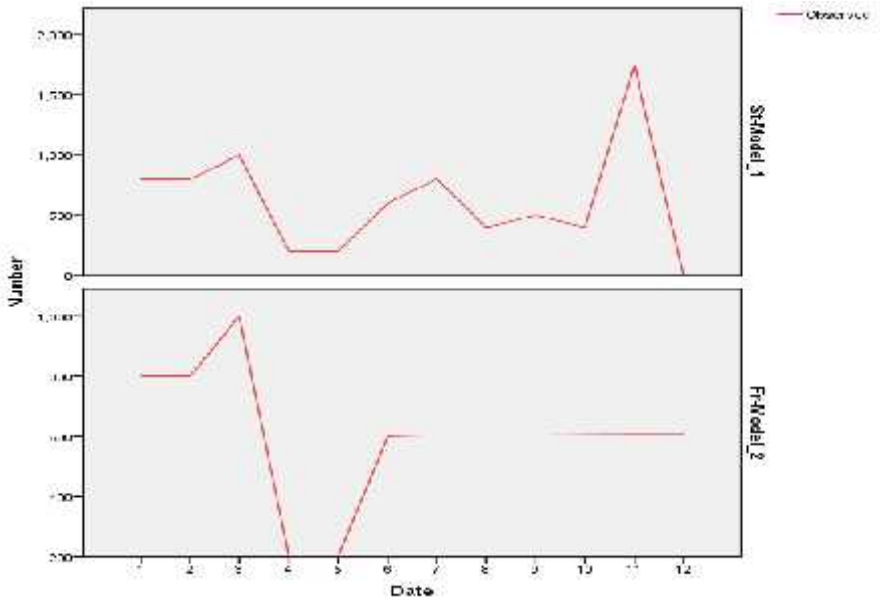

Figure 5. Demand Fluctuation Trends

In the first Stock Model image (ST-Model_1) there is an up and down trend indicating that the observed variables experienced fluctuations or changes in the period analyzed. An up-and-down trend can indicate a cyclical pattern or natural fluctuation in company data before forecasting is carried out in 2020. In contrast to the image of the Second Forecasting Model (Fr-Model_2), after the fifth month, there is a stable fluctuation until the twelfth month based on market demand for 9969B Printable products Splicing Tape.

The results for $\sigma = 0.5$ tracking signal for the value in the 7th month (2023 period) with an actual stock value of 608 with a forecasting stock result of 607, the result is a reduction of 0.70 and divided by MAD of -1.04, the tracking signal is -0.68, The following is the basis of the analysis:

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$$t_i = \frac{\sum a \quad - f}{M}$$

a. The forecasting results for stock in the 7th month (July 2023) were set at 607 rolls with a forecasting tracking error of -0.68 (this is said to be feasible because the tracking error value is below 4 or e < 4)
b. Forecasting results for stock in the 8th month (August 2023) were set at 607 rolls with a forecasting tracking error of -0.92 (this is said to be feasible because the tracking error value is below 4 or e < 4)
c. The forecasting results for stock in the 9th month (September 2023) were set at 608 rolls with a forecasting tracking error of -1.04 (this is said to be feasible because the tracking error value is below 4 or e < 4)

$$t_i = \frac{\sum 608 - 607}{-1.04}$$
$$= -0.68$$

d. The forecasting results for stock in the 10th month (October 2023) were set at 608 rolls with a forecasting tracking error of -1.10 (this is said to be feasible because the tracking error value is below 4 or e < 4)
e. Forecasting results for stock in the 11th month (November 2023) were set at 609 rolls with a forecasting tracking error of -1.13 (this is said to be feasible because the tracking error value is below 4 or e < 4)
f. The forecasting results for stock in the 12th month (December 2023) were set at 610 rolls with a tracking error forecast of -1.14 (this is said to be feasible because the tracking error value is below 4 or e < 4)

IV. CONCLUSION

1. Inventory estimates for product 9969B after forecasting, the number of rolls of double tape type 9969B during 2023 is needed at 7234 rolls with a demand of 6470 rolls so the difference is smaller, namely 764 rolls or around 11.8% of the initial (original) stock of 15.1%, there is an estimated decrease in stock around 3.3%.
2. Forecasting for Product 9969B on average per month during December 2023, it is estimated that the average forecast for the company's Inventory Control must stock 608 rolls with a tracking error or forecast error of -1 (e < 4) so it is very permissible.
3. The ARIMA model has the notation (p, d, q). Where the order p is Autoregressive (AR), d is a difference, and q is Moving Average (MA). Based on Figure 2 and Figure 3, the temporary ARIMA model obtained is p = 8 (PACF dying down plot), d = 2 (one differencing), and q = 1. So, the temporary ARIMA model obtained is (8, 2, 1)
4. In the first Stock Model image (ST-Model_1) there is an up and down trend indicating that the observed variables experienced fluctuations or changes in the period analyzed. An up-and-down trend can indicate a cyclical pattern or natural fluctuation in company data before forecasting is carried out in 2020. In contrast to the image of the Second Forecasting Model (Fr-Model_2), after the fifth month, there is a stable fluctuation until the twelfth month based on market demand for 9969B Printable products Splicing Tape.

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