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Comparative Analysis of the Accuracy Value of Playgo Sales Forecasting Using the Single and Weight Moving Average Method at PT. XYZ

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A B STR ACT

The development of the business world continues to increase along with the large number of requests for products needed, so it is important for companies to create optimal planning strategies, both production planning and demand planning, so that companies are able to achieve their targeted goals. To achieve company goals, one of the company's activities is to carry out forecasting related to the number of sales or consumer demand for the goods or services produced. PT. XYZ is a developing company whose production results are superior and certified educational toys for children. The analysis used in forecasting is a single 2 period and 3 period moving average method as well as a weighted moving average with weightings of 50,20,30 and 50,25,25. The aim of this research is, firstly, to find out the sales forecasting of playgo type children's educational toys and secondly to find out the most accurate sales forecasting method. The research results show that the method with the smallest error value is the Weight Moving Average method with weightings of 50, 20, 30, where the Mean Absolute Error (MAE) value is 570, the Mean Square Error (MSE) is 447,036, and the Mean Absolute Percentage Error (MAPE) of 1.97%.

INTRODUCTION

The progress of the business world along with the large number of requests for the products needed also continues to increase. This is a challenge as well as an opportunity for companies to fulfill consumers' desires so that they are not disappointed with the products they order. It is also important to know that consumer needs cannot be predicted with certainty at any time, consumer demand is sometimes high but sometimes low, but in any case the company does not want to experience losses. and disappoint customers due to erratic demand. For this reason, companies must be able to create optimal planning strategies, both in production planning and demand planning so that the company can achieve the set goals. To achieve this goal, it is important for companies to forecast the number of sales or consumer demand for the goods or services produced.

PT. XYZ is a developing company whose products are superior and certified educational toys for children. The resulting products have been marketed throughout Indonesia. The need for toys for children's development from an early age made PT. XYZ is present in society.

PT. XYZ was founded on April 1 2005, the first products produced included: Mix 10, Mix 4, Dream Cake. To date, he has created more than 100 toy products education. So that companies can meet consumer needs while not losing money if demand decreases. So the company must create a consumer demand planning strategy for the coming period. In order for a company to be able to predict consumer demand in the coming period, the company must review sales data in the previous period as a determining factor in forecasting for the coming period. Based on information from the company's marketing department and sales data for the previous period, the number of consumer demands for educational toy products is unstable. For this reason, if forecasting is not carried out in the future period, it will result in losses if demand falls and vice versa, if demand rises and the company does not have stock, it will result in loss of consumer confidence. Based on the background of the problem above, the formulation of the problem in this research is what are the forecast results for sales of Playgo type educational toy products in the June 2024 period using the Single Moving Average (SMA) and Weight Moving Average (WMA) methods in PT. XYZ and how to get the most accurate sales forecasting method.

The aim of conducting research using the Single Moving Average and Weight Moving Average methods is that it is hoped that it can predict sales in the coming period with a proportional amount and can balance meeting consumer needs.

LITERATURE REVIEW

Single Moving Average

Single Moving Average is one of the simple and widely used forecasting methods in time series analysis. According Spyros Makridakis, Steven C. Wheelwright, and Rob J. Hyndman in the book “Forecasting: Methods and Applications" Single Moving Average is a forecasting technique used to smooth out fluctuations in time series data and highlight underlying trends. This method is particularly effective when the data does not have a clear trend or

seasonal pattern. Douglas C. Montgomery, Cheryl L. Jennings, and Murat Kulahci in the book "Introduction to Time Series Analysis and Forecasting": According to them, the Single Moving Average method is a simple approach to forecasting time series data by combining the average of a number of previous periods. This helps in reducing noise and makes it easier to identify patterns in the data. John E. Hanke and Dean W. Wichern in the book "Business Forecasting": They state that Single Moving Average is the basic method used in business forecasting. By averaging the values from several previous periods, this method provides a clearer view of future trends. David R. Anderson, Dennis J. Sweeney, and Thomas A. Williams in the book "Statistics for Business and Economics": These authors explain that Single Moving Average is a technique used to smooth time series data by averaging the values of the last few periods. It is an effective method for forecasting relatively stable data in the absence of strong seasonal patterns. Malhotra explains that Single Moving Average is used in marketing research to forecast demand for products and services. By smoothing historical data, companies can make better decisions based on identified trends. In general, experts agree that Single Moving Average is a simple yet effective method for forecasting time series data, especially when the data does not show significant trends or seasonal patterns. This method helps in reducing data variability and provides a clearer view of future direction.

Weight Moving Average

Weighted Moving Average (WMA) is a forecasting method that gives different weights to historical data, with more recent data usually given greater weight. Spyros Makridakis, Steven C. Wheelwright, and Rob J. Hyndman in "Forecasting: Methods and Applications": They explain that the Weighted Moving Average (WMA) is an extension of the simple Moving Average method. In WMA, a higher weight is given to the most recent observation, making it more responsive to recent changes in the time series data. This makes it more suitable for data with changing trends. Douglas C. Montgomery, Cheryl L. Jennings, and Murat Kulahci in "Introduction to Time Series Analysis and Forecasting": They state that the Weighted Moving Average gives greater weight to the most recent observations to reflect the importance of new information. This method is effective for time series data where recent conditions are more relevant than older conditions. John E. Hanke and Dean W. Wichern in "Business Forecasting": According to them, Weighted Moving Average is a more adaptive forecasting technique than Simple Moving Average. By giving different weights to different periods, WMA can capture changes faster and provide more accurate forecasts in situations where changes occur dynamically. David R. Anderson, Dennis J. Sweeney, and Thomas A. Williams in "Statistics for Business and Economics": They explain that WMA is a method used to place more emphasis on recent data in an effort to create more accurate forecasts. By adjusting the weights according to the importance of each period, WMA can reduce the impact of insignificant fluctuations from older historical data. N. K. Malhotra in "Marketing Research: An Applied Orientation":

Malhotra explains that Weighted Moving Average is used in marketing research to account for changes in consumer behavior by giving greater weight to the most recent data. This helps in making more informed marketing decisions based on the latest trends. Overall, experts agree that Weighted Moving Average is a more sophisticated method compared to Simple Moving Average, as it allows for more emphasis on recent data. This makes WMA more responsive to recent changes in time series data, making it suitable for situations where recent conditions are more relevant in forecasting the future.

METHODOLOGY

The method used in this research is the Single Moving Average and Weight Moving Average methods. This research conducted in PT. XYZ which is located at Jl. Raya Serang KM 12.8, Cikupa District, Tangerang Regency. The object of this research is focused first on sales of products with the highest demand.

The steps for solving the problem in this research are as follows:

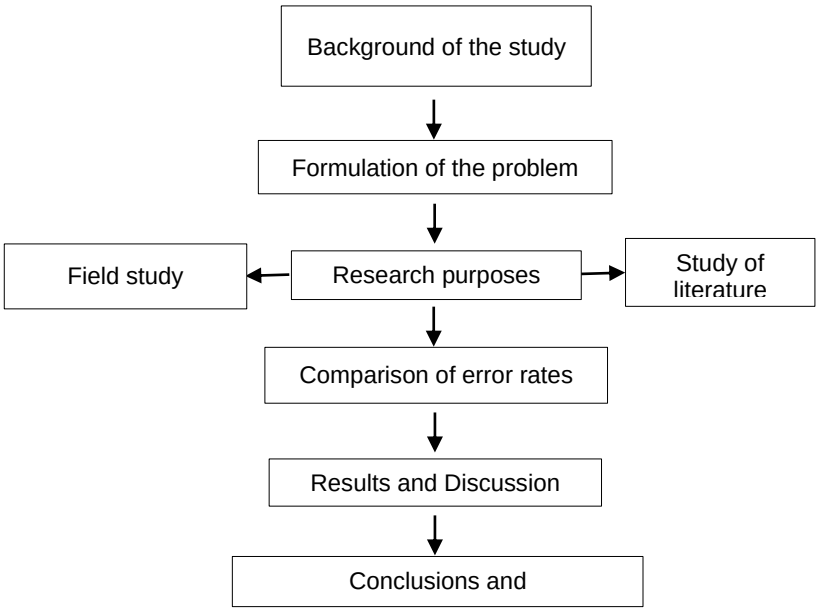

Figure 1. Research Steps

The data collection techniques used in this research are:

1. Primary data
   Is data obtained directly from sources through observation or interviews in the field. There are two methods of collecting primary data that can be used, namely:
   a. Observation Method
      Observation is a data collection technique that has specific characteristics, because observation is not limited to people, but also other objects. Observation is a method of obtaining primary data where a researcher looks and observes directly the research object to be taken.
   b. Interview Method

Interviews are a data collection technique used by a researcher to obtain oral information through conversation and face to face between the researcher and the source of the research.

2. Secondary Data
   Secondary data is data obtained indirectly which functions to strengthen or support primary data. Secondary data can be in the form of reference books and product sales data, as well as other documents in the field related to research.
   The data processing used in this research is as follows:
   1. In this study, researchers used data for the period December 2023-May 2024
   2. For data processing analysis as follows:
      a. From actual sales data in the previous period obtained by the company, it is processed to be used as a basis for forecasting calculations for the next period.
      b. Calculate the forecast value for the next period using the Single Moving Average (SMA) method. With the following calculations:

$$S_{t+1} = \frac{X_1 - X_{t-1} + \cdots + X_{t-n+1}}{n}$$

S_{t+1} = Forecast untuk periode ke t + 1

X_t = Data pada periode t

n = Jangka waktu moving average

In this section, we will find out about forecasting demand for the next period using a predetermined method.

      c. Calculate forecasting values for the next period using the Weighted Moving Average (WMA) method. With the following calculations:

$$WMA = \frac{\sum D_t \times weight}{\sum weight}$$

Information :
D_t = Actual data in period t
weight = weight given for each month

      d. Calculate the error rate value. With the following calculations:

$$MAE = \sum \frac{|A_t - F_t|}{n}$$

Information :

MAE = average deviation/absolute error

At = actual demand in period-t

Ft = demand forecasting (forecast)in the t-period

n = number of forecasting periods involved

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

Information :

MSE = mean squared error

A_t =actual demand in period-t

Ft= demand forecast (forecast) in period-t

N= number of forecasting periods involved

$$MAPE = \frac{\sum \left| A_t - F_t / A_t \right|}{n} \times 100$$

Information :

MAPE = mean absolute percentage error

At = actual demand in the t-the period (forecast) in the t-period

n = number of periods involved

At this stage the level of accuracy will be known in sales forecasting using the Single Moving Average (SMA) method and whether it is suitable as a reference in determining the number of production processes for the next period.

Comparing the error level in forecasting between the 2 methods, at this stage the one method with the lowest error level in the forecasting calculation process will be used as reference for determining the number of production processes in the next period.

RESEARCH RESULT

In this section, some data obtained when carrying out research in PT. XYZ and how to process data.

1. Data on sales of educational toy products for the period December 2023-May 2024.

Table 1. Sales Data for Educational Toy Products

Bulan	Forecasting Peusahaan	Aktual Penjualan	Jenis Produk Terjual					
			Playgo	Mobil Extreme	Mobil fighter	Mobil super	Mobil combat	Barber Shop
Des-23	132.000	103.400	31.020	25.850	15.510	10.340	10.340	10.340
Jan-24	134.000	96.000	28.800	24.000	14.400	9.600	9.600	9.600
Feb-24	140.000	100.000	30.000	25.000	15.000	10.000	10.000	10.000
Mar-24	143.000	101.200	30.360	25.300	15.180	10.120	10.120	10.120
Apr-24	120.000	96.000	28.800	24.000	14.400	9.600	9.600	9.600
Mei-24	130.000	96.000	28.800	24.000	14.400	9.600	9.600	9.600
Jumlah	**799.000**	**592.600**	**177.780**	**148.150**	**88.890**	**59.260**	**59.260**	**59.260**

Considering the limitations of time and costs, research is only carried out on products that have the largest number of sales. The following is a Pareto diagram as seen in Figure 1 below:

Figure 1. Pareto Diagram of Sales Levels for Children's Educational Toys

From table 1 and figure 1 it shows that the largest number of sales is the Playgo children's toy product type, for this reason the research will focus on the Playgo product type, in table 2 below is the number of actual sales and company forecasts based on intuition for Playgo products during the period December 2023 to May 2024.

Table 2. Playgo Product Sales and Forecast for Period December 2023- May 2024

Month	Company Forecasting	Actual Sales
December 2023	39,600	31,020
January 2024	40,200	28,800
February 2024	42,000	30,000
March 2024	42,900	30,360
April 2024	36,000	28,800
May 2024	39,900	28,800

Month	Company Forecasting	Actual Sales
Amount	239,700	177,780

From table 2 above, it is necessary to calculate the error value to find out the MAPE value as a comparison material which will be used as a basis for making decisions on using the best forecasting method.

Table 3. Forecasting PT. XYZ

Bulan	Forecasting Perusahaan	Aktual Penjualan	Error	Mean Absolute Error (MAE)	Mean Square Error (MSE)	Mean Absolute Percentage Error (MAPE)
Des-23	39.600	31.020	- 8.580	8.580	73.616.400	27,66%
Jan-24	40.200	28.800	- 11.400	11.400	129.960.000	39,58%
Feb-24	42.000	30.000	- 12.000	12.000	144.000.000	40,00%
Mar-24	42.900	30.360	- 12.540	12.540	157.251.600	41,30%
Apr-24	36.000	28.800	- 7.200	7.200	51.840.000	25,00%
Mei-24	39.000	28.800	- 10.200	10.200	104.040.000	35,42%
		Jumlah		**61.920**	**660.708.000**	
		Rata-Rata		**10.320**	**110.118.000**	**34,83%**

Based on Table 2 above, it will be processed and analyzed using single and weight moving average forecasting methods and trial and error will be carried out to determine sales forecasts for the period December 2023-May 2024 so that the company can estimate sales and meet consumer needs.

2. Data processing

After data collection is carried out, the next step is to process the data. The first data processing is to forecast using a single moving average method and then a weighted moving average.

a. Single Moving Average (SMA) Method

This calculation will carry out forecasting using the SMA 2, SMA 3 methods. Calculations for forecasting using the SMA 2 method as in table 4 and table 5 below:

Table 4. Forecasting SMA 2

Periode	Actual Sales	2 Periode Single Moving Average				
		Forecast	Error	Mean Absolute Error (MAE)	Mean Square Error (MSE)	Mean Absolute Percentage Error (MAPE)
Des-23	31.020					
Jan-24	28.800					
Feb-24	30.000	29.910	90	90	8.100	0,30%
Mar-24	30.360	29.400	960	960	921.600	3,16%
Apr-24	28.800	30.180	-1.380	1.380	1.904.400	4,79%
Mei-24	28.800	29.580	-780	780	608.400	2,71%
Jun-24		28.800				
		Jumlah		**3.210**	**3.442.500**	
		Rata-Rata		**802,50**	**860.625**	**2,74%**

Forecasting calculations for February 2023 use the following formula

$$S_{t+1} = \frac{X_1 - X_{t-1} + X_{t-n+1}}{n} = \frac{31.020 + 28.800}{2}$$

$$S_3 = \frac{59.820}{2}$$

$$S_4 = 29.910$$

For March 2023 onwards, this will be done in the same way

Calculation of Mean Absolute Deviation/Error (MAE) uses the following formula

$$\text{MAE} = \sum \frac{|\text{A}_\text{t} - \text{F}_\text{t}|}{\text{n}}$$

$$\text{MAE} = \frac{|(30.000 - 29.910) + (30.360 - 29.400) + (28.800 - 30.180) + (28.800 - 29.580)|}{4}$$

$$\text{MAE} = \frac{3.210}{4}$$

$$\text{MAE} = 802{,}50$$

The Mean Square Error (MSE) calculation uses the following formula

$$\text{MSE} = \sum \frac{(\text{A}_\text{t} - \text{F}_\text{t})^2}{\text{n}}$$

$$\text{MSE} = \sum \frac{(30.000-29.910)^2+(30.360-29.400)^2+(28.800-30.180)^2+\left((28.800-29.580)\right)^2}{4}$$

$$\text{MSE} = \frac{3.442.500}{4} = 860.625$$

Calculation of Mean Absolute Percentage Error (MAPE) uses the following formula

$$\text{MAPE} = \frac{\sum \left| A_t - {F_t}/{A_t} \right|}{n} \times 100$$

$$= \frac{\left|{30.000 - 29.910}/{30.000}\right| + \cdots + \left|{28.800 - 29.580}/{28.800}\right|}{4} \times 100$$

$$= 2{,}74\%$$

Calculations for forecasting using the SMA 3 method are as shown in table 5 below:

Table 5. Forecasting SMA 3

Periode	Actual Sales	3 Periode Single Moving Average				
		Forecast	Error	Mean Absolute Error (MAE)	Mean Square Error (MSE)	Mean Absolute Percentage Error (MAPE)
Des-23	31.020					
Jan-24	28.800					
Feb-24	30.000					
Mar-24	30.360	29.940	420	420	176.400	1,38%
Apr-24	28.800	29.720	-920	920	846.400	3,19%
Mei-24	28.800	29.720	-920	920	846.400	3,19%
Jun-24		29.320				
Jumlah				**2.260**	**1.869.200**	
Rata-Rata				**753**	**623.066,67**	**2,59%**

Forecasting calculations for February 2023 use the following formula

$$S_{t+1} = \frac{X_1 - X_{t-1} + \cdots + X_{t-n+1}}{n}$$

$$S_{3+1} = \frac{31.020 + 28.800 + 30.000}{3}$$

$$S_4 = \frac{89.920}{3}$$

$$S_4 = 29.940$$

For March 2023 onwards, this will be done in the same way

b. Weight Moving Average (WMA) Method

1. This calculation uses the 3-month Weight Moving Average (WMA 3) experience method with weights of 50,25,25

Table 6. Forecasting 6 Period Weight Moving Average (50, 25, 25)

Periode	Actual Sales	3 Periode Weight Moving Average (50,25,25)				
		Forecast	Error	Mean Absolute Error (MAE)	Mean Square Error (MSE)	Mean Absolute Percentage Error (MAPE)
Des-23	31.020					
Jan-24	28.800					
Feb-24	30.000					
Mar-24	30.360	30.210	150	150	22.500	0,49%
Apr-24	28.800	29.490	-690	690	476.100	2,40%
Mei-24	28.800	29.790	-990	990	980.100	3,44%
Jun-24		29.580				
Jumlah				**1.830**	**1.478.700**	
Rata-Rata				**610**	**492.900**	**2,11%**

Calculations using the WMA method with weightings of 50,25,25 as in table 6 are calculated using the formula

$$WMA = \frac{\sum D_t \times bobot}{\sum bobot}$$

$$WMA = \frac{\sum(31.020 \times 50) \times (28.800 \times 25) \times (30.000 \times 25)}{100}$$

$$WMA = 30.210$$

For the months of April, May and June 2024 onwards, this will be done in the same way

2. This calculation uses the 3-month Weight Moving Average (WMA 3) experience method with weights of 50,20,30.

Table 7. Forecasting 3 Period Weight Moving Average (50, 20, 30)

Periode	Actual Sales	3 Periode Weight Moving Average (50,20,30)				
		Forecast	Error	Mean Absolute Error (MAE)	Mean Square Error (MSE)	Mean Absolute Percentage Error (MAPE)
Des-23	31.020					
Jan-24	28.800					
Feb-24	30.000					
Mar-24	30.360	30.270	90	90	8.100	0,30%
Apr-24	28.800	29.508	-708	708	501.264	2,46%
Mei-24	28.800	29.712	-912	912	831.744	3,17%
Jun-24		29.580				
Jumlah				**1.710**	**1.341.108**	
Rata-Rata				**570**	**447.036**	**1,97%**

The calculation results as shown in table 7 above refer to the formula:

$$WMA = \frac{\sum D_t \times bobot}{\sum bobot}$$

$$WMA = \frac{\sum(31.020 \times 50) \times (28.800 \times 20) \times (30.000 \times 30)}{100}$$

$$WMA = 30.270$$

For the months of April, May and June 2024 onwards, this will be done in the same way

3. Comparison of Error Values

Based on Tables 3, 4, 5, 6, 7 using Microsoft Excel, the forecast values obtained using the Single Moving Average (SMA) and Weight Moving Average (WMA) methods are used as a reference for finding the lowest error value and forecasting results in the following period. The error value calculation for the moving average method is as follows:

Table 8. Error Values for Single and Weight Moving Average Methods

Mean Absolute Error (MAE)				
Company	SMA 2	SMA 3	WMA 50,25,25	WMA 50,20,30
10,320	802.50	753	610	570
Mean Square Error (MSE)				
Company	SMA 2	SMA 3	WMA 50,25,25	WMA 50,20,30
110,118,000	860.625	623,066.67	492,900	447,036
Mean Absolute Percentage Error (MAPE)				
Company	SMA 2	SMA 3	WMA 50,25,25	WMA 50,20,30
34.83%	2.74%	2.59%	2.11%	1.97%

Based on the calculation of error values for the single moving average and weight Moving Average methods, the smallest error value was obtained, namely the Weight Moving Average method with weightings of 50,20,30, where the Mean Absolute Error (MAE) value was 570, the Mean Square Error (MSE) was 447,036, and Mean Absolute Percentage Error (MAPE) of 1.97%.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the research results and discussion, the following research conclusions were obtained:

Based on forecasting calculations using the Single Moving Average and Weight Moving Average methods using Microsoft Excel, the following results were obtained:

1. Calculations based on the company's intuition obtained successive accuracy values, namely MAE 10,320, MSE 110,118,000, MAPE 34.83%
2. Calculations using the 2-month single moving average order method obtained successive accuracy values, namely MAE 802.50, MSE 860,625, MAPE 2.74%
3. Calculations using the 3-month single moving average order method obtained successive accuracy values, namely MAE 753, MSE 623,066.67, MAPE 2.59%
4. Calculations using the Weight Moving Average with weightings of 50,20,30 obtained successive accuracy values, namely MAE 570, MSE 447,036, MAPE 1.97%
5. Calculations using the Weight Moving Average with weightings of 50,25,25 obtained successive accuracy values, namely MAE 610, MSE 492,900, MAPE 2.11%

Based on the calculation of error values for the single moving average and weight moving average methods, the smallest error value was obtained, namely the weight moving average method with a weight of 50, 20, 30, where the Mean Absolute Error (MAE) value was 570, the Mean Square Error (MSE)

was 447,036, and Mean Absolute Percentage Error (MAPE) of 1.97%. So that the correct choice of the 4 methods mentioned above after several trials is carried out, the WMA 3 method (50,20,30) is the right method, so that for forecasting June 2024 it is 29,580 units.

Suggestions

From the conclusions presented above, the suggestions that can be given are as follows:

1. Based on the conclusions, the best forecasting method is obtained and it is hoped that it can be applied in the company concerned so that it can anticipate when demand falls and rises.
2. It is hoped that in the future it can be used as a reference or point of reference for further research and further research will be carried out based on other factors.

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