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Yamaha Nmax Motorcycle Demand Forecasting Model at Yamaha Rolya Motor Dealers with Exponential Smoothing Method

Artowikocy Muhammad Keiran Prasetyo, Rr Erlina
Faculty of Economics and Business, Universitas Lampung
Emails: keiranprasetyo@gmail.com, erlina1962@feb.ac.id

ABSTRACT:
Demand forecasting is basically a projection of the demand for a company's products or services. Forecasting is also referred to as forecasting sales. Rolya Motor's main problem lies in the fluctuating demand for Yamaha Nmax motorbikes, making demand targets not in accordance with what has been determined and excess or shortage of goods. Exponential smoothing is a moving average time series method that weighs past data exponentially so that the most recent data has greater weight. The purpose of this study is to forecast the demand for Yamaha NMAX motorcycles one season ahead and adjust them to future targets and inventory stocks using the Exponential Smoothing method. Trial and error method on parameter values 0,1<α< 0,9 ; 0,1<β<0,9 ; 0,1<γ<0,9, indicating the smallest MSE value is located at point α = 0,9; β =0,1 ; γ =0,9 with a value of 0.058. Based on the research results, companies should use the Holt-Winter Exponential Smoothing method because it has quite good demand forecasting results when compared to the actual demand six months ahead in 2022.

Keywords: Demand Forecasting, Exponential Smoothing, MSE.

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INTRODUCTION

The development of the business world in Indonesia is currently growing. Every company is required to use their resources efficiently and make good strategic decisions in the future to survive and increase their income, especially as the current market conditions are becoming increasingly competitive. In facing this competition, company management must have many ways to be able to compete with competitors meet consumer needs.

Fulfillment of consumer needs is an important factor in facing market competition. Analyzing and interpreting the movement of variations in current consumer needs is a must for business actors to anticipate production activities, supply and demand volume so as not to experience excess or shortage of stock (Nirmala et al., 2021). Inventory is a general term that indicates everything or organizational resources that are stored in anticipation of fulfilling requests (Hani, 2000).

The company's main challenge in managing inventory is to adjust the restock of inventory to demand, namely providing goods in the warehouse that are adjusted to future buyer requests (Ehrenthal et al., 2014). The ability of company managers to predict or foresee future sales volume correlates with increased customer satisfaction, reduced resource waste, reduced sales revenue, and more efficient and effective production plans (Aras et al., 2017).

Forecasting is an activity to estimate or estimate what will happen in the future so that actions can be prepared to be taken (Wijono et al., 2018). Demand forecasting is the projection of demand for a company's products or services. This forecast is also called sales forecasting which controls production, capacity, and scheduling systems and becomes input for financial, marketing, and human resource planning (Heizer & Render, 2015). Without useful predictions, planning and control activities cannot be carried out effectively. Poor forecasts have a negative impact on the capacity of organizations and companies to fulfill their goals, because it results in problems such as the inability to meet demand, which in turn can lead to a loss of market share (Aras et al., 2017).

Forecasting is very important for companies because the prediction of future events must be fed into the decision-making process, such as the total demand for a product must be estimated to plan the total promotion effort, produce a number of items damaged by a process operating over time or determine whether an investment in a factory and new equipment will be required in the future or plan production schedules and inventory maintenance (Sugiarto et al., 2015). Therefore inventory must have forecasts or stock estimates for the future, with the aim of anticipating events that will occur in the future (Wijono et al., 2018).

Rolya Motor is a privately owned company engaged in the automotive sector, particularly Yamaha products. At first Rolya Motor was an ordinary motorcycle repair shop but on December 15, 1995, Rolya Motor was inaugurated as an official Yamaha Dealer. The initial location of the Yamaha Rolya Motor Dealer is located on Jl. Kartini No.62, Payung Durian, Tj District. Karang Pusat, City of Bandar Lampung, Lampung but in 2016 Rolya Motor moved its location to Jl. Sultan Agung No.21, Kedaton, District. Kedaton, Bandar Lampung City, Lampung until now.

Rolya Motor serves the sale of goods and services, such as motorcycle maintenance, spare parts sales, and motorcycle sales. Rolya Motor's main focus is selling motorcycles. Rolya Motor offers a variety of motorcycle products, both sport and automatic motorcycles. One of the automatic motorcycle products that Rolya Motor sells is the Yamaha NMAX motorbike, which is a superior product from Yamaha and is also popular among consumers because of its premium appearance.

Rolya Motor's main problem lies in the fluctuating demand for Yamaha Nmax motorbikes, making demand targets not in accordance with what has been determined and excess or shortage of goods. Rolya Motor does not make estimates or forecasts mathematically in estimating the level of demand for Yamaha NMAX motorcycles. The unstable demand for Yamaha NMAX motorbikes every year is presented in Figure 1.

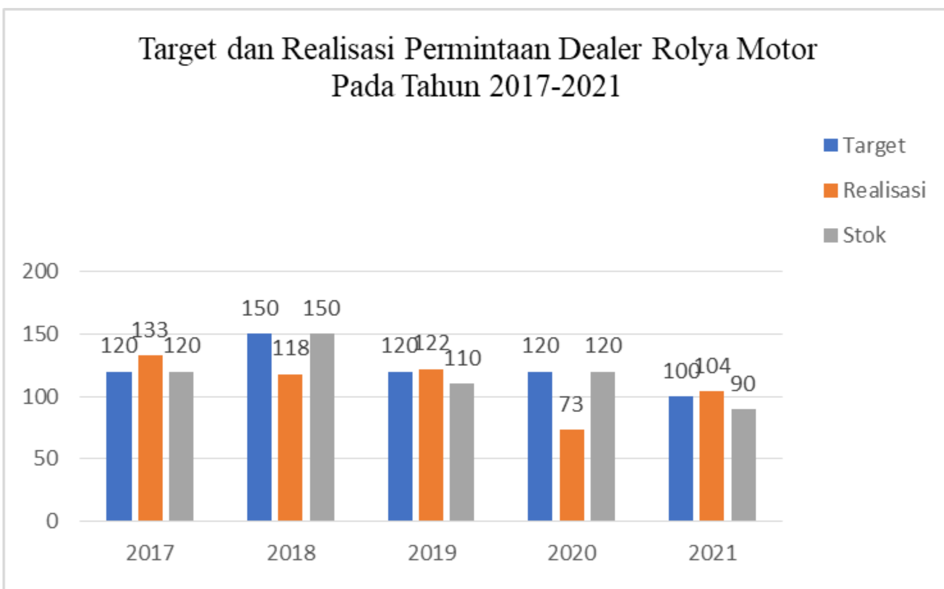

Figure 1. Target and Realization of Demand in 2017-2021

Source: Yamaha Rolya Motor Dealers, 2022.

Demand for Yamaha Nmax motorcycles in 2017 exceeded the target set by Rolya Motor. As shown in Figure 1.1, actual demand was 13 units higher than the target set by Rolya Motor. Excess demand from the demand target set by Rolya Motor made distributors believe in providing more stock than the previous year and made Rolya Motor increase its demand target in 2018. However, demand in 2018 decreased by 15 units from 2017, shown in Figure 1.1 . This is because in 2017 Rolya Motor experienced a shortage of Yamaha Nmax motorbikes which caused consumers to choose to buy from other dealers in 2018. demand for Yamaha NMAX motorcycles has stabilized if you look at 2018 and 2019. Rolya Motor itself determines the target demand for 2019 from the realization of demand for 2018.

Rolya Motor's 2020 demand target follows the 2019 demand target, this is because Rolya Motor realizes that it cannot compete with other competitors in terms of marketing in the previous year and also lacks trust from distributors to provide more stock. Compared to previous years, requests in 2020 have the furthest distance from the target request. The main factor causing the demand for Yamaha Nmax motorcycles has decreased due to the Covid-19 pandemic. The Covid-19 pandemic has made the community's economy unstable, people prefer to fulfill their primary needs. In 2021 Rolya Motor lowered its demand target from the previous year, this is because the community's economy has not fully recovered due to the impact of the Covid-19 pandemic.

The target and realization of unstable consumer demand made it difficult for Rolya Motor to determine the amount of inventory for Yamaha NMAX motorcycles as shown in Figure 1.1. Excess and shortage of inventory has always been a major problem at Rolya Motor Dealers, resulting in the distribution of Yamaha NMAX motorbikes from Central Yamaha Dealers often not matching the demand for inventory stocks that Rolya Motor Dealers expect and also losing market share. Based on this, Rolya Motor Dealers need a special method in predicting or predicting future demand targets to match the actual demand.

The time series method is a forecasting method that connects the relationship between the dependent variable (the variable sought) and the independent variables or variables that influence it and then connects it to time, weeks, months or years (Heizer & Render, 2015). Time series or time series uses a quantitative approach with past data which is used as a reference for future forecasting (Wijono et al., 2018). One method in time series or time series is exponential smoothing (Exponential Smoothing). Exponential Smoothing is a type of moving average forecasting technique that weighs past data exponentially so that the most recent data has a larger weight or scale (Hani, 2000).

According to (Wijono et al., 2018) Exponential Smoothing is a group of methods that show exponentially decreasing weighting of longer observation values. The Exponential Smoothing method has one or more smoothing parameters that are specified explicitly, and the results of this choice determine the weight assigned to the observed value. Exponential Smoothing has a simple formulation that is efficient in forecasting calculations, easily adjusted to changes in data and the accuracy of this method is quite large (Matsumoto & Ikeda, 2015). The exponential smoothing method is often used because the method is flexible based on constant values to smooth it and the accuracy of the exponential method's forecasting errors can be optimized based on their constant values (Nirmala et al., 2021).

Previous research conducted by (Wijono et al., 2018) with the title "Comparison of the Exponential Smoothing Method and the Decomposition Method for Forecasting Rice Stocks (Case Study of Bulog Lhokseumawe Divre)" proved that the Holt Winter Exponential Smoothing method showed a better level of accuracy of the model obtained. compared to the Decomposition method with forecast results for 2019 of 7.18513 Kg of Rice, Year 2021 of 7.23739, Year 2022 of 7.28964 Kg of Rice, Year 2023 of 7.34190 Kg of Rice. Then research conducted by (Nugraheni et al., 2022) with the title "Application of the Exponential Smoothing Winters Method in Rice Price Prediction" proves that the calculation of rice price predictions in Sukoharjo Regency uses the Exponential Smoothing Winters method using rice price data in Sukoharjo Regency in the month January 2016 to August 2019 shows premium rice prices and medium rice prices produce a Mean Absolute Percentage Error (MAPE) of 3.91% and 4.24%, respectively, which are in the <10 category, which means the forecasting results are good, where the value of ▯ = 0.4 ▯ = 0.1 and ▯ = 0.3.

The purpose of this study was to determine the forecasting demand for Yamaha NMAX motorcycles using the Exponential Smoothing method at Yamaha Rolya Motor Dealers.

RESEARCH METHODS

This study uses a descriptive method with a quantitative approach. The descriptive research method according to (Sugiyono, 2018) is a study conducted to determine the value of an independent variable, either one variable or more (independent) without making comparisons or connecting with other variables. The quantitative approach is an approach in research proposals, processes, hypotheses, field work, data analysis and data conclusions up to writing using aspects of measurement, calculation, formulas and certainty of numerical data.

Primary data in this study were obtained through direct interviews with one of the employees at Rolya Motor conducted by the researcher. Secondary data in this study were obtained from company records and documents consisting of requests for goods, target demand for goods, and inventory stock collected by researchers directly in certain periods.

The data collection method is carried out using several techniques, namely:

1. Interview

   Techniques for obtaining data or information by asking questions directly with company owners and with employees concerned with this research. (List of interview questions attached)

2. Documentation

   By studying company documents in the form of reports on the number of requests.

The time series model that will be used in this study is the Exponential Smoothing method, this method is used because the data used is very complex but the formulas are easy to use, and obtain accurate results that can be useful for companies to solve demand forecasting problems.

RESULTS AND DISCUSSION

A. Data Collection

Data collection for Yamaha NMAX motorcycles was carried out at the Yamaha Rolya Motor Dealer, Jl. Sultan Agung No. 21, Kedaton, Kec. Kedaton, Bandar Lampung City, Lampung. In this study, the data used for analysis is demand data for Yamaha NMAX motorbikes in 2017 – 2021 which can be presented in the following table:

Table 1. Demand Data for Yamaha NMAX Motorcycles (Units)

Month	Year					Total
	2017	2018	2019	2020	2021	
January	11	11	9	10	8	49
February	13	12	11	13	11	59
March	10	8	7	9	10	44
April	15	11	14	6	12	57
May	12	10	10	5	7	43
June	11	13	10	6	10	50
July	13	8	11	2	4	38
August	10	10	12	4	8	44
September	9	9	8	2	6	34
October	7	6	7	3	6	29
November	8	9	9	7	10	43
December	14	11	14	6	12	58
Total	131	118	122	73	104	548

Source: Dealer Yamaha Rolya Motor, 2022

B. Plotting Time Series Data

The initial step after the data was obtained from the Yamaha Rolya Motor Dealer was to plot the data, to see what the data is graphically. Each time series data obtained is shown as a point. The period is located on the abscissa (X-axis) and the number of requests is located on the ordinate (Y-axis). The Rolya Motor Dealer Yamaha NMAX motorcycle demand data plot is shown in Figure 1.

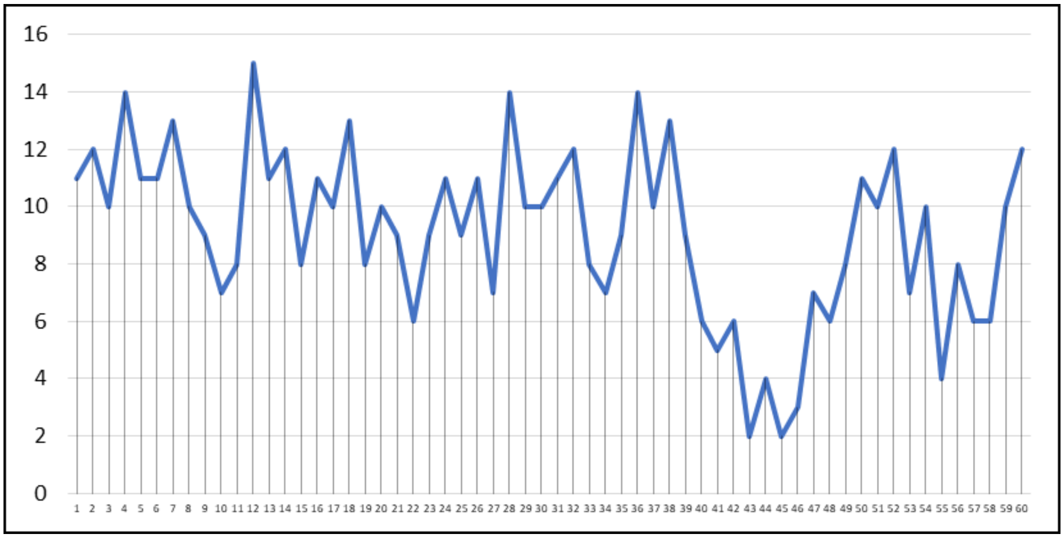

Figure 1. Plot of Demand Data in 2017-2021 (Units)
Source: Yamaha Rolya Motor Dealers, 2022.

Based on the results of the data plot in Figure 4.1 it can be concluded that the number of requests for Yamaha NMAX has a seasonal pattern. This is because it can be seen from the graph that there is a repetition, namely an increase in April and December, and a decrease in March and September. To clarify the shape of the pattern contained in the Yamaha NMAX Rolya Motor request data, a mathematical pattern test is carried out as follows.

C. Testing Time Series Data

1. Data Adequacy Test

Sample testing was carried out to find out whether the sample used was acceptable or not (Jakaria & Putra, 2020). Sample testing is done with the following equation:

$$N' = \left[\frac{\frac{k}{s}\sqrt[2]{N\sum_{t=1}^{n} Y_t^2 - \left(\sum_{t=1}^{N} Y_t\right)^2}}{\sum_{t=1}^{N} Y_t}\right]^2$$

From the calculation results obtained:

N = 60 (Amount of data used)

$\sum Y_t$ = 548 (Total amount of data from 2017-2021)

$\sum Y_t^2$ = 5,534 (Total number of civil squares from 2017-2021)

The level of accuracy used by researchers is 10%, which is the maximum deviation from the measurement results to the actual value and the level of confidence used by researchers is 95%, namely the amount of confidence or the probability that the data we get lies within a predetermined level of accuracy. So with an accuracy level of 10% and 95% confidence K⁄S=20 (Arif et al., 2017).

So:

$$N' = \left[\frac{20\sqrt[2]{60 \times 5.534 - (550)^2}}{548}\right]^2$$

$$N' = [6.5]^2$$

$$N' = 42.2$$

Because N' is 42.2 < N is 60, the demand data for Yamaha NMAX motorbikes from Rolya Motor Dealers in Table 4.1 can be accepted as a sample in this study.

2. Testing for Seasonal Patterns

Testing for the existence of a seasonal pattern is carried out to find out whether the data used contains a seasonal pattern or not. Based on the results of the data plots in section 4.2, the data used contains seasonal patterns because it can be seen in the graph that it experiences repetition, namely increasing in April and December, and decreasing in March and September. So to clarify whether the data used contains seasonal patterns or not, a seasonal test is carried out mathematically. Seasonal tests were carried out with analysis of variance (Kadir, 2018). The hypothesis used in the seasonal test is as follows.

H_0 = Data is not affected by seasonality.

H_a = Seasonally influenced data.

The test criteria are:

If Fcount ≤ Ftable then Ho is accepted (not influenced by seasonality).

If Fcount > Ftable then Ho is rejected (there is a seasonal influence).

The following is the F_count formula:

$$F_{hitung} = \frac{KT_{antarperlakuan}}{KT_{galat}}$$

The population is assumed to be normal, if Y_ij is denoted as the value of the -I period, the jth year with I = 1,2,3,... and j = 1,2,3,..., to calculate the seasonality test the data used is presented in Table 4.1. Before performing the F_count calculation, there are several calculations that need to be done to find the mean square of the treatment or monthly (KT_between treatments) and the mean square of the error or error 〖(KT〗_error). The calculation of the seasonal test begins by calculating the Total Square (JK), which is the total square of each data (unit) giving a result of 5,582 (JK calculation attached)

The result of the sum of the squares (JK) is performed to find the average sum of the squares (RJK). After that, calculate the average sum of squares (RJK) with a result of 5,041.67, the average sum of squared treatments or per month (RJK_between treatments) with a result of 178.50, and the average sum of squared errors or errors (RJK_error) with results of 361.83 (Calculations of RJK, RJK_between treatments, and RJK_errors are attached).

After getting the results from RJK, RJK_between treatments, and RJK_errors, calculations are performed to find the middle squares of treatments or monthly (KT_between treatments) and the mean squares of errors or errors 〖(KT〗_errors) which will be used to calculate F_count. Calculations from the mean square of treatment or per month (KT_between treatments) yield a value of 44.62 and the mean square of error or error 〖(KT〗_error) yields a value of 6.578 (Calculations of KT_between treatments and KT_error are attached). After getting the results of KT_between treatments and KT_errors, the F_count calculation is performed as follows:

a. Count F_count

$$F_{hitung} = \frac{KT_{antarperlakuan}}{KT_{galat}}$$

$$F_{hitung} = 6{,}7831$$

b. Compile an analysis of variance table

Compiling a table of variance analysis is done to show the final result of each calculation with the addition of the F_table column. F_table is obtained from F_((0.05;p-1;b-p)), which is 0.05 indicating the level of trust and accuracy of the researcher with a maximum research error of 5%. Then P shows the period or how many years are used and B shows the amount of data used.

Table 2. Analysis of Variance

Source of Variance	Db	RJK	KT	F_{hitung}	F_{tabel}
Average	1	5.041,67			
Between treatments	4	178,50	44,62	6,7831	2,5397
Error	55	361,83	6,578		
Amount	60				

Source: Data processed by researchers, 2022

Based on the calculation above, it can be seen that F_count is 6.7831 and F_table (0.05;4;55) is 2.539 (F table is attached) then F_count > F_table and H_a is accepted. It can be concluded that the data has significant differences per period so that the data contains seasonal patterns.

3. Testing for a Trend

Testing for a trend is carried out to test whether or not there is an up or down trend in data in the long term, around a fixed average. The results of testing for a trend are one of the factors in determining which Exponential Smoothing method to use. The trend test is carried out with a run test, while the hypothesis in the Trend Test is:

H_0 : The frequency of rising and falling in the data is the same, meaning there is no trend

H_1 : The frequency of rising and falling is not the same, meaning it is influenced by the trend

The test criteria are:

If Z_count ≤ Z_table then Ho is accepted (not influenced by trend)

If Z_count > Z_table then Ho is rejected (influenced by trend)

Table 3. Testing for a Trend

Period	Data (Yt)	Sign Change	Period	Data (Yt)	Sign Change
1	11	+	31	11	+
2	13	+	32	12	+
3	10	-	33	8	-
4	15	+	34	7	-
5	12	+	35	9	-
6	11	+	36	14	+
7	13	+	37	10	-
8	10	-	38	13	+
9	9	-	39	9	-
10	7	-	40	6	-
11	8	-	41	5	-
12	14	+	42	6	-
13	11	+	43	2	-
14	12	+	44	4	-
15	8	-	45	2	-
16	11	+	46	3	-

Source: Data processed by researchers, 2022

After processing the Rolya Motor request data, the data is obtained as listed in Table 4.4. The trend test calculation begins by calculating the median in Table 4.4, it can be seen that the median is 10. The - (minus) and + (plus) signs are used to mark whether the data for each period is below or above the median score. The - sign means the data is below the median and the + sign means the data is above the median.

So from the table above obtained:

N_1 (+ sign) = 21

N_2 (sign -) = 39

N_r (change of sign from + to – and vice versa) = 27

The formula used to calculate Z_count is written as follows.

$$Z_{\text{hitung}} = \frac{n_r - \mu_r}{\sigma_r}$$

The first step before calculating Z_count is to find the average value (μ_r) and standard deviation (σ_r) in Table 4.4. The calculation of the average value (μ_r) has a result of 28.3 and the standard deviation (σ_r) has a result of 3.4 (Calculation of the average value and standard deviation is attached). After that, the Z_count calculation is carried out as follows:

$$Z = \frac{27 - 28{,}3}{3{,}4}$$

$$Z = -0{,}37$$

Based on the above calculations and with a significance level of α = 0.05 or the confidence level of researchers in this study of 95%, Z_table = 1.645 (Z table attached) so that it can be concluded that the Rolya Motor request data does not contain a data pattern in the form of a trend because the data used does not random proved by H_0 accepted, namely Z_count of -0.37 < Z_table of 1.645.

D. Calculating Trial and Error to find the Smallest MSE

The results of the data plot, seasonal test, and trend test show that there is a seasonal data pattern in the demand data for Yamaha NMAX motorcycles from Rolya Motor Dealers, so the appropriate method to use is the Exponential Smoothing Holt-Winter method. The forecasting model with Holt-Winter exponential smoothing uses three parameters or constants namely □, □ and □, according to (Heizer & Render, 2015) the formulation constant functions as a weighing factor. If the constant is close to 1, it means that the new forecast value has included an adjustment factor for each error rate that occurs in the old forecast value. Conversely, if the constant is close to 0, it means that the new forecast value is almost the same as the old forecast value.

1. Determining the Value of Constants □, □ and □

   Determining the optimal values of parameters or constants □, □ and □ is generally done by trial and error (trial and error in forecasting) to determine the lowest error value. Where the value of each parameter is 0 to 1. In conducting trial and error, the MSE calculation is carried out by finding the smallest value. The calculation of the MSE value starts from 0.1 to 0.9 and will be trialed sequentially with the addition of a parameter value of 0.1 in order to obtain the best smoothing constant value.

   Before looking for the values of the constants □, □ and □, it is necessary to calculate the initial value of the forecast (Rosalina & Sugiarto, 2016). The calculation of the initial value of the forecast is done because Rolya Motor has never done a forecast before, whereas to find the values of the constants □, □ and □ and calculate the forecast for one season ahead in 2022, it is necessary to forecast the value of the first season in 2017.

a. Initial Value Calculation:

The value of S can be equated with the actual value or data (X_L)

S_L=X_L→S_12=X_12→S_12=16

b. Initial seasonal influence initialization value (I)

I_L=X_L/¯X

where:

$$\overline{X} = \sum_{i=1}^{L} \frac{X_i}{L}$$

From the equation above, the values I_1 – I_12 are obtained as follows.

Table 4. Seasonal Influence Calculation

Period	**Data (Xt)**	$\frac{X_i}{L}$	I_i
1	11	0,92	1,01
2	12	1,00	1,10
3	10	0,83	0,92
4	14	1,17	1,28
5	11	0,92	1,01
6	11	0,92	1,01

Source: Data processed by researchers, 2022

c. Initial trend (b) initialization value

Calculation of the initial trend initialization value is obtained by using the following formula.

$$b_L = \frac{1}{L}\left[\frac{X_{L+1} - X_1}{L} + \frac{X_{L+2} - X_2}{L} + \cdots + \frac{X_{L+L} - X_L}{L}\right]$$

So

$$b_{12} = \frac{1}{12}\left[\frac{X_{13} - X_1}{12} + \frac{X_{14} - X_2}{12} + \cdots + \frac{X_{24} - X_{12}}{12}\right]$$

$$b_{12} = \frac{1}{12}\left[\frac{0}{12} + \frac{-1}{12} + \cdots + \frac{-3}{12}\right]$$

$$b_{12} = -0{,}10$$

After getting the initial value, then perform a trial and error method calculation with the help of a computer (Microsoft Excel) to determine the smallest MSE (Mean Square Error) value in order to determine the best constants , , and . The calculation of the trial and error method with the MSE (Mean Square Error) value uses the following formula.

$$MSE = \sum \frac{(A_t - F_t)^2}{n}$$

Where:

A_t = Actual demand in t-period
F_t = Forecasting demand in the t-period
n = Number of request data involved

Calculation of the trial and error method with the MSE (Mean Square Error) value is carried out on the parameter value 0.1 < α < 0.9 ; 0.1 < β < 0.9 ; 0.1 < γ < 0.9 (Calculation of MSE value to parameter value 0.1 < α < 0.9 ; 0.1 < β < 0.9 ; 0.1 < γ < 0.9 attached). Some of the results of the trial and error method calculations with MSE (Mean Square Error) values are presented in Table 5.

**Table 5. Constant values , , and **

No	α	β	γ	MSE
1	0,1	0,1	0,1	5,22
2	0,2	0,1	0,1	3,81
3	0,3	0,1	0,1	4,20
4	0,4	0,1	0,1	2,99
5	0,5	0,1	0,2	2,06
6	0,6	0,1	0,2	1,33
7	0,7	0,1	0,2	0,75
8	0,8	0,1	0,4	0,33
9	0,9	0,1	0,9	0,10

Source: Data processed by researchers, 2022

Based on the table above, the results of the calculation of the trial and error method with the MSE (Mean Square Error) value for the parameter value are 0.1 < α < 0.9 ; 0.1 < β < 0.9 ; 0.1 < γ < 0.9 it can be concluded that the smallest MSE value is located at point α = 0.9; β =0,1 ; γ = 0.9 with a value of 0.10. So to forecast the demand for one season in the future it will use the parameter value.

E. One Season Demand Forecasting in 2022

Forecasting the demand for one season ahead in 2022 is carried out using the triple exponential smoothing forecasting model from Holt-Winter with a parameter value α = 0.9 ; β =0,1 ; γ =0.9. Forecasting demand for the next season in 2022 is calculated by the following formula.

Forecast:

$$F_{t+m} = (S_t + b_t m) I_{t-L+m}$$

The results of forecasting the demand for Yamaha NMAX motorcycles for the next season are presented in Table 4.6 (Calculation of demand forecasting for the next season in 2022 is attached).

Table 6. Forecasting Demand for Yamaha NMAX One Season Next in 2022

Period	Demand Forecasting
January	10,94
February	12,29
March	9,56
April	12,91
May	10,99
June	12,38
July	9,97
August	12,70
September	9,45
October	8,38
November	10,20
December	14,87

Source: Data processed by researchers, 2022

F. Comparison of Forecasting with Realization in the Next Six Months in 2022

The results of a comparison of forecasting demand for Yamaha NMAX motorcycles with the actual demand for Yamaha NMAX motorcycles in the next six months in 2022 can be presented in Table 4.7. The difference between the demand forecasting results and the actual demand has a small distance and still contains a seasonal pattern, which can be seen in April, which has increased as in previous years. It can be concluded that demand forecasting for Yamaha NMAX motorcycles has very good results.

Table 7. Comparison of Demand Forecasting Results with Demand Realization in the Next Six Months in 2022

Period	**Demand Forecasting**	**Request Realization**
January	10,94	11
February	12,29	14
March	9,56	10
April	12,91	15
May	10,99	13
June	12,38	12

Source: Data processed by researchers, 2022

G. Discussion of Research Results

This study uses demand data for Yamaha NMAX Rolya Motor motorbikes from January 2017 to December 2021. Before deciding which Exponential Smoothing method to use, it is necessary to look at the data graphically using data plots. Data plots are used to see whether the data used contains stationary, trend, or seasonal patterns. Based on the results of the data plots in Figure 4.1, the data used contains seasonal patterns.

After that, do a data adequacy test to see whether the data under study can be used or not. Based on the results of the data adequacy test, N' is 42.8 < N is 60 or it can be concluded that the data studied can be used. Seasonal tests and trend tests are carried out to strengthen the results of data plots whether the data used contains stationary, trending, or seasonal patterns. Testing for seasonality is carried out by analysis of variance, based on the results of the seasonal test in Table 4.3 it is known that F_count is 6.7831 > F_table (0.05;4;55) of 2.539 so that H_a is accepted, which means that the data contains seasonal patterns.

The trend test is carried out to see whether the data contains a trend pattern or not, based on the results of the trend test it is known with a significance level of α = 0.05, so Z_table =

1.645 so that it can be concluded that the demand data for Yamaha NMAX motorbikes does not contain a data pattern in the form of a trend because $Z_{(count)}$ of -0.37 < Z_{table} of 1.645. Based on the results of data plots, seasonal tests, and trend tests, demand data for Yamaha NMAX Rolya Motor motorbikes from January 2017 to December 2021 contains seasonal patterns but does not contain trends, it can be concluded that the Exponential Smoothing method that will be used is Exponential Smoothing. The Three Parameters of Holt-Winter.

The next step is to determine the optimal parameter value using the trial and error method by minimizing the MSE value. The weighting in the Exponential Smoothing method of Three Parameters from Holt-Winter is □, □, and □. The value of the parameter to be searched for is between 0 to 1, using the combination 0.1 < □ < 0.9 ; 0.1 < β < 0.9; 0.1 < γ < 0.9. Based on the trial and error method for parameter values 0.1 < α < 0.9 ; 0.1 < β < 0.9 ; 0.1 < γ < 0.9 it can be concluded that the smallest MSE value is located at point α = 0.9; β =0,1 ; γ = 0.9 with a value of 0.058. So to do the forecasting will use the value of these parameters.

The final step is to forecast the next season (twelve months) with the Holt-Winter Three-Parameter Exponential Smoothing method using the parameter value α = 0.9; β = 0.1 ; γ = 0.9. Based on the forecasting results for the next one season, the demand forecast value for the next season (twelve months) or in 2022 in January, February, March, April, May, June, July, August, September, October, November and December respectively of 11, 12, 10, 13, 11, 12, 10, 13, 9, 8, 10, and 15. Forecasting demand for the next six months in 2022 has quite good results when compared to actual demand as shown in Table 4.18 .

The results of this study are in line with the results of research from several researchers that have been conducted before, such as (Wijono et al., 2018) with the title "Comparison of the Exponential Smoothing Method and the Decomposition Method for Predicting Rice Supply (Case Study of the Regional Logistics Logistics Agency Lhokseumawe)" proving that the Exponential method Smoothing Holt Winter shows the level of accuracy of the model obtained is better than the Decomposition method with forecast results for 2019 of 7.18513 Kg of Rice, Year 2021 of 7.23739, Year 2022 of 7.28964 Kg of Rice, Year 2023 of 7.34190 Kg Rice.

Research from (Nugraheni et al., 2022) entitled "Application of the Exponential Smoothing Winters Method in Rice Price Prediction" proves that the calculation of rice price predictions in Sukoharjo Regency uses the Exponential Smoothing Winters method using rice price data in Sukoharjo Regency from January 2016 to with August 2019 showing premium rice prices and medium rice prices producing a Mean Absolute Percentage Error (MAPE) of 3.91% and 4.24% respectively which are in the category <10 which means the forecasting results are good, where the value of □ = 0.4 □ = 0, 1 and □ = 0.3. And research conducted by (Sugiarto et al., 2015) entitled "Forecasting of Rice Stock using Winter's Exponential Smoothing and Autoregressive Moving Average Models" shows that the Holt-Winter exponential smoothing model is a good method for predicting data through constant smoothing which serves to address factors affecting the data such as baseline, trend and seasonality. With a Mean Square Error (MSE) result of 88.36.

CONCLUSION

The results of data plots, seasonal tests, and trend tests show that the data used contains seasonal patterns. The appropriate method used is the Holt-Winter Three-Parameter Exponential Smoothing Method. The trial and error method in the Three Parameter Exponential Smoothing Method from Holt-Winter produces the smallest MSE value of 0.058 which lies within the parameter α = 0.9; β =0,1 ; γ =0.9.

Results Forecasting the demand for the next six months in 2022 has quite good results when compared to the actual demand in 2022.

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