

Comparison of Moving Average and Exponential Smoothing Methods in Sales Forecasting of Banana Chips Products in Pd. Dwi Putra Tulang Bawang Barat

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ABSTRACT

Sales forecasts predict a company's sales. PD Dwi Putra's banana chip sales have fluctuated every month for the past few years, resulting in stock shortages and excesses. Forecasting using historical sales data uses time series methods like moving average and exponential smoothing. This study compares the two forecasting methods to find the lowest error rate and the best method for the company to use for the next four years. The exponential smoothing method outperforms the moving average method for MAPE, MSE, and MAD values, so it is used for future forecasting. According to research, companies should use exponential smoothing with parameter $\alpha = 0.6$ for the next four years because it has the lowest forecasting error rate. Thus, these parameters are used to forecast the next few years.

INTRODUCTION

The changing times and intense business competition require companies to be more courageous in making decisions and seeing the conditions and future business opportunities. Sales are the company's peak activity (Sasangka & Rusmayadi, 2018), so effective sales are a profit factor. This maximizes benefits. Plan company sales forecasting. Forecasting is crucial for companies directly producing to cut costs and sell enough. Forecasting involves predicting future events (Heizer & Render, 2015). Forecasting uses past sales data to predict the future. Forecasting improves plant efficiency.

Forecasting begins with understanding the data pattern. Is the data pattern seasonal, constant, cyclic, or up/down? Academics and operational researchers using forecasting methods are concerned about forecasting-themed research due to the wide variety of model choices (Kurniawan et al., 2022). According to (Hajjah & Marlim, 2021), knowing the best method to forecast company sales in the coming period can help the company make inventory stocking decisions to avoid significant shortages and surpluses. Kurniawan et al. (2022) compared exponential smoothing and moving average methods for forecasting bottled water sales. The exponential smoothing method has a higher error rate than the moving average method, with a two-month average movement for predicting 2021–2022 data. Research (Achmadani & Rochmoeljati, 2021) compares moving averages and exponential smoothing methods to forecast seaweed snack sales. The exponential smoothing method has a higher error rate than the three-month moving average method, according to 2020 data. (Hajjah & Marlim, 2021) found that exponential smoothing with parameter $\alpha=0.9$ has the lowest error rate for forecasting LED light sales in 2019, which is forecast in 2020.

PD. Dwi Putra conducted this research on Jalan Raya Murni Jaya, Daya Asri, Tumijajar District, West Tulang Bawang Regency, Lampung Province. Banana chips are the company's main product. The company was founded during a global crisis in Indonesia. This company needs sales forecasting to plan for the future. With such a high production value, it is risky to meet customer demand or overproduce, causing product stockpiles. In 2022, PD. Dwi Putra will sell 12,500 banana chips per month. In April 2022, 15,255 pcs exceeded the sales target by 122%, followed by 15,050 pcs in December 2022 by 120%. The lowest product sales achievement was 8,855 pcs in September 2022 (71%), followed by 8,964 in May 2022 (72%). This study compares moving averages and exponential smoothing because they are the most commonly used time series model forecasting methods, especially for long-term forecasting. The moving average method was chosen because it forecasts using the latest actual data. Additionally, fluctuating data will even out data distribution. The exponential smoothing method with the alpha smoothing constant is chosen because it is one of the most sophisticated time series methods and is still easy to use and understand. This research is appealing because high sales in April and December 2022 and low demand in September and May 2022 cause stock shortages and excesses.

LITERATURE REVIEW

A. Operation management

Operations management is one of the sciences in the management field, which is concentrated in the operating sector of the company. This field is very important because it is directly involved in the company's production or operational processes. According to (Heizer & Render, 2015), operations management is creating products and services by transforming inputs into outputs. According to (Hendrawaty, 2018), operations management is the process of achieving and utilizing resources to organize or produce useful goods or services to achieve organizational goals and objectives. Meanwhile (Stevenson & Chuong, 2014) argues that operations management is the main figure in the system. It has ultimate responsibility for the creation of goods or the provision of services.

B. Forecasting

Forecasting is one of the interesting topics in research. In addition, forecasting can also provide an overview for a company to decide on the future of the company or business. According to (Wardah & Iskandar, 2016), forecasting is a method for calculating future values using past data. According to (Yuniastari & Wirawan, 2017), forecasting in a company is widely used to provide and describe the company's future conditions that can assist decision-making regarding what steps can be taken to meet consumer demand. Forecasting is a way to measure, estimate, and predict what needs are needed to meet consumer demand for goods and services.

C. Moving Average

Moving average or moving average is a forecasting method from a group of observational data. It calculates the average value of the data as a forecast value for the next period. Forecasting using the moving average method performs a calculation process from the most recent data values and deletes old data values (Hajjah & Marlim, 2021). The moving average method can be calculated using the following equation.

$$F_t = \frac{\sum \text{Data requests } n \text{ previous periods}}{n}$$

F_t = forecasting value in period t

\sum = Total data requests for the previous period

n = The number of data periods of the moving average

D. Exponential Smoothing

Exponential smoothing or exponential smoothing is a moving average forecasting method with a sophisticated weighting system but is still easy to use. The exponential smoothing method is generally used to predict data with irregular patterns or patterns with large and volatile changes (Hajjah & Marlim, 2021). The exponential smoothing method can be calculated using the following equation.

$$F_t = F_{t-1} + \alpha (A_{t-1} - F_{t-1})$$

- F_t = New forecast
- F_{t-1} = Previous forecast
- α = Smoothing constant
- A_{t-1} = Actual demand for the previous period

E. Sale

Sales are the peak of activity in a company. This is because the income earned comes from these sales. A company's profit is also based on how much the product is sold and is useful for customers. According to (Triani et al., 2020), selling introduces, influences, and provides explanations so buyers can find the services or goods provided and reach a transaction or agreement on a price that benefits both parties. According to (Rudiyanto & Hariyanti, 2016), sales are the transfer of ownership rights to goods or the provision of services carried out by sales to purchases at a mutually agreed price with the amount charged to the customer in the sale of goods or services in an accounting period, the success of the sales business can be seen of the sales volume obtained. Factors that affect sales (Swastha, 2012) are categorized into five factors: Conditions and Capabilities of Sellers, Market Conditions, Capital, Company Organizational Conditions, and Other Factors.

F. Production

According to (Anil et al., 2008), production is defined as the step-by-step conversion of one form of material to another through a chemical or mechanical process to create or enhance product usability for the user. According to (Edwood Buffa in Anil Kumar & Suresh, 2008), Edwood Buffa defines production as creating goods and services. Meanwhile, according to (Hendrawaty, 2018), production is the addition or creation of uses or utilities due to form and place, thus requiring factors of production. In economics, the factors of production consist of land, nature, capital, labor, and capabilities, as well as technology.

G. MAD (Mean Absolute Deviation)

MAD is a way to measure the value of forecasting error (error) for a model (Kurniawan et al., 2022). The value is calculated by dividing the absolute total value of each forecasting error by the number of data periods (Amalia et al., 2020). The final mark in this measurement is useful to avoid negative error values. The smaller the MAD value obtained, the better the forecasting results. The following equation can calculate the MAD value.

$$MAD = \frac{\sum_{t=1}^n |A_t - F_t|}{n}$$

- A_t = Actual value in period t
- F_t = forecasting value in period t
- n = Number of data

H. MSE (Mean Squared Error)

MSE is a way to measure forecast error through an absolute average value or an overall average that is squared (Kurniawan et al., 2022). MSE is a calculation technique by calculating the difference between the forecast data and the actual data, which is then squared. The smaller the MSE value generated, the better the forecasting results. The following equation can calculate the MSE value.

$$MSE = \frac{\sum_{t=1}^n (At - Ft)^2}{n}$$

At = Actual value in period t
 Ft = forecasting value in period t
 n = Number of data

I. MAPE (Mean Absolute Percentage Error)

MAPE (Mean Absolute Percentage Error) is calculated as the average of the absolute differences between the predicted and actual values and is expressed as a percentage of the actual value (Amalia et al., 2020). MAPE is used to determine the level of accuracy of forecasting results. MAPE calculates the absolute error value in each period divided by the actual value, then calculates the average percentage value of the absolute value. The following equation can search the MAPE value.

$$MAPE = \left(\sum_{t=1}^n \frac{|At - Ft|}{At} \right) \left(\frac{100\%}{n} \right)$$

At = Actual value in period t
 Ft = forecasting value in period t
 n = Number of data

Research from (Hajjah & Marlim, 2021) states that the forecasting results are good if the MAPE value obtained is smaller. The criteria for the MAPE score are as follows:

Table.1 MAPE Value Criteria

MAPE Value	Criteria
$x < 10\%$	Very good forecasting ability
$10\% \leq x < 20\%$	Good forecasting ability
$20\% \leq x < 50\%$	Quite good forecasting ability
$x \geq 50\%$	Poor forecasting ability

(Source: Hajjah & Marlim, 2021)

J. POM-QM Software

Production and Operation Management Quantitative Methods or more commonly known as POM-QM, is a software or software that can be used on a computer to solve a problem in production and operations in a quantitative way. This software is also very useful in carrying out a sales forecast using historical data from company sales that have occurred in previous years to be implemented or implied in the future. According to (Weiss et al., 2018), POM-QM software or software is software designed for production and operations management, quantitative methods, management science, and operations research. The POM-QM software can be used either to solve a problem or to check an answer that has been created manually.

METHOD

1. Research Design

This study uses comparative quantitative research to find the method with the lowest forecasting error. Quantitative research methods like comparative function compare two or more variables or treatments (Bungin, 2014). Quantitative research compares two or more events, activities, or programs. The research component's relationships show the comparison. Similarities and differences in planning, implementation, and supporting factors are calculated. The snack food trading company PD Dwi Putra, which makes kapok banana chips, conducted this research. Jalan Raya Murni Jaya, Daya Asri, Tumijajar District, West Tulang Bawang Regency, Lampung Province, houses the company. We use sales from April 2019 to March 2023 were forecasted for April 2023 to March 2027 in this study. PD Dwi Putra's main product, banana chips, is the focus of this research.

2. Data Type, Source, and Collection

This study uses quantitative data. This study uses PD Dwi Putra's 2019–2023 banana chip sales data. This study's qualitative data comes from interviewees. This study's primary data source will be used to write this scientific paper and support quantitative data forecasts for April 2023 to March 2027. Secondary data is data. Researchers gathered them from company documents. This data provides PD Dwi Putra's history and employee count. Forecasting research also used product sales archives. Data collection is crucial to research. The researcher interviewed and documented PD Dwi Putra in this study to obtain information and company data.

3. Observation Time

The relevant company, PD Dwi Putra, permitted researchers to observe and collect data. Researchers observed and communicated with the company in October 2022 and collected data in January 2023. April 2023 collected more data. Researchers did this because data adequacy tests needed more data. So data is collected again for 48 months (four years) from April 2019 to March 2023 to forecast from April 2023 to March 2027.

4. Statistical Analysis

After collecting research data, test its adequacy before analyzing it. Research data sample size affects forecast confidence and accuracy. Next, plot the data results in graphical form to determine if the data is trend, seasonal, constant, or cyclical. This study forecast errors using POM-QM for Windows v5. MAD, MSE, and MAPE calculate forecasting errors. Figure 3.1 shows POM-QM's Windows v5 debut. The data was also tested for adequacy, plots, and normality.

5. MAD, MSE, MAP

Amalia et al. (2020) calculate MAD by dividing the total absolute value of each forecasting error by the number of data periods. This MAD calculation removes plus and minus signs to simplify data processing. MSE is the average forecasting error squared (Amalia et al., 2020). Forecasting will be more accurate if the MSE value is close to zero. MAPE (Mean Absolute Percentage Error) is the average absolute difference between predicted and actual values expressed as a percentage of the actual value (Amalia et al., 2020). Because it shows a percentage of the forecasted data, the MAPE value makes forecast data analysis easier.

RESEARCH RESULT

A. Data collection

Sales data or demand data for PD Dwi Putra's banana chips were collected directly from the company located on Jalan Raya Murni Jaya, Daya Asri, Tumijajar District, West Tulang Bawang Regency, Lampung Province. The data was taken as an Excel file through the Accosys software used at the company. In this study, the data used for analysis is PD Dwi Putra's historical sales data from 2019 to 2023 or, in more detail, from April 2019 to March 2023. PD Dwi Putra's historical sales data can be seen in the following table.

Table.2 Sales Historical Data of PD Dwi Putra April 2019 - March 2023

Month	Year					Total
	2019	2020	2021	2022	2023	
January		5,331	9,446	9,491	10,207	34,475
February		5,192	9,993	10,295	9,973	35,453
March		4,739	9,935	10,342	11,972	36,988
April	9,072	6,964	8,887	15,255		40,178
May	11,238	7,483	10,621	8,964		38,306
June	7,944	4,255	7,994	9,129		29,322
July	8,364	5,091	9,428	9,680		32,563
August	8,592	5,177	9,070	11,487		34,326
September	8,110	4,513	8,813	8,855		30,291
October	8,621	5,090	10,491	11,070		35,272
November	8,073	4,758	9,798	9,983		32,612
December	10,532	6,925	10,550	15,050		43,057
Total	80,546	65,518	115,026	129,601	32,152	422,843

(Source: Data Processed by Researchers, 2023)

B. Data Adequacy Test

The data adequacy test is carried out after obtaining the historical sales data needed to be processed and forecast sales for the next few years. This data adequacy test is carried out to see whether the data that has been collected is sufficient or not sufficient to carry out a sales forecast. If the value of N' , which is the required data in this case, is smaller than that of N , which is the current amount of data, then the research data obtained is sufficient and acceptable. Meanwhile, if the value of N' is greater than that of N , then data must be taken again to be sufficient.

$$N' = \left[\frac{\frac{k}{s} \sqrt{N \cdot \sum Xi^2 - (\sum Xi)^2}}{\sum Xi} \right]^2$$

$$N' = \left[\frac{20 \sqrt{48 \cdot 4,010,530,993 - (422,843)^2}}{422,843} \right]^2$$

$$N' = \left[\frac{20 \sqrt{48 \cdot 4,010,530,993 - 178,796,202,645}}{422,843} \right]^2$$

$$N' = \left[\frac{20 \sqrt{192,505,487,664 - 178,796,202,645}}{422,843} \right]^2$$

$$N' = \left[\frac{20 \sqrt{13,709,285,015}}{422,843} \right]^2$$

$$N' = \left[\frac{20 \cdot 117,087}{422,843} \right]^2$$

$$N' = \left[\frac{2,341,733}{422,843} \right]^2$$

$$N' = 5,538067605^2$$

$$N' = 30,67019279$$

From the results of the calculation above, the value is obtained:

$N = 48$ (Number of processed data or samples)

$\sum Xi = 422,843$ (Total amount of data from 2019-2023)

$\sum Xi^2 = 4,010,530,993$ (Total sum of civil squares Year 2019-2023)

$N' = 30.67019279$ (Amount of data needed)

The level of accuracy used by the researcher is 10%, namely the maximum deviation from the measurement results to the actual value, and the level of confidence used by the researcher is 95%, namely the amount of confidence or probability that the data that has been obtained lies at a predetermined level of accuracy. Then with a level of accuracy of 10% and a confidence level of 95%, the value of $K/S = 20$. The data adequacy test above obtained a value of N' of $30.67019279 <$ the value of N , namely 48. Thus, because the value of N' is smaller than that of N , the historical sales data of PD Dwi Putra can be accepted for processing sales forecasting data for the next few years.

C. Data Plots

The data plot is done in graphical form to see the properties of the data. Each periodic data series obtained is shown as a point. The data period is located in the coordinates (x-axis), and the number of sales is in the coordinates (y-axis). PD Dwi Putra's sales historical data plot can be seen in the following figure.

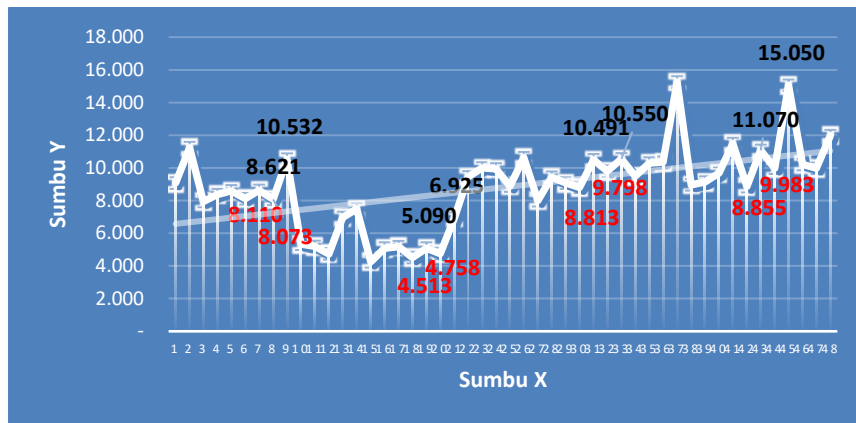


Figure.1 Sales Data Plot of PD Dwi Putra April 2019 - March 2023
 (Source: Data Processed by Researchers, 2023)

Based on the data plots in Figure below, it can be concluded that the total sales of PD Dwi Putra from April 2019 to March 2023 have the form of a seasonal pattern seen in the graph, which often experiences repetition in the same period. Sales increases often occur in October and December. The decline in sales often occurs in September and November. The data plot also detects an upward trend in sales from 2019 to 2023.

D. Normality test

The Kolmogorov-Smirnov normality test used in this study is the principle of finding the largest deviation from the cumulative distribution function of the observation data to the theoretical cumulative distribution function. In the normality test, the data is normally distributed if the statistical Z value is > 0.05 . Meanwhile, the data is not normally distributed if the statistical Z value is < 0.05 .

Table.3 Normality Test Results

N		48
Normal Parameters ^{a,b}	Mean	8.80923
	Std.	2.465119
	Deviation	
Most Extreme Differences	Absolute	0.113
	Positive	0.108
	Negative	-0.113
Test Statistic		0.113
Asymp. Sig. (2-tailed)		0.166

(Source: Data Processed by Researchers, 2023)

The results of the normality test in the table above, which were carried out using the Kolmogorov Smirnov test type, obtained a significance value for the normality test of 0.166 which in this case is greater than 0.05, which means that the data processed in this study is normally distributed.

E. Measuring Forecasting Error

Measurement of forecasting errors or errors in this study was carried out using the help of POM-QM software with three forecasting error measurement tools in it, namely MAD (Mean Absolute Deviation), MSE (Mean Squared Error), and MAPE (Mean Absolute Percentage Error). This study focuses on the MAPE (Mean Absolute Percentage Error) value results, which are used to determine the lowest error rate in forecasting sales data, which is processed as a percentage error. If the error rate is smaller and closer to 0, the forecast will be better and more accurate.

Data plots that have been done previously show a seasonal data pattern and have also confirmed the method used in this study. This study used two research methods, namely moving average and exponential smoothing, which then compared the results of forecasting errors between the two methods. The moving average method uses the parameters MA1, MA2, MA3, MA4, and MA6. Meanwhile, the exponential smoothing method uses the parameter α (alpha) 0.1; 0.2; 0.3; 0.4; 0.5; 0.6; 0.7; 0.8; and 0.9. The recapitulation of error measurement results was carried out using the help of Microsoft Excel.

The results of forecasting error measurements can be seen in the following table.

Table 1. Forecasting Error Calculation Results

<i>FORECAST ERROR MOVING AVERAGE (n)</i>	MAD	MSE	MAPE
MA1	1572,57	4908209	18,49%
MA2	1468,58	3791019	17,72%
MA3	1464,55	3766140	17,72%
MA4	1415,36	3563076	17,35%
MA6	1513,69	4073938	18,57%
<i>FORECAST ERROR EXPONENTIAL SMOOTHING (a)</i>	MAD	MSE	MAPE
0,1	1680,14	4579318	21,69%
0,2	1487,58	3740991	18,51%
0,3	1415,05	3474543	17,22%
0,4	1391,91	3429477	16,72%
0,5	1398,17	3495818	16,67%
0,6	1405,29	3634189	16,65%
0,7	1427,96	3831058	16,83%
0,8	1459,15	4085275	17,18%
0,9	1492,72	4404497	17,57%

(Source: Data Processed by Researchers, 2023)

The results of forecasting errors are obtained after the data is processed using the POM-QM software using the moving average and exponential smoothing methods. Processing to calculate forecasting errors is carried out individually with the period parameter set in the moving average method and the alpha parameter set in the exponential smoothing method. The moving average method selects the MA1, MA2, MA3, MA4, and MA6 periods based on these periods that can be used in division within one year. In the exponential smoothing method, the data is processed with the alpha parameter as a whole with a value of 0.1 to 0.9.

Recapitulation of the results of forecasting errors is then carried out to make it easier to read the result of the data processing that has been done. By focusing on the objective results of this study, namely, to find out which method has the lowest error rate, the MAPE (Mean Absolute Percentage Error) value is used as a reference or basis for decision-making. The MAPE score criteria in this study refer to Table MAPE Score Criteria.

Measure	Value
Error Measures	
Bias (Mean Error)	79,73
MAD (Mean Absolute Deviation)	1405,29
MSE (Mean Squared Error)	3634189
Standard Error (denom=n-2=46)	1947,36
MAPE (Mean Absolute Percent Error)	16,65%
Forecast	
next period	11368,28

**Figure 1. Results of MAPE Values on Measurement of Forecasting Errors
 (Source: Data Processed by Researchers, 2023)**

The results of forecasting error data processing in this study show that the MAPE (Mean Absolute Percentage Error) value with the smallest number is in the exponential smoothing method with the parameter alpha (α) set at 0.6 with a percentage value of 16.65%. With the value that has been obtained, if the percentage of forecasting error has a value of $10\% \leq x < 20\%$, then this percentage value is included in the MAPE value criteria with good forecasting ability.

F. Sales Forecasting for 2023-2027

Sales forecasting is carried out for the next four years, to be exact, from April 2023 to March 2027, with a focus on collecting company sales data. This is because this research focuses on forecasting products already in the form of finished goods. The method chosen and used to predict sales or demand in the next few years in this study is the exponential smoothing method with parameter alpha (α) = 0.6 with a forecasting error rate of 16.65%.

Forecasting data processing in this study uses the help of POM-QM software with the following forecasting results.

	Demand(y)	Forecast	Error	Error	Error^2	Pct Error
April	9072	9072	0	0	0	0%
May	11238	9072	2166	2166	4691556	19,27%
June	7944	10371,6	-2427,6	2427,6	5893240	30,56%
July	8364	8915,04	-551,04	551,04	303645,1	6,59%
August	8592	8584,42	7,58	7,58	57,52	,09%
September	8110	8588,97	-478,97	478,97	229409,2	5,91%
October	8621	8301,59	319,41	319,41	102024,7	3,71%
November	8073	8493,23	-420,23	420,23	176596,9	5,21%
December	10532	8241,09	2290,91	2290,91	5248252,0	21,75%
January	5331	9615,64	-4284,64	4284,64	18358120	80,37%
February	5192	7044,86	-1852,86	1852,86	3433072,0	35,69%
March	4739	5933,14	-1194,14	1194,14	1425975,0	25,2%
April	6964	5216,66	1747,34	1747,34	3053209,0	25,09%
May	7483	6265,06	1217,94	1217,94	1483372,0	16,28%
June	4255	6995,83	-2740,83	2740,83	7512123	64,41%
July	5091	5351,33	-260,33	260,33	67771,75	5,11%
August	5177	5195,13	-18,13	18,13	328,76	,35%
September	4513	5184,25	-671,25	671,25	450580,5	14,87%
October	5090	4781,5	308,5	308,5	95171,65	6,06%
November	4758	4966,6	-208,6	208,6	43514,2	4,38%
December	6925	4841,44	2083,56	2083,56	4341221,0	30,09%
January	9446	6091,58	3354,42	3354,42	11252160	35,51%
February	9993	8104,23	1888,77	1888,77	3567450,0	18,9%
March	9935	9237,49	697,51	697,51	486517,2	7,02%
April	8887	9656	-769	769	591356,5	8,65%
May	10621	9194,6	1426,4	1426,4	2034621,0	13,43%
June	7994	10050,44	-2056,44	2056,44	4228943	25,72%
July	9428	8816,58	611,42	611,42	373839,1	6,49%
August	9070	9183,43	-113,43	113,43	12866,52	1,25%
September	8813	9115,37	-302,37	302,37	91428,87	3,43%
October	10491	8933,95	1557,05	1557,05	2424407,0	14,84%
November	9798	9868,18	-70,18	70,18	4925,19	,72%
December	10550	9826,07	723,93	723,93	524071,4	6,86%
January	9491	10260,43	-769,43	769,43	592020,6	8,11%
February	10295	9798,77	496,23	496,23	246242,7	4,82%
March	10342	10096,51	245,49	245,49	60265,93	2,37%

April	15255	10243,8	5011,2	5011,2	25112090	32,85%
May	8964	13250,52	-4286,52	4286,52	18374270	47,82%
June	9129	10678,61	-1549,61	1549,61	2401286,0	16,97%
July	9680	9748,84	-68,84	68,84	4739,46	,71%
August	11487	9707,54	1779,46	1779,46	3166488,0	15,49%
September	8855	10775,21	-1920,22	1920,22	3687225	21,69%
October	11070	9623,09	1446,91	1446,91	2093560,0	13,07%
November	9983	10491,23	-508,23	508,23	258302,2	5,09%
December	15050	10186,29	4863,71	4863,71	23655640	32,32%
January	10207	13104,52	-2897,52	2897,52	8395608	28,39%
February	9973	11366,01	-1393,01	1393,01	1940468	13,97%
March	11927	10530,2	1396,8	1396,8	1951042,0	11,71%
TOTALS	422798		3827,13	67453,95	174441100	799,19%
AVERAGE	8808,29		79,73	1405,29	3634189	16,65%
Next period forecast		11368,28	(Bias)	(MAD)	(MSE)	(MAPE)
				Std err	1947,36	

Figure 2. Forecasting Results with the Exponential Smoothing Method $\alpha = 0,6$ (Source: Data Processed by Researchers, 2023)

DISCUSSION

This research is a type of comparative quantitative research that compares two or more methods to see the best results obtained and can be implemented in related companies in the future. The methods used in this study are the moving average method and the exponential smoothing method. The moving average method is processed using the parameters MA1, MA2, MA3, MA4, and MA6, while the exponential smoothing method is processed using the parameter alpha (α) 0.1; 0.2; 0.3; 0.4; 0.5; 0.6; 0.7; 0.8; and 0.9. This research uses historical data on sales of PD Dwi Putra from April 2019 to March 2023. Before entering the forecasting stage, the first step must be to collect historical sales data and ensure that the data is sufficient for forecasting in the coming several years. The data collected and obtained must be tested with a data adequacy test beforehand when a forecast is to be made.

Data adequacy testing is carried out so that the processed data meets or meets the requirements specified in forecasting. This study uses an accuracy level of 10% and a confidence level of 95% with a K/S value of 20. The data is considered sufficient if N' , which in this case is the amount currently required, has a value smaller than the value of N , which is the amount of data – used for processing. Based on the results of the data adequacy test in this study, which in this case obtained an N' value of 30.67019279 which in this case was smaller than the N value of 48, therefore the data was declared sufficient or accepted and could be used for the next stage for plotted data. Data plots in graphical form in this study were carried out to see the nature of the historical data on the sales of PD Dwi Putra that were formed. When plotting the data, the result is that the data is in seasonal form with graphical indications showing an increase in sales which always occurs in October and December. Sales decline also always occurs in September and November. Apart from that, there is an increasing trend in the data from 2019 to 2023. When the data plots have been done, the next step is to test the normality of the data.

The data normality test in this study was conducted to see whether the data taken as research samples were normally distributed or not normally distributed. In the normality test conducted using the Kolmogorov Smirnov with parameters, the data is normally distributed if the Z statistic value is > 0.05 . The data is not normally distributed if the Z statistic value is < 0.05 . The normality test conducted using Kolmogorov Smirnov found that the significant value in the sample or research data was 0.166, which in this case had a value greater than 0.05. Thus, the data or sample in this study is normally distributed. In addition, the data plot in a histogram graph also shows normally distributed data marked by an inverted bell-shaped curve, in which case most of the data is inside the curve. So that the data in this study are normally distributed. After the normality test, the next step is to measure the forecasting data error.

Forecasting error measurement is carried out using POM-QM software using MAD (Mean Absolute Deviation), MSE (Mean Squared Error), and MAPE (Mean Absolute Percentage Error) tools. However, this study focuses on the results of the MAPE score concerning the criteria for the MAPE value. Based on the results of calculating forecasting error measurements in this study, it was found that the exponential smoothing method using the parameter alpha (α) 0.6 has the lowest error rate compared to other parameters, namely with a MAPE value of (16.65%), MSE of (3634189), and MAD of (1405.29), so for forecasting the next four years using the values of these methods and parameters.

This study's results align with previous research (Hajjah & Marlim, 2021) with the title "Error Analysis Toward Sales Data Forecasting" to predict LED lamp sales by comparing two methods, namely moving average and exponential smoothing. The results of this study show that the exponential smoothing method has the lowest error rate compared to the moving average method. The results of this study also contradict previous research from (Achmadani & Rochmoeljati, 2021) with the title "Sales Forecasting Analysis of Sea Snack at PD Adi Nugraha Food Industry" and previous research from (Kurniawan et al., 2022) with the title "Model Comparison Single Moving Average & Exponential Smoothing for Forecasting Sales of NUCless AMDK, both of which get the result that the forecasting method using the moving average method has better results compared to the exponential smoothing method in making a forecast.

CONCLUSION AND RECOMMENDATION

Data collection, adequacy tests, plots, and processing show seasonal patterns. The exponential smoothing method outperforms the moving average method, with the parameter alpha (α) 0.6 yielding the lowest forecasting error with MAPE values of (16.65%), MSE of (3634189), and MAD of (1405.29). The selected methods and parameters are used to forecast the next few years. Researchers recommend that companies review their methods for predicting future requests after four years or by April 2027. The latest historical data can change the value of $K/S = 20$, used in this study, affecting the forecasting method. The company should implement the exponential smoothing method with an alpha (α) parameter of 0.6 for the next four years to predict future requests and reduce seasonal requests. Forecasting research should start with data plots and data adequacy tests

to determine whether data patterns are seasonal, constant, trend, or a combination of patterns. The data adequacy test also verifies data needed for forecasting.

ADVANCED RESEARCH

Other researchers who discuss the topic of forecasting should pay attention to several initial things, such as data plots and data adequacy tests, in order to determine whether the pattern contained in the data is in the form of a seasonal pattern, a constant trend, or a combination of a few different patterns. In addition, the data's authenticity, required as a prerequisite before making a forecast, is evaluated as part of the data adequacy test.

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