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Comparative Analysis of Arima Model and Exponential Smoothing in Predicting Inventory in Automotive Companies

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Abstract

Forecasting is an activity to predict future events by using and considering data from the past. Forecasting is an important tool in effective and efficient planning. So that demand forecasting can be predicted and the amount of inventory can be determined in order to anticipate the number of varied and fluctuating demand. In order to obtain good forecast results, a forecasting method is used that can predict seasonal data. This study aims to determine the best forecasting model using ARIMA and exponential smoothing methods and to compare the forecasting results with the two methods in order to obtain the best method. Data on the number of requests for cars PT. Suzuki Indomobil Motor 2017 – 2019 is data that contains seasonal patterns so that ARIMA and Holt-Winters exponential smoothing can be used. Data obtained by means of documentation with secondary data collection and literature study. The results show that PT Suzuki Indomobil Motor is more appropriate to use the Holt-Winters Additive exponential smoothing method because the resulting error rate is smaller.

Keywords
ARIMA; exponential smoothing; forecasting

I. Introduction

Various parties are increasingly paying attention to global competition and free trade. Every company was founded to achieve various goals, one of which is to gain profits and maintain business continuity. Companies need to develop plans to achieve the desired profit and must be able to survive and compete in the midst of globalization that occurs in the world of services and industry. Therefore, every company must be able to compete with similar companies (Sentosa & Trianti: 2017).

Development is a systematic and continuous effort made to realize something that is aspired. Development is a change towards improvement. Changes towards improvement require the mobilization of all human resources and reason to realize what is aspired. In addition, development is also very dependent on the availability of natural resource wealth. The availability of natural resources is one of the keys to economic growth in an area. (Shah, M. et al. 2020)

In the operational plan, in terms of the availability of manpower, raw materials, machinery and other equipment, the effectiveness of the production plan is highly considered by company management. One of the important factors is planning the supply of raw materials on time to meet customer needs by supporting the smooth implementation of the company's production process (Wijayanti: 2018). Many physical inventories involve a very large investment. If the company invests too much of its funds in inventory, it will cause excessive storage costs (extra carrying cost), as well as if the company does not have sufficient inventory, it will result in additional costs that occur due to lack of materials and non-smooth production processes (stock out cost). .

Forecasting methods are needed to determine the amount of demand in the future so that policies can be determined in inventory planning. Forecasting must also be careful in

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choosing an effective forecasting method because forecasting that is too low will result in a shortage of inventory, so that consumer demand cannot be met. On the other hand, too high a forecast will result in a buildup of stock in the warehouse, which can also risk damaged or lost goods causing company losses. The accuracy of the forecasting results plays an important role in balancing the ideal inventory. Forecasting methods can be done qualitatively and quantitatively as well as to analyze consumer demand for cycles, trends and seasonality,

PT. Suzuki Indomobil Motor is a private company engaged in the automotive industry. In fulfilling the needs of its consumers, PT. Suzuki Indomobil Motor prioritizes professional services in the field of product marketing. This can be seen from PT. Suzuki Indomobil Motor which is very consistent with after-sales service of spare parts as well as repair and maintenance throughout Indonesia which is solid and integrated in serving Suzuki customers. So that in carrying out its business, PT. Suzuki Indomobil Motor also pays attention to the level of effectiveness and efficiency of all activities carried out to support productivity and product quality.

II. Review of Literature

2.1 Forecasting

Forecasting is a picture of the state of the company in the future. This picture is very important for company management because with this picture the company can predict what steps are taken to meet consumer demand. Forecasting is intended to minimize the effect of risk and uncertainty on the company (Rahmadayanti et al: 2019).

2.2 Inventory

Inventory is a current asset which includes goods belonging to the company with the intention of being sold in a normal business period or inventory of goods that are still in the work of the production process or inventory of raw materials waiting for their use in a production process (Rahmadayanti et al: 2017). In general, various organizations use three main types of forecasting in planning operations for the future, namely (Hayuningtyas (2017):

1. Economic forecasting includes economic flows by forecasting inflation, money supply, housing development, and other planning indicators.
2. Technological forecasts are related to the level of technological development, which can result in the creation of new, more attractive products, which require new industries and new equipment.
3. Demand forecasts are forecasts of demand for a company's products or services. Forecasting plans are estimates of the company's sales for each period.

Economic actors, basically have very important functions. Because it has two functions at once, namely as a supplier of all the needs of the community, both primary, secondary and tertiary. At the same time, they also function as absorbers of community labor, which can economically increase purchasing power. (Ansari, T. 2019)

Forecasting time horizons are classified by the time horizon in the future that surrounds them. Viewed from the time horizon, forecasting is classified into three categories (Wijayanti: 2018), namely:

1. Short term forecasting.
   This forecast has a time span of up to one year, but generally less than three months. Used for purchasing plans, action plans, labor levels, work assignments, and production levels.

2. Medium term forecasting.
   Intermediate range, or intermediate, forecasting generally covers a time range from three months to three months. Useful in sales planning, production planning and budgeting, cash budgeting, and analysis of variations in operational plans.
3. Long term forecasting.
   Generally three years or more in time span, long-term forecasting is used in planning for new products, capital expenditures, location of facilities or expansions, research, and development.

2.3 Previous Research

Based on several previous studies regarding inventory prediction analysis, there have been quite a number of related studies from various sources. The use of ARIMA and Exponential Smoothing models as an analytical tool to predict inventory is considered to be a fairly accurate model. Previous research often uses secondary data to predict the inventory itself through documentation data in the previous period. The recapitulation of previous research used for review in conducting research is presented as follows:

Research conducted by Rahmadayanti et al (2015) by comparing the Autoregressive Integrated Moving Average (ARIMA) and Exponential Smoothing models in Forecasting Cement Sales at PT. Eternal Light. From the calculation results, it can be concluded that the ARIMA method is more accurate because it has a smaller MSE value than the Exponential Smoothing method. Meanwhile, research conducted by Safitri et al (2017) compared the Holt-Winters and ARIMA Exponential Smoothing Method. The results show that the forecasting comparison is more appropriate using the Holt-Winters exponential smoothing method than ARIMA because it produces a smaller error value than the ARIMA method error value.

2.4 Research Hypothesis

The relationship between each variable can be concluded that the hypothesis in this study is as follows:

1. The first hypothesis was determined, namely that: The ARIMA model is more accurate than the Exponential Smoothing Model.
2. The second hypothesis is determined that: Exponential Smoothing Model is more accurate than ARIMA Model.

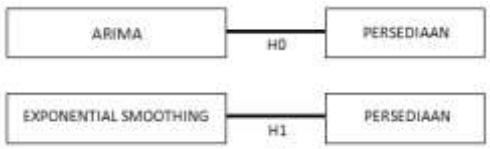


***Figure 1**. Research Model*

This study aims to obtain an overview of the object and obtain forecasting results which are then converted for the benefit of company management to calculate raw material inventory and help management make decisions, one of which is to hold a safety stock of raw materials.

The population in this study is the entire production demand of PT Suzuki Indomobil in the Cikarang area since the period the company was founded until now. While the research sample is the demand for the product to be studied is the demand for the car product of PT. Suzuki Indomobil Motor (January 2017 – June 2019) which can

be a representation to describe the demand behavior of the company. The sampling technique used is non-probability sampling, namely purposive sampling to facilitate researchers in determining the nature and characteristics that will be used in this study with certain considerations.

III. Research Method

In this study, the data were analyzed using two forecasting models, namely Exponential Smoothing and ARIMA models with the help of Eviews.10 and Microsoft Excel 2010 software.

3.1 Arima

The following is the forecasting process using the ARIMA method which will be carried out starting from:

1. Input data to be forecasted.
2. Create a request data pattern.
3. Test the stationarity of the data using the stationary test on the average.
4. Carry out the differentiation process *(differentiated).*
5. Identify the appropriate Box Jenkins models, namely AR, MA, and ARMA models.
6. Choose the best model from the Box Jenkins model.
7. ARIMA model verification.
8. Estimating the Box Jenkins model parameters and testing the significance of the parameters.
9. Forecasting with the best models.
10. Forecasting results obtained by measuring the level of error.

3.2 Exponential Smoothing

The following is the forecasting process using the Exponential Smoothing method

1. Enter the data that will be carried out in the forecasting process.
2. Plot the request data.
3. Test the stationarity of the data using the stationary test on the average.
4. Determination of the best parameters.
5. Identify the model *Exponential Smoothing* the appropriate one based on the plot of the graphic data.
6. Doing forecasting with the method *Exponential Smoothing.*
7. Forecasting results obtained by measuring the level of error.

3.3 Comparison of ARIMA and Exponential Smoothing

After the MSE and MAPE values from the ARIMA and Exponential Smoothing models are obtained from the data test results, then a comparison will be made to the MSE and MAPE values as follows:

1. If the value of MSE and MAPE Exponential Smoothing < MSE and MAPE ARIMA, then the Exponential Smoothing model provides better performance than ARIMA because the resulting error rate is smaller.
2. If the MSE and MAPE ARIMA values are <MSE and MAPE Exponential Smoothing, then the ARIMA model provides better performance than Exponential Smoothing because the resulting error rate is smaller.

IV. Results and Discussion

4.1 ARIMA method

a. Data Pattern

Through the data graph, it can be seen whether the data has a declining trend or there are seasonal fluctuations. Based on the picture above, it can be seen that there is an indication that the data is not stationary on average. It can be seen from the graph that the trend is decreasing.

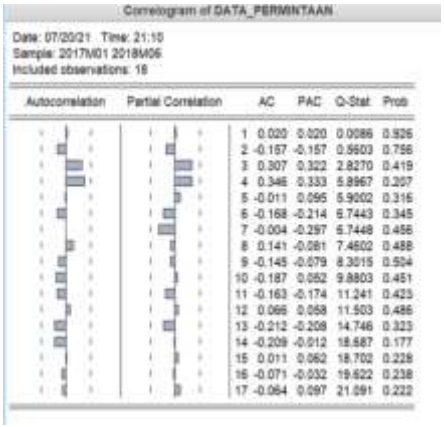
Source: Eviews Data Processing Results

Figure 1. *Demand Data Pattern of PT. Suzuki Indomobil Motor*

The data pattern in the figure contains seasonal or seasonal patterns, then the stationary data is calculated so that it can determine the method to be used in the forecasting process. The stationarity of the data can be tested by plotting the data and calculating the ACF.

b. Parameter Estimation

To determine the arima model (p,d,q), first determine the value of d with a data stationarity test using the ACF and PACF plots from the correlogram as follows:



Source: Eviews Data Processing Results

Figure 2. *Autocorrelation plots (ACF) and partial autocorrelation plots (PACF)*

Based on the autocorrelation plot (ACF) and the partial autocorrelation plot (PACF) at level 0, the autocorrelation graph of all lags is within the Bartlett Test line and decreases exponentially or slowly gets smaller. By looking at the ACF and PACF

patterns above, it can be said that the data is stationary with respect to the average because there is no pattern that exceeds the line, and shows the ACF dying down and PACF dying down patterns which mean AR (autoregressive) and MA (moving average). The probability value of lag 1 to the last lag is close to zero, which means it is smaller than alpha 5% so the data is stationary.

So it is ensured that using the ARIMA model (p, d, q) to make estimates and find the most appropriate order with d = 0. Based on the ADF output, it turns out that p-value = 0.0001 < alpha = 0.05, so reject H0 which means that the data does not have a unit root (stationary data). Because the data is stationary at differencing 0, it can continue the analysis, which will later be used for the estimation of exponential smoothing and ARIMA.

Based on the box-Jenkins procedure to determine the most appropriate form of ARIMA seen from the ACF and PACF plots from stationary data. Based on the previous data plot, it is known that to get stationary data, all demand data is transformed by natural logarithm. After identifying the model, then the estimation of the model parameters and the coefficient significance test are carried out. Because there are several candidate models, it will perform parameter estimates one by one.

Table 1. Parameter Estimation of ARIMA Model

Model	P	q	Prob
ARIMA(1,0,0)	0.9323		0.0000
ARIMA(2,0,0)	0.5008		0.0000
ARIMA(3,0,0)	0.0889		0.0000
ARIMA(4,0,0)	0.0546		0.0000
ARIMA(5,0,0)	0.9643		0.0000
ARIMA(0,0,1)		0.8846	0.0000
ARIMA(0,0,2)		0.7088	0.0000
ARIMA(0,0,3)		0.0218	0.0000
ARIMA(0,0,4)		0.8563	0.0000
ARIMA(0,0,5)		0.8563	0.0000
ARIMA(1,0,1)	0.3760	0.9999	0.0000
ARIMA(1,0,2)	0.7340	0.6121	0.0000
ARIMA(2,0,1)	0.4176	0.6546	0.0000
ARIMA(2,0,2)	0.0000	0.0000	0.0000

Source: Results of data processing using Microsoft Excel

From the data above, it can be seen that the appropriate ARIMA model is the ARIMA model (2,0,2) because it has a significance value of 0.000 <alpha=0.05.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.220331	0.139831	23.03022	0.0000
AR(2)	-1.000000	0.000231	-4328.874	0.0000
MA(2)	0.999954	0.000228	4386.568	0.0000
SIGMASQ	0.208687	0.087324	2.389805	0.0315

R-squared	0.303934	Mean dependent var	3.245222
Adjusted R-squared	0.154777	S.D. dependent var	0.563422
S.E. of regression	0.517988	Akaike info criterion	1.893223
Sum squared resid	3.756361	Schwarz criterion	2.091084
Log likelihood	-13.03901	Hannan-Quinn criter.	1.920506
F-statistic	2.037677	Durbin-Watson stat	1.389826
Prob(F-statistic)	0.154854		

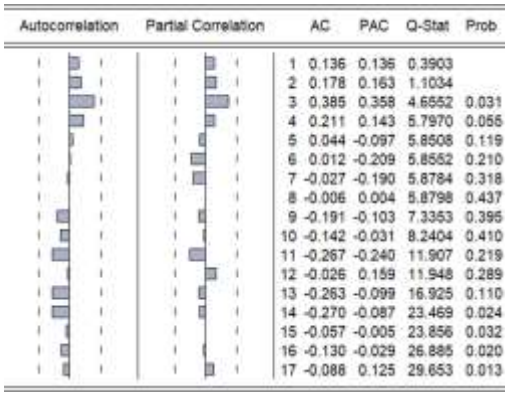
Source: Eviews Data Processing Results

***Figure 3**. Parameter Test*

Based on the output, the output estimate above is a candidate for the ARIMA(2,0,2) model. It can be seen that all parameters are significant, the value of prob = 0.0000 < alpha = 0.05 and the AIC or akaike info criterion value of 1.893223.

c. Diagnostic check

One way to see white noise can be tested through the ACF and PACF chorelogram of the residuals. If ACF and PACF are not significant, this indicates residual white noise, meaning that the model is suitable, otherwise the model is not suitable.



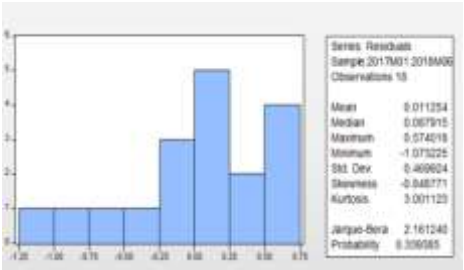
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.136	0.136	0.3903	
		2	0.178	0.163	1.1034	
		3	0.385	0.358	4.6552	0.031
		4	0.211	0.143	5.7970	0.055
		5	0.044	-0.097	5.8508	0.119
		6	0.012	-0.209	5.8552	0.210
		7	-0.027	-0.190	5.8784	0.318
		8	-0.006	0.004	5.8798	0.437
		9	-0.191	-0.103	7.3353	0.395
		10	-0.142	-0.031	8.2404	0.410
		11	-0.267	-0.240	11.907	0.219
		12	-0.026	0.159	11.948	0.289
		13	-0.263	-0.099	16.925	0.110
		14	-0.270	-0.087	23.469	0.024
		15	-0.057	-0.005	23.856	0.032
		16	-0.130	-0.029	26.885	0.020
		17	-0.088	0.125	29.653	0.013

Source: Results of data processing using EViews.

Figure 4. *White Noise Test*

From the output above, it can be seen that from lag 1 to 17 there is no significant lag. This means that there is no correlation between the residuals, the residuals are homogeneous and there is no pattern in the residuals. This indicates that the residual is already white noise, so it can be said that the model is suitable.

c. Residual Assumption Test



Source: Results of data processing using Eviews

Figure 5. *Residual Assumption Test*

Based on the graph above, it shows that the residuals are normal, which is indicated by a symmetrical uniform shape and bell-shaped and reinforced by the results of the Jarque-Bera test where p-value = 0.33 > alpha-0.05 then accept H0 which means the residuals are normally distributed.

d. ARIMA Forecast Results (2,0,2)

Comparison of Actual Data and ARIMA Forecast shows that the results of the comparison have far deviations. This means that the ARIMA forecast results are not close to the actual value.

Table 2. ARIMA Forecast Results (2,0,2)

Bulan ke	Aktual	Forecast	Error (A-F)	Abs_error (A-F)	(A-F)^2	(A-F)/Actual * 100
19	3.264	3.104	160	160	25.600	4,90
20	3.068	3.026	42	42	1.764	1,37
21	3.102	3.335	-233	233	54.289	7,51
22	2.383	3.414	-1031	1031	1.062.961	43,26
23	2.596	3.104	-508	508	258.064	19,57
24	2.341	3.026	-685	685	469.225	29,26
25	1.943	3.335	-1392	1392	1.937.664	71,64
26	2.053	3.414	-1361	1361	1.852.321	66,29
27	2.917	3.104	-187	187	34.969	6,41
28	2.272	3.026	-754	754	568.516	33,19
29	3.822	3.335	487	487	237.169	12,74
30	3.533	3.414	119	119	14.161	3,37
		Total error	-5343	6.959	6.516.703	299,52
				MSE	592.428	
					MAPE	24,96

Source: Results of data processing using Microsoft Excel

In table 2. it can be seen the results of the ARIMA method forecast (2,0,2). Then do the calculations to get the MSE and MAPE values. And the MSE value obtained is 592,428, the MAPE value is 24.96%.

e. Exponential Smoothing Method

Identifying the exponential smoothing model in an automotive company, namely PT Suzuki Indomobil Motor, the method used is Holt-Winters-Additive because the data is in the form of seasonal patterns. In the eviews window the best alpha, beta, and gamma values are the alpha, beta, and gamma columns filled with "E". The following output appears:

Date: 07/24/21 Time: 15:12
Sample: 2017M01 2018M06
Included observations: 18
Method: Holt-Winters Additive Seasonal
Original Series: DATA_PERMINTAAN
Forecast Series: DATA_ADDDITIVE

Parameters:	Alpha	0.4700
	Beta	0.0000
	Gamma	0.1000
Sum of Squared Residuals		2.162520
Root Mean Squared Error		0.346612
End of Period Levels:	Mean	2.699469
	Trend	0.000000

Source: Results of data processing using Eviews

Figure 6. *Forecasting Results Using Holt-Winter-Additive*

By using the best value of 0.4700, the forecast value will approach the actual value, the best value of 0.0000 and the best gamma value of 0.1000. The Holt-Winter-Additive method obtained an SSE value of 2.162520 and an RMSE of 0.346612 using the initial value for a trend of 0.000000.

Holt-Winters-Aditive Exponential Smoothing Forecast Results

The results of the forecasting can be seen in the table below:

Table 3. Forecast Exponential Smoothing Holt-Winters-Aditive

Bulan ke	Aktual	Forecast	Error (A-F)	Abs_error (A-F)	(A-F)^2	(A-F)/Actual * 100
19	3.264	2.562	702	702	492.804	21,51
20	3.068	2.428	640	640	409.600	20,86
21	3.102	3.299	-197	197	38.809	6,35
22	2.383	2.613	-230	230	52.900	9,65
23	2.596	2.139	457	457	208.849	17,60
24	2.341	2.017	324	324	104.976	13,84
25	1.943	2.908	-965	965	931.225	49,67
26	2.053	3.166	-1113	1.113	1.238.769	54,21
27	2.917	2.624	293	293	85.849	10,04
28	2.272	2.908	-636	636	404.496	27,99
29	3.822	3.223	599	599	358.801	15,67
30	3.533	2.499	1034	1.034	1.069.156	29,27
		Total error	908	7.190	5.396.234	276,67
				MSE	490.567	
					MAPE	23,06

Source: Results of data processing using Microsoft Excel

Table 3 shows the results of the Holt-Winters-Additive Exponential Smoothing forecast. Then do the calculations to get the MSE and MAPE values. And the MSE value obtained is 490.567 and the MAPE value is 23.06 %.

V. Conclusion

Based on the exposure of the research results, it can be concluded as follows:

1. The comparison or comparison between the ARIMA method and exponential smoothing, which is obtained from the request data of PT Suzuki Indomobil Motor, is more appropriate to use the Holt-Winters-Additive Exponential Smoothing method because the resulting error rate is smaller.
2. The results of the forecasting between the ARIMA method and Exponential Smoothing show that the forecasting that has the smallest error value is by using the Exponential Smoothing method which has a MAPE value of 23.06 %, which means the forecast is very good.

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