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FORECASTING ANALYSIS OF URETHANE BLADE NEEDS ON BELT CLEANER TO MINIMIZE FORECAST ERROR: CASE STUDY AT PT. MS ENGINEERING

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ABSTRACT

PT. MS Engineering is a company engaged in the field engineering, which is producing belt cleaners for cleaning conveyor belts in mining areas, the cement industry and the power plant. In the belt cleaner, has several parts assembled into one, including metal parts and urethane blade parts. PT MS Engineering has low forecasting accuracy, causing excess stock, especially for parts of urethane blade that have expired. The company only sees based on historical data. Therefore, to overcome these problems, it is necessary to forecast demand with the appropriate method. In this study by comparing several forecasting methods to find the highest error rate. The methods to be used include Single Moving Average, Exponential Smoothing and Weighted Moving Averages. From the discussion and analysis of the three calculation methods above, it is known that the calculation results with the 4 monthly Single Moving Average methods are better and more suitable to be applied by PT. MS Engineering in predicting the needs of Urethane Blade in January 2020, because the method has a lower error rate than the method other. The forecast error rate, MAD (Mean Absolute Deviation) of 58,906 and MSE (Mean Square Error) of 4484.57 with forecast results for January 2020 of 292.5 pcs.

Keywords: Forecasting, Forecast Error, Urethane blade, Belt Cleaner, Single Moving Average, Exponential Smoothing, Weighted Moving Averages.

1. INTRODUCTION

An established company has the goal to produce goods and services that are the needs of consumers and at the same time to benefit from the business. At present the company must be able to face intense competition with other companies whose numbers are increasing. The company is also required to always be able to pay attention to the needs and desires of customers and try to meet what is expected by customers in a better way to satisfy customers than what has been done by competitors. Inventory management functions to manage the large volume of inventory items that must be provided and when and how many orders must be made (Russell, 2008). The problem of inventory that often arises is how to manage inventory so that every time there is a demand, the demand can immediately be fulfilled but by continuing to minimize the amount of inventory itself (Ramdhanu & Hasibuan, 2017).

Forecasting is the art and science of estimating future events. Therefore companies need to predict what will happen in the future. This is due to obtain meaningful input in determining company policy (Heizer & Render, 2005). Forecasting is done aims to determine the estimated number of sales to come so as to meet the needs of consumers the company's management makes forecasting product needs. Forecasting needs about the number of products that will be ordered or requested in the coming period and the forecasting is obtained from product demand data in the previous period. Forecasting is the activity of knowing and estimating what happens in the future, then forecasting serves as the basis for the company to make the right decision in its production. In forecasting activities require the application of

appropriate methods, this aims to be able to know future requests and minimize forecasting errors. Inaccuracies in inventory analysis as well as errors in demand data withdrawal can result in overstock and additional costs (Ravinder & Misra, 2016). Every company must have adequate inventory. The main purpose of holding inventory is to reduce costs associated with investing in inventory and maintain efficiency in production and sales operations (Riza & Purba, 2018).

PT. MS Engineering is a company engaged in manufacturing that produces belt cleaners for cleaning conveyor belts in mining areas, the cement industry and power plants. Belt cleaner has several parts that are assembled into one, namely the metal part and urethane blade. PT MS Engineering has low forecasting accuracy, causing excess stock, especially for parts of urethane blade that have expired. The company only sees based on previous historical data. Therefore, to overcome these problems, the need for forecasting needs with the appropriate method.

1.2 Formulation of the problem

Based on the background of the above problems, it can be formulated that the main issues to be discussed in this study are:

1. What is the forecast need for urethane blade parts with the Single Moving Averages method with a period of 3 and 4 months, Exponential Smoothing with alpha ($\alpha = 0.1$; $\alpha = 0.5$; $\alpha = 0.9$), and Weighted Moving Averages at PT.MS Engineering for the period will come ?
2. What is the forecast error from the forecast results with the three methods?
3. What is the appropriate forecasting method to determine the urethane blade requirements in the upcoming period at PT. MS Engineering?

1.3 Research Purpose

This research was conducted with the aim that the results of the study can provide benefits in accordance with what is desired. The purpose of this study are:

1. To find out the forecast of urethane blade needs with the Single Moving Averages method with 3 and 4 monthly time periods, Exponential Smoothing with alpha ($\alpha = 0.1$; $\alpha = 0.5$; $\alpha = 0.9$), and Weighted Moving Averages in the upcoming PT.MS Engineering .
2. To find out the forcast error from the forecast results with the three methods.
3. To find out the correct forecasting method in determining the amount of urethane blade requirements in the coming period at PT. MS Engineering.

2. LITERATURE REVIEW

Manufacturing system has a definition as a whole entity that works in a certain rule to convert into products that can be sold by companies by carrying out certain production processes to increase the added value of a resource. From this opinion it can be seen that the main function of the manufacturing system is producing customer demand. There are two aspects of customer demand that must be met by the manufacturing system, namely the number and design aspects. To meet both aspects of the demand, the manufacturing system must be designed as optimal as possible. The design includes material selection, equipment selection, production flow, production floor layout, quality design, material handling equipment design to the costs required to carry out the design.

Inventories are idle resources that are waiting for further processing. As a result of inventory that has not been running optimally is an excess or lack of inventory. If excess inventory (inventory is too large), it will result in storage costs on raw material inventory will be high, capital retention, and reduced funds for investment in other fields.

There are two things that must be considered in accurate and accurate forecasting. First is data collection, data must be relevant so that the forecasting produced can provide accurate information. Second is the selection of the right technique. Single Moving Averages, Exponential Smoothing and Weight Moving Averages are methods with statistical quantitative forecasting techniques that generally use historical data that emphasizes patterns, pattern changes, and disturbances caused by random effects.

Forecasting is a process for estimating some future needs which include needs in terms of quantity, quality, time and location needed in order to meet the demand for goods or services (Nasution &

Prasetyawan, 2008). The main purpose of forecasting is to predict future demand, so that an estimate is approaching the actual situation. Forecasting is a picture of the state of the company in the future. This picture is very important for company management because with this description the company can predict what steps are taken in meeting consumer demand. Forecasting is not always 100% accurate, because the future contains uncertainty issues, but with the selection of the right method can make forecast with a small error rate.

Forecasting define as an objective calculation and by using past data, to determine something in the future (Sumayang, 2003). Forecasting is the art and science of estimating future events (Heizer & Render, 2005). Forecasting is estimating something that will happen (Subagyo, 2000). Forecasting activity is a business function that tries to estimate the sale and use of products so that the products can be made in the right quantity. From the opinions of the experts above, it can be concluded that forecasting is estimating something that will happen by using past data.

3. METHOD

3.1 Object of research

The study was conducted at PT. MS Engineering which has not implemented the forecasting needs of urethane blades. PT. MS Engineering is a manufacturing company manufacturing belt conveyor parts, located in Tangerang, Banten provice - Indonesia.

3.2 Data source

The data source in this study is secondary data, secondary data that is data obtained through other parties or other sources, not directly obtained by the authors of the research subjects. Secondary data in this study include:

a. Descriptive Data

Descriptive data will be used to provide a general description of the company in the study. Descriptive data used are: The production process of making belt conveyor parts.

b. Quantitative Data

The urethane blade part data needs from January 2019 to December 2019 which will be used to predict the January-April 2020 period.

3.3 Data collection technique

a. Observation Method, namely direct field observation, researchers conduct observations and direct records of the activities carried out by PT. MS Engineering to support forecasting data in the problem under study.

b. Interview Method, namely conducting question and answer with employees who are directly related to the production process along with the officers concerned in the company environment PT. MS Engineering.

3.4 Data analysis technique

There are two things that must be considered in accurate and accurate forecasting. First is data collection, data must be relevant so that the forecasting produced can provide accurate information. Second is the selection of the right technique.

In this study, data analysis techniques used by the author regarding the forecasting of urethane blade requirements at PT. MS Engineering is the Single Moving Averages, Exponential Smoothing, and Weighted Moving Averages methods. And to calculate forecasting errors using MAD (Mean Absolute Devition) and MSE (Mean Squere Error).

a. Single Moving Averages Method.

The urethane blade needs to change significantly from time to time, the forecast must be aggressive enough to anticipate these changes, so that a small value will be more suitable for use. Systematically the Single Moving Averages are stated as follows:

Moving average

$$= \frac{\sum \text{needs of urethane blade in previous } n}{\text{n}} \quad (1)$$

n = time period (3 and 4 months)

b. Exponential Smoothing Method (Exponential Smoothing).
Exponential smoothing is a moving average forecasting technique by weighting where the data is weighted by an exponential function. This method records very little of past data. To predict the future urethane blade part requirements, an exponential refinement analysis is needed. The exponential refining formula can be shown as follows:

$$F_1 = F_{t-1} + \alpha(A_{t-1} - F_{t-1}) \quad (2)$$

Information :
F1 = forecasting the need for urethane blade parts
Ft-1 = forecasting the need for urethane blade parts before
α = smoothing (weighting) constant ($0 \leq \alpha \leq 1$)
At-1 = actual urethane blade request last month
The magnitude of α = between 0-1, where getting closer to 1 means the latest data is given a greater weight.
1) α = 0.1 means giving less weight to the previous forecasting compared to the previous data.
2) α = 0.5 means giving the same weight between the previous forecasting so that the balance occurs.
3) α = 0.9 means giving greater weight to the previous forecasting compared to the previous data. This method is more suitable for predicting things with random or irregular fluctuations.

c. Weight Moving Averages Method.
Moving averages with weighting can be described mathematically as follows:
Average by weighting

$$= \frac{\sum(\text{weight in period } n) \text{ x } (\text{need for urethane blade in period } n)}{\text{n}} \quad (3)$$

Note: n is the number of periods in the weighted moving average.
Measurement of Forecasting Accuracy Results The technique used by the author to measure the level of difference between forecasting results and the actual urethane blade requirements is the Mean Absolute Deviation (MAD) and Mean Square Error (MSE).

$$\text{MAD} = \sum \left| \frac{A_t - F_t}{\text{n}} \right| \quad (4)$$

$$\text{MSE} = \sum \frac{(A_t - F_t)^2}{\text{n}} \quad (5)$$

At = Actual need for urethane blade in period - t.
Ft = Forecast of urethane blade in t-period.
n = Number of forecasting periods involved.

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3.5 Flow of Research Framework

In analyzing forecasting a research flow needs to be made so that research is directed. The flow of the research framework is as follows:

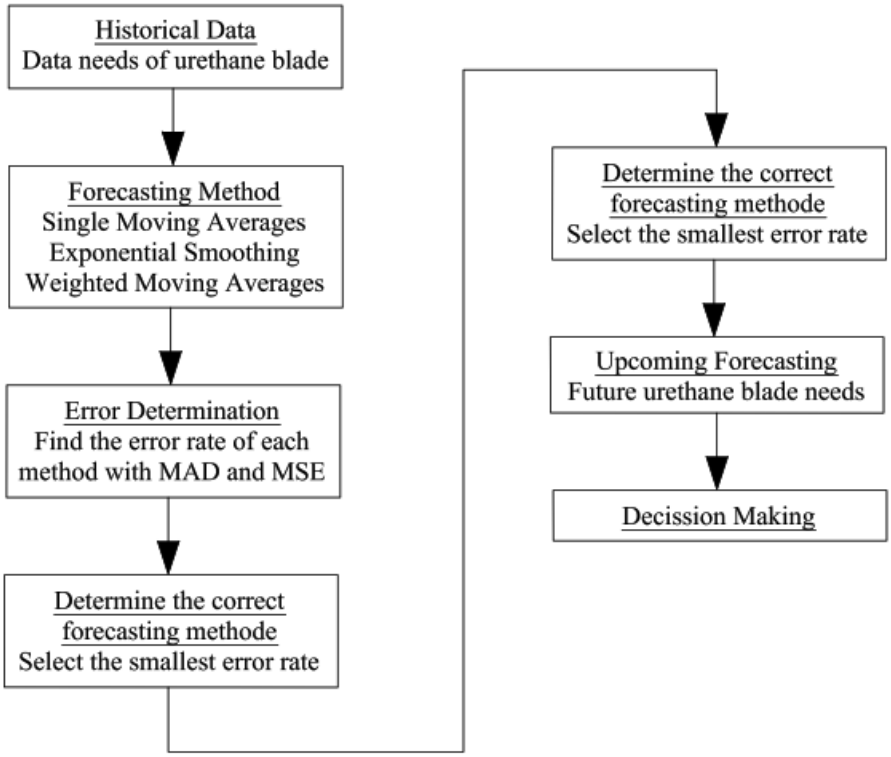

Figure 1: Flow of research framework

Every company experiences ups and downs in the demand for a product, generally the consumer demand for its products always changes in each period, with the uncertainty of a demand, so the company needs to make a demand forecast. Where to make these predictions requires a historical data in the previous periods. Previous data is used to predict future period requests. In calculating these data three methods are used, namely Single Moving Averages, Exponential Smoothing, and Weighted Moving Averages.

From the forecasting results, the error rate in each forecasting method is searched. Calculation of forecasting errors uses MAD (Mean Absolute Error) and MSE (Mean Square Error). Furthermore, to find out the most appropriate method that is looking for error rates (errors) that are closer to zero in each forecasting method. With the results of these forecasts, providing convenience in knowing the amount of product needs, it will be used as a basis in production planning by company managers in making decisions after knowing the forecasting data and planning.

4. RESULTS AND DISCUSSION

4.1 Identify historical patterns from the actual data request

To select a particular forecasting model, it must identify the historical pattern from the actual data request for the urethane blade. The actual data for the demand for urethane blade in 2019 is as follows:

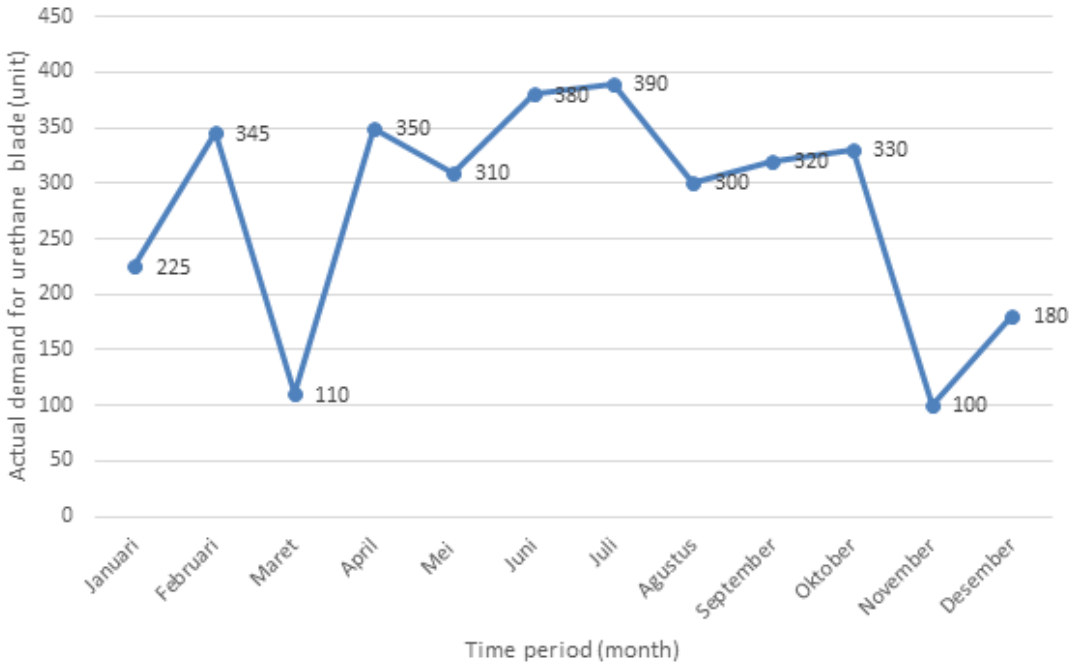

Figure 2: Graph of request for urethane blade 2019

From Figure 2, it is known that historical patterns from the actual data of urethane blade demand during 2019 do not form trend line trends, thus forecasting models that consider trend trends do not need to be considered. Next will be considered a model of moving average forecasting, exponential smoothing and Weight Moving Average.

4.2 Select a forecasting model that suits historical patterns

Based on historical patterns from actual demand data, the moving average forecasting model is chosen. Basically there are two types of moving average forecasting models, namely the weightless moving average and the weighted moving average. The use of the moving average model has no weight problem in how to choose the n-period that is estimated to be right.

4.3 Data analysis is based on the selected forecasting model

The next step is to analyze the data based on the moving average forecasting model with values of n = 3 months and n = 4 months to the actual data of the belt cleaner demand. The results of data analysis are as follows:

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a. Forecasting moving average with a value of n = 3

Model Moving Averages Solution

	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
January	225					
February	345					
March	110					
April	350	226,667	123,333	123,333	15211,11	35,238%
May	310	268,333	41,667	41,667	1736,113	13,441%
June	380	256,667	123,333	123,333	15211,11	32,456%
July	390	346,667	43,333	43,333	1877,779	11,111%
August	300	360	-60	60	3600	20%
September	320	356,667	-36,667	36,667	1344,444	11,458%
October	330	336,667	-6,667	6,667	44,444	2,02%
November	250	316,667	-66,667	66,667	4444,447	26,667%
December	270	300	-30	30	900	11,111%
TOTALS	3580		131,667	531,667	44369,45	163,503%
AVERAGE	298,333		14,63	59,074	4929,939	18,167%
Next period forecast		283,333	(Bias)	(MAD)	(MSE)	(MAPE)
				Std err	79,615	

Figure 3: Calculation of Urethane Blade Forecasting needs with 3 monthly single moving averages method

From the figure above, total demand for year 2019 it is 3580 urethane blades. And for the next period forecast on January 2020 it has shown 283,333 urethane blades.

Model Moving Averages Solution

Measure	Value
Error Measures	
Bias (Mean Error)	14,63
MAD (Mean Absolute Deviation)	59,074
MSE (Mean Squared Error)	4929,939
Standard Error (denom=n-2=7)	79,615
MAPE (Mean Absolute Percent Error)	18,167%
Forecast	
next period	283,333

Figure 4: Calculation Results Forecasting Urethane Blade requirements using the 3 monthly single moving averages method

The results of forecasting urethane blade needs in January 2020 using software POM For Windows with a single moving average method of 3 months is 28333 pcs with an error rate of MAD 59,074 and MSE 4929,939.

b. Forecasting moving average with a value of n = 4

Model Moving Averages Solution

	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
January	225					
February	345					
March	110					
April	350					
May	310	257,5	52,5	52,5	2756,25	16,935%
June	380	278,75	101,25	101,25	10251,56	26,645%
July	390	287,5	102,5	102,5	10506,25	26,282%
August	300	357,5	-57,5	57,5	3306,25	19,167%
September	320	345	-25	25	625	7,813%
October	330	347,5	-17,5	17,5	306,25	5,303%
November	250	335	-85	85	7225	34%
December	270	300	-30	30	900	11,111%
TOTALS	3580		41,25	471,25	35876,56	147,256%
AVERAGE	298,333		5,156	58,906	4484,57	18,407%
Next period forecast		292,5	(Bias)	(MAD)	(MSE)	(MAPE)
				Std err	77,327	

Figure 5: Calculation of Forecasting Urethane Blade needs with the 4 monthly single moving average methods

From the figure above, total demand for year 2019 it is 3580 urethane blades. And for the next period forecast on January 2020 it has shown 292,5 urethane blades.

Model Moving Averages Solution

Measure	Value
Error Measures	
Bias (Mean Error)	5,156
MAD (Mean Absolute Deviation)	58,906
MSE (Mean Squared Error)	4484,57
Standard Error (denom=n-2=6)	77,327
MAPE (Mean Absolute Percent Error)	18,407%
Forecast	
next period	292,5

Figure 6: Calculation Results forecasting the needs of the Urethane Blade using the 4-month single moving average method

The results of forecasting urethane blade needs in January 2020 using software POM For Windows with a single moving average method of 4 months is 292,5 pcs with an error rate of MAD 58,906 and MSE 4484,57.

c. Exponential Smoothing method with alpha 0.1

	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
Januari	225					
Februari	345	225	120	120	14400	34.783%
Maret	110	237	-127	127	16129	115.455%
April	350	224.3	125.7	125.7	15800.49	35.914%
Mei	310	236.87	73.13	73.13	5347.998	23.59%
Juni	380	244.183	135.817	135.817	18446.26	35.741%
Juli	390	257.765	132.235	132.235	17486.17	33.906%
Agustus	300	270.988	29.012	29.012	841.682	9.671%
September	320	273.889	46.111	46.111	2126.184	14.41%
Oktober	330	278.501	51.5	51.5	2652.2	15.606%
November	250	283.651	-33.65	33.65	1132.353	13.46%
Desember	270	280.285	-10.285	10.285	105.79	3.809%
TOTALS	3580		542.568	884.44	94468.13	336.345%
AVERAGE	298.333		49.324	80.404	8588.012	30.577%
Next period forecast		279.257	(Bias)	(MAD)	(MSE)	(MAPE)

Figure 7: Calculation of Forecasting Urethane Blade needs with the Exponential Smoothing Method α = 0.1

From the figure above, total demand for year 2019 it is 3580 urethane blades. And for the next period forecast on January 2020 it has shown 279,257 urethane blades.

Measure	Value
Error Measures	
Bias (Mean Error)	49.324
MAD (Mean Absolute Deviation)	80.404
MSE (Mean Squared Error)	8588.012
Standard Error (denom=n-2=9)	102.452
MAPE (Mean Absolute Percent Error)	30.577%
Forecast	
next period	279.257

Figure 8: Calculation Results Forecasting the needs of the Urethane Blade with the Exponential Smoothing Method α = 0.1

The results of forecasting the needs of the Urethane Blade in January 2020 using software POM For Windows with the Exponential Smoothing method α = 0.1 is 279,257 pcs with an error size of MAD 80,404 and MSE 8588,012.

d. Exponential Smoothing method with alpha 0.5

	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
Januari	225					
Februari	345	225	120	120	14400	34.783%
Maret	110	333	-223	223	49729	202.727%
April	350	132.3	217.7	217.7	47393.29	62.2%
Mei	310	328.23	-18.23	18.23	332.332	5.881%
Juni	380	311.823	68.177	68.177	4648.104	17.941%
Juli	390	373.182	16.818	16.818	282.835	4.312%
Agustus	300	388.318	-88.318	88.318	7800.111	29.439%
September	320	308.832	11.168	11.168	124.728	3.49%
Oktober	330	318.883	11.117	11.117	123.584	3.369%
November	250	328.888	-78.888	78.888	6223.365	31.555%
Desember	270	257.889	12.111	12.111	146.681	4.486%
TOTALS	3580		48.654	865.528	131204.0	400.183%
AVERAGE	298.333		4.423	78.684	11927.64	36.38%
Next period forecast		268.789	(Bias)	(MAD)	(MSE)	(MAPE)

Figure 9: Calculation of Forecasting Urethane Blade requirements by Method Exponential Smoothing α = 0.5

From the figure above, total demand for year 2019 it is 3580 urethane blades. And for the next period forecast on January 2020 it has shown 268,789 urethane blades.

Measure	Value
Error Measures	
Bias (Mean Error)	9.903
MAD (Mean Absolute Deviation)	72.86
MSE (Mean Squared Error)	8256.512
Standard Error (denom=n-2=9)	100.455
MAPE (Mean Absolute Percent Error)	31.838%
Forecast	
next period	279.468

Figure 10: Hasil Perhitungan Peramalan kebutuhan Urethane Blade dengan Metode Exponential Smoothing α = 0,5

The results of forecasting the needs of the Urethane Blade in January 2020 using software POM For Windows with the Exponential Smoothing method α = 0.5 is 279,468 pcs with an error rate of MAD 72,86 and MSE 8256,512.

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e. Exponential Smoothing Methode with Alpha 0.9

	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
Januari	225					
Februari	345					
Maret	110	285	-175	175	30625	159.091%
April	350	227.5	122.5	122.5	15006.25	35%
Mei	310	230	80	80	6400	25.806%
Juni	380	330	50	50	2500	13.158%
Juli	390	345	45	45	2025	11.538%
Agustus	300	385	-85	85	7225	28.333%
September	320	345	-25	25	625	7.813%
Oktober	330	310	20	20	400	6.061%
November	250	325	-75	75	5625	30%
Desember	270	290	-20	20	400	7.407%
TOTALS	3580		-62.5	697.5	70831.25	324.208%
AVERAGE	298.333		-6.25	69.75	7083.125	32.421%
Next period forecast		260	(Bias)	(MAD)	(MSE)	(MAPE)

Figure 11: Calculation of Forecasting Urethane Blade requirements by Method Exponential Smoothing α = 0.9

From the figure above, total demand for year 2019 it is 3580 urethane blades. And for the next period forecast on January 2020 it has shown 260 urethane blades.

Measure	Value
Error Measures	
Bias (Mean Error)	4.423
MAD (Mean Absolute Deviation)	78.684
MSE (Mean Squared Error)	11927.64
Standard Error (denom=n-2=9)	120.74
MAPE (Mean Absolute Percent Error)	36.38%
Forecast	
next period	268.789

Figure 12: Calculation Results Forecasting the needs of the Urethane Blade with the Exponential Smoothing Method α = 0.9

The results of forecasting the needs of the Urethane Blade in January 2020 using software POM For Windows with the Exponential Smoothing method α = 0.9 is 268,789 pcs with a size of the error level of MAD 78,684 and MSE 11927,64.

f. Weight Moving Average

	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
Januari	225					
Februari	345					
Maret	110	285	-175	175	30625	159.091%
April	350	227.5	122.5	122.5	15006.25	35%
Mei	310	230	80	80	6400	25.806%
Juni	380	330	50	50	2500	13.158%
Juli	390	345	45	45	2025	11.538%
Agustus	300	385	-85	85	7225	28.333%
September	320	345	-25	25	625	7.813%
Oktober	330	310	20	20	400	6.061%
November	250	325	-75	75	5625	30%
Desember	270	290	-20	20	400	7.407%
TOTALS	3580		-62.5	697.5	70831.25	324.208%
AVERAGE	298.333		-6.25	69.75	7083.125	32.421%
Next period forecast		260	(Bias)	(MAD)	(MSE)	(MAPE)

Figure 13: Calculation of Forecasting Urethane Blade needs using the Weight Moving Average method with a weight of 3

From the figure above, total demand for year 2019 it is 3580 urethane blades. And for the next period forecast on January 2020 it has shown 260 urethane blades.

Measure	Value
Error Measures	
Bias (Mean Error)	-6.25
MAD (Mean Absolute Deviation)	69.75
MSE (Mean Squared Error)	7083.125
Standard Error (denom=n-2=8)	94.095
MAPE (Mean Absolute Percent Error)	32.421%
Forecast	
next period	260

Figure 14: alculation Results Forecasting Urethane Blade needs using the Weight Moving Average method with a weight of 3

The results of forecasting the needs of the Urethane Blade in January 2020 using software POM For Windows with Weight Moving Average weighting method 3 is 260 pcs with a size of the error level of MAD 69,75 and MSE 7083,125.

4.4 Comparison of Forecasting Errors with MAD

When compared with the forecasting level of Urethane Blade requirements, the comparison of Mean Absolute Deviation (MAD) and Mean Square Error (MSE) for each method can be seen in Table 1.1 as follows:

Tabel 1.1 Comparison of Forecasting Results of PT MS Engineering Urethane Blade Needs

Description		MAD	MSE	Forecasting for Januari 2020
Single Moving Average	3 months	59,074	4929,939	283,333
	4 months	58,906	4484,57	292,5
Exponential Smoothing	α = 0,1	80,404	8588,012	279,257
	α = 0,5	72,86	8256,512	279,468
	α = 0,9	78,684	11927,64	268,789
Weight Moving Average	Weight 3	69,75	7083,125	260

From the table above we use the lowest value of MAD (Mean Absolute Deviation) showed 58,906 that is for Single Moving Average (4 months) with the MSE (Mean Square Error) showed 4484,57 and forecasting for January 2020 will be 292,5 urethane blades.

5. CONCLUSION

From the discussion and analysis of the three calculation methods above, it is known that the calculation results with the 4 monthly Single Moving Average method are better and more suitable to be applied by PT. MS Engineering in predicting the needs of Urethane Blade in January 2020, because the method has a lower error rate than the method other. The forecast error rate, MAD (Mean Absolute Deviation) of 58,906 and MSE (Mean Square Error) of 4484.57 with forecast results for January 2020 of 292.5 pcs.

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