FORECASTING ANALYSIS OF CAR WHEEL RIM DEMAND CASE STUDY AT PT. XX TO REDUCE WASTE USING POM-QM SOFTWARE

[1]Aditya Paramitha*, [2]Joumil Aidil Saifuddin Z.S
[1,2]Program Studi Teknik Industri, Fakultas Teknik Universitas Pembangunan Nasional "Veteran" Jawa Timur
* aditya.paramithaa@gmail.com

ARTICLE I N F O

Accepted: 10 December 2022
Revised: 11 January 2023
Approved: 31 July 2023

Keywords:
Error, Forecasting, Single Exponential Smooting Method, Single Moving Average Method, and Weighted Moving Average Method.

A B S T R A C T

PT. XX is one of the car wheel rim companies in Indonesia whose products are sent to a number of local and international assembly companies. But, due to the Covid-19 pandemic, the demand for car wheel production has decreased and made it difficult for companies to determine the outsourcing employees needed in the production process. So, PT. XX requires the results of demand forecasting to help solve these problems and the main goal of this research is to forecast the demand for car wheel rim production using three forecasting methods at PT. XX. The research results are in the form of the value of demand forecasting calculation along with the error rate. It is known that there are three methods used, namely Single Moving Average, Weighted Moving Average, and Single Exponential Smoothing methods. Based on calculations from the POM-QM software, the method that is suitable to be applied in this research is the Weighted Moving Average method because the smallest error value is obtained as in the MAPE error value is 12.124%, the Mean error value is 1177.773 the MAD error value is 24587.23, the MSE error value is 1099377000, and the forecast value in the next period is 243013 units. Through this research and forecasting, the writer hoped that PT. XX could consider it a plan for the next batch of production.

**Corresponding author*: aditya.paramithaa@gmail.com

I. INTRODUCTION

The COVID-19 pandemic that has occurred almost in the past two years has caused various impacts on the economy, the automotive manufacturing industry has had an impact on production operations. People's buying interest in automotive, especially cars, has decreased and has caused companies to need various methods to estimate the number of raw materials ordered is equal to the existing demand.

Car wheel rims are an important part of a car that must be in good condition before driving because the wheels are in the outermost position that supports the tire when it rotates touching the road surface [1]. Wheel wheels are needed for both passenger cars and commercial cars, Car wheel rims provide two uses: they reduce friction and provide leverage because they rotate around a rod called an axle [2]. Car wheel rims which are the most important spare parts, also have to do various forecasting so as not to suffer losses. To be able to meet the demand for these orders, an appropriate forecasting calculation method is needed, namely where the number of goods available will be predicted based on the demand for car wheel rims in the last year.

Demand can be interpreted as the desire to purchase goods or services by consumers within a certain price range, period, and amount [3]. The existence of fluctuating demand for goods can lead to various challenges, such as decisions in purchasing raw material supplies and pricing [4]. Changes in fluctuating demand patterns can be caused by internal factors originating from marketing policies, selling prices, and innovation, as well as external factors originating from the country's economic conditions, such as during a pandemic [5]. Fluctuating customer demand is one thing that cannot be predicted; therefore, various ways are needed to avoid losses from this. However, the supply of goods must also be able to meet demand so as not to disappoint customers and so that customer trust in the company is maintained properly. Therefore, companies are required to be able to predict demand and make plans for purchasing raw materials so they can still make production stock according to market demand [6].

Forecasting is a method applied by management in determining decisions to be taken in the future. The use of a forecasting analysis approach can provide an overview of thinking patterns, work, problem-solving, and the level of confidence in applying forecasting results [7]. This forecasting can analyze future sales demand based on previously collected data using either qualitative analysis in the form of intuition or mathematical qualitative analysis. Qualitative forecasting comes from the results of qualitative forecasting data collected in the previous period, along with additional opinions based on the experience of professionals in a field. Examples of the application of qualitative forecasting, namely

a. Forecasting in management is usually done by a senior manager.
b. Forecasting historical data of products with non-volatile sales or products with similar values
c. The Dhelfi method of forecasting through expert analysis of data from questionnaires distributed to customers
d. Market forecasting is the result of an analysis of criticism and suggestions from customers.

Quantitative forecasting is a forecasting method obtained from the analysis of quantitative data from the previous period [8]. There are various kinds of methods in quantitative forecasting, namely:

DOI: https://doi.org/10.35261/barometer.v8i2.7702
ISSN: 1979-889X (cetak), ISSN: 2549-9041 (online)
http://www.journal.unsika.ac.id

a. The time series method is a forecasting method based on the analysis of coherent quantitative data according to a certain time series. This method can be divided into several methods, namely exponential smoothing, moving average, Holt-Winter, classic decomposition census II X-11A, and ARIMA.
b. The causal method is based on an analysis of the things that affect customer demand. This causal method is divided into several methods, namely linear regression forecasting, multiple linear regression, econometric methods, and input-output analysis methods.
c. Other quantitative methods are demand forecasting based on the flow of purchases in the market, operation research, and artificial [9].

Operational implementation planning for the future can be predicted through Economic Forecast, Technological Forecast, and Demand Forecast [10]. Being an important part of the implementation of trade, the method applied in forecasting becomes the main focus because it has advantages and disadvantages, such as quantitative methods that are compiled systematically and according to established standards and cannot understand needs based on more abstract or unpredictable data in the future. As a result, forecasting must be done qualitatively but, qualitative methodologies cannot provide concrete numerical results as production references. So it would be better if these two approaches were carried out simultaneously or partially [11]. The results of this forecasting can later affect almost all existing activities within the company, such as ordering raw materials, production capacity, production scheduling, marketing strategies, and the need for human resources. Therefore, very accurate results are needed to avoid losses and increase profits. Furthermore, the benefits of implementing demand forecasting can reduce the "Bullwhip Effect," or disruption to the procurement management of raw materials and manufactured goods [3]. The following steps must be taken in order to forecast:

1) Conduct historical data analysis to determine patterns of purchasing behavior made by customers.
2) Determine the data to be used in forecasting with the hope that the forecast results will achieve maximum accuracy.
3) Project historical data by applying the selected method and analyzing changes that may occur at this time [9].

Forecasting can be divided into three groups based on the calculation time: short-term, medium-term, and long-term. Short-term forecasts are daily demand projections. Medium-term forecasts are used for a period of several months to a year, which will depict a graph of fluctuations in demand and production needs by guaranteeing the fulfillment of needs in the next period. Long-term forecasting is usually used for several years for planning new products, developing company facilities, and financing in the long term [12].

The Single Moving Average method is a simple forecasting calculation using actual demand data by finding the average data value according to the required period [13]. The use of the Single Moving Average method in demand forecasting is considered very effective and efficient. This is because the Single Moving Average method does not require a weight value for each data point, so it can be used on changing data [14]. However, due to the use of the same weight values for all data, the Single Moving Average method has an impact on the results given. Forecasting data sometimes have values that are quite far from the latest data [15]. The Weighted Moving Average (WMA) method forecasts demand in the same way as the Moving Average (MA) method, but with different weights [16]. Even though it has a concept that is almost the same as the Single Moving Average, the WMA method produces more accurate forecasting values. This is because adding weight can determine trends that occur so that companies can be more careful in taking steps to provide production raw materials [17]. The Single Exponential Smoothing method, which is forecasting that is carried out continuously with the average value from the previous period and uses data weighting with an exponential function, has advantages in transparency and accuracy of values [18]. Exponential Smoothing or also known as simple Exponential Smoothing is the result of the development of the Single Moving Average method which can calculate forecasting data continuously with the addition of weight in the form of alpha for each data [19]. The results of the forecasting calculations that are considered good and meet the requirements to be used as a reference are those with the lowest error rates, which include MSE (Mean Squared Error), MAPE (Mean Absolute Percentage Error), and MAD (Mean Absolute Deviation) [20].

Forecasting is done to reduce the waste that occurs in the company. Waste here means that there is an action but it does not provide benefits to the customer. Waste has a very broad meaning, including raw materials, time, energy, and work areas [21]. All types of waste are usually called 7 wastes. The 7 types of waste that must be trimmed or eliminated to achieve an efficient production process are overproduction, defects, inventory, transportation, motion, waiting, and overprocessing [22]. Forecasting consumer demand for car wheels from PT. XX can later reduce various wastes that can occur, such as reducing waste in overproduction because the production process involves the operation of many machines and lots of human resources, reducing waste in inventory because production results in the form of wheels take up a lot of space if stored for too long in the warehouse, and reducing movement waste because the transportation of finished products in the form of wheels using a forklift will increase the cost of transportation, so that forecasting is needed for efficiency to be implemented by lean manufacturing.

POM-QM (Production Operation Management Quantitative Method) is an application that can assist in decision-making because it is able to solve various quantitative problems such as determining the cost of repairing machines, determining the number of human resources needed, and so on as a step in optimizing the production process [23]. The advantage of using this application is that it can calculate complex data and variables and produce forecasts accurately in a time series [24].

After forecasting, it would be great if the forecasting data could be stored in a database and can use in the future. The database is a system that was created to store all records of transaction results for forecasting results within the company so that the data can improve user experience and

.

DOI: https://doi.org/10.35261/barometer.v8i2.7702
ISSN: 1979-889X (cetak), ISSN: 2549-9041 (online)
http://www.journal.unsika.ac.id

product development through the processes of market response analysis, market research, and customer types by continuously innovating to develop all possible new things. for the development of the company in a better direction [25]. The use of technology resulting from industry 4.0 innovations that can be used, namely cloud computing, has emerged from the distribution of software architecture to provide services hosted over the internet [26].

II. RESEARCH METHOD

In this study, a quantitative research method was used, or what is commonly called the positivistic method, which is based on concrete, empirical, objective, measurable, rational, and systematic scientific principles. The data is processed using primary data obtained directly from the company in a time series based on certain periodic intervals. In addition, this research applies a quantitative and inferential approach that analyzes the relationship between variables by testing hypotheses. The following is the stage of data collection and processing that has been carried out by researchers:

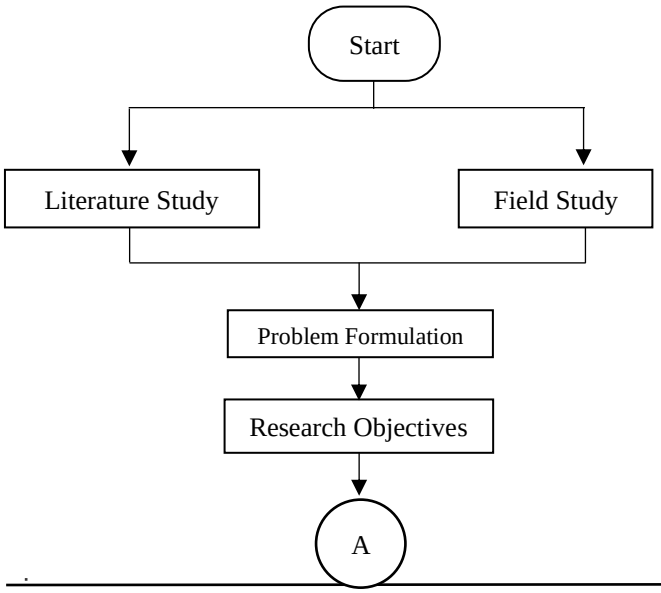
A. Data Collection Stage

Data collection is a research process in which researchers use scientific methods to collect data systematically for analysis, or the method used by researchers to collect data related to the research problems they take with the following data:

a. Demand data for 12 months;
b. The average value of weight data;
c. The value of alpha data.

B. Data Processing Stage

Data processing is the conversion of data or its manipulation into an informative form so that it can be used. Information is the result of processing data in a certain form that is more meaningful than an activity or event. This conversion, or "processing," is performed using a predetermined sequence of operations, either manually or automatically. In this paper, the forecasting methods using Single Moving Average method, Weighted Moving Average method, and Single Exponential Smoothing method for forecasting the total production at PT. XX.



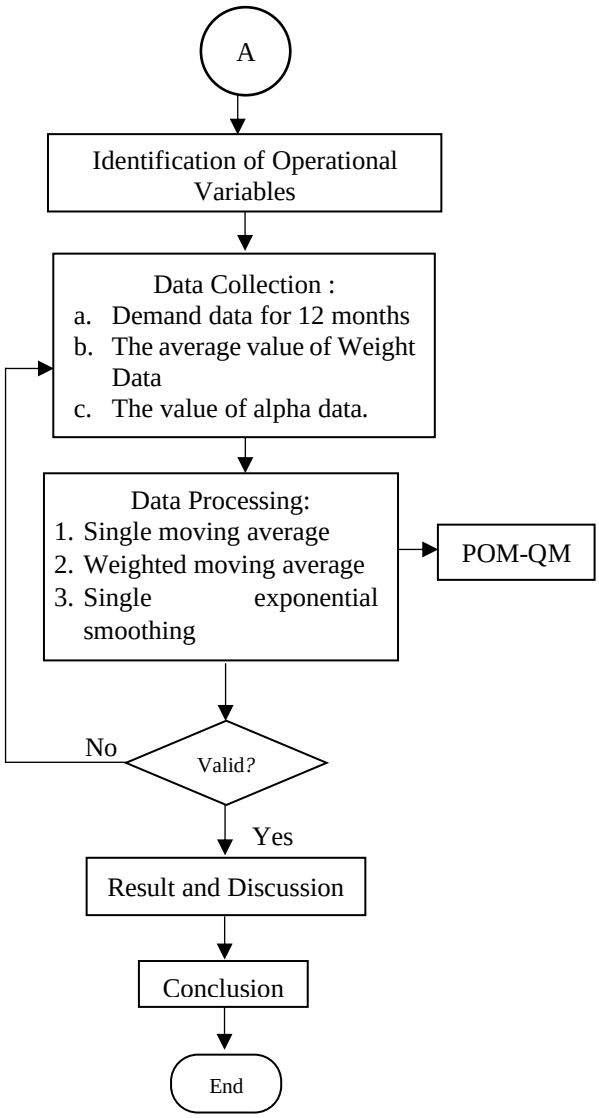


Figure 1 Flowchart research stages

Explanation of Troubleshooting Steps

Before conducting research, a field survey and literature study are needed. The field survey aims to determine the real condition of the object to be studied. While literature study is the stage of seeking references from books, journals, and previous research, Then the results of the field survey and literature study can be used to formulate a problem to be solved, and the formulation of the problem will be used as a theoretical basis for data collection, the selection of analytical methods, and drawing conclusions. At the time of writing this article, there is a forecasting problem formulation with case studies at PT XX. Based on the problems that have been determined, it is necessary to limit the problem so that it does not spread too far. After the limitation of the problem, it is continued with the formulation of research objectives so that the expected goals can solve the problem through selecting the type of data to be tested and for the purpose of writing this article, namely to obtain accurate data and optimize forecasting at PT. XX. Then there is the identification of operational variables, where identify the variables that will be processed to obtain results in accordance with the desired research objectives. The independent variables are demand data for 12 months,

DOI: https://doi.org/10.35261/barometer.v8i2.7702
ISSN: 1979-889X (cetak), ISSN: 2549-9041 (online)
http://www.journal.unsika.ac.id

data for the average value of weight, and data for alpha values, while the dependent variable is mean error, MAD (mean absolute deviation), MSE (mean squared error), standard error, MAPE (mean absolute percent error), and forecast in the next period. Furthermore, the data collection process includes demand data for a period of 12 months, the value of weight data, and the value of alpha data. Meanwhile, data processing is using the single moving average method, the weighted moving average method, and the single exponential smoothing method using POM-QM software. If it is valid, you can proceed to the next process, but if not, data collection must be repeated. Validation is an activity to measure the extent to which the difference in scores reflects the actual difference between individuals, groups, or situations regarding the characteristics being measured. After the data processing has been validated, the data is generated, and results and conclusions can be drawn. The results and discussion are presented carefully and clearly, and the results of the data analysis and discussion are based on the literature review and theoretical framework. Meanwhile, the conclusions contain a succinct, clear, and systematic description of the overall results of analysis, discussion, and testing of hypotheses in a study, as well as ideas or views from researchers linked to fixing issues that are the subject of research or the prospect of additional research.

C. Forecasting Method

1. Single Moving Average

This method is commonly used to find out long-term forecasting data because the longer the time sought, the better the calculation results will be. However, this technique is not recommended for time series data showing a trend or seasonal effects [27]. Furthermore, the single-moving average method has the limitation of not being able to track rapid changes. The formulation of the Single Moving Average method is:

$$S_{t+1} = \frac{X_t + X_{t-1} + \cdots + X_{t-(n+1)}}{n} \quad (1)$$

Where :

S_{t+1} = Forecast for t+1 period
X_t = Period t Data
n = Period of the moving average [11].

2. Weighted Moving Average

Another term for this method is the "weighted moving average method," which prioritizes the "weight factor," which is subjective based on the experience and provisions of data analysts [28]. Forecasting using the Weighted Moving Average method can be formulated as follows:

$$Y't = \frac{W_1 A_{t-1} + W_2 A_{t-2} + \cdots + W_n A_{t-n}}{n} \quad (2)$$

Where :

t = Period t forecasting value
W_1 = Period t-1 weight given
W_2 = Weight given in t-2 period
W_n = Weight given in time interval t-n
n = Number of periods [29].

3. Exponential Smoothing

This method is quite easy to do and is suitable for medium- to long-term forecasting that relies on current actual data, the latest forecasts, and smoothing constants symbolized by alpha (α) [30]. The alpha value is used to help find the best forecasting results, the alpha value in the current actual value is greater if the data series in the past evolved rapidly, and the alpha value in the current actual value is smaller if the data series in the past is uncertain. The formula for Single Exponential Smoothing is:

$$\hat{Y}_{t+1} = \alpha Y_t + (1- \alpha)\, Y_{t-1} \quad (3)$$

Where :

$\hat{Y}_{t+1}$ = forecasting for the following period
α = Constant of Smoothing ($0 < \alpha < 1$)
Y_t = The current true value
Y_{t-1} = Forecasting at a previous time [11].

D. Error Value Calculation

1. MSE (Mean Squared Error)

MSE is a measure of forecast deviation that does not take into account whether the error is positive or negative, MSE can be express :

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

Where :

D_t = Time t's true value
F_t = Value predicted at time t
n = The number of times the area was covered [29].

2. MAPE (Mean Absolute Precentage Error)

MAPE is forecast error calculated as a percentage and MAPE can be express :

$$MAPE = \frac{\sum |D_t - F_t|}{\sum D_t}$$

Where :

D_t = Time t's true value
F_t = Value predicted at time t [29].

3. MAD (Mean Absolute Deviation)

MAD is the average absolute error generated using equations. The following equation can be used to calculate forecasting error. MAD can be express :

$$MAD = \frac{\sum |D_t - F_t|}{n}$$

Where :

D_t = Time t's true value
F_t = Value predicted at time t
n = The number of times the area was covered [29].

III. RESULT AND DISCUSSION

A. Data Processing

PT. XX is an automotive industry company engaged in the production of car wheels and wants to forecast demand in the coming period to prepare raw materials for the next period's production. There are 12 months of sales data and want to forecast demand for the next period with $W_1 = 0.24$; $W_2 = 0.32$; $W_3 = 0.44$ with $\alpha = 0.5$. What are the results of forecasting the demand for car wheels and which method is recommended to be applied in the next period?

DOI: https://doi.org/10.35261/barometer.v8i2.7702
ISSN: 1979-889X (cetak), ISSN: 2549-9041 (online)
http://www.journal.unsika.ac.id

TABEL I
TIME SERIES FORECASTING INPUT DATA

Period (Month)	Demand (Pcs)
October	166271
November	243267
December	252768
January	243267
February	224265
March	256543
April	246052
May	160880
June	242301
July	236589
August	242302
September	247032

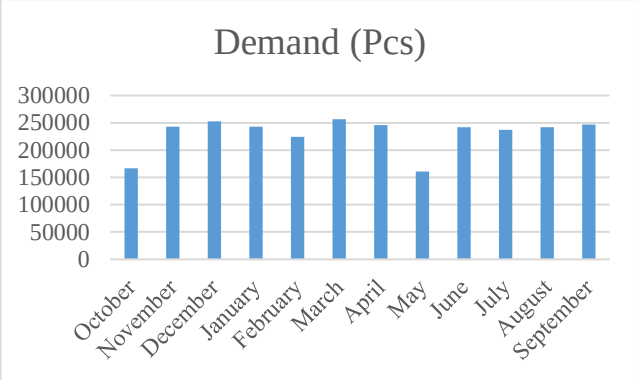


Figure 2 Demand chart on PT. XX

1. Input Data on POM-QM

	Demand(y)
Oktober	166271
November	243267
Desember	252768
Januari	243267
Februari	224265
Maret	256543
April	246052
Mei	160880
Juni	242301
Juli	236589
Agustus	242302
September	247032

Figure 3 Input data on POM-QM

2. Output Data on POM-QM

a) Single Moving Average

Forecasting/Time Series Analysis Results

1000 Solution

Measure	Value
Error Measures	
Bias (Mean Error)	1895,552
MAD (Mean Absolute Deviation)	24912,37
MSE (Mean Squared Error)	1073212000
Standard Error (denom=n-2=7)	37146,24
MAPE (Mean Absolute Percent Error)	12,22%
Forecast	
next period	241974,3

Figure 4 Single moving average solution

The output above shows that data processing result Bias (Mean Error), MAD (Mean Absolute Deviation), MSE (Mean Squared Error), Standard Error, MAPE (Mean Absolute Percent Error), and Forecast in the next period.

	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
Oktober	166271					
November	243267					
Desember	252768					
Januari	243267	220768,7	22498,33	22498,33	506174800	9,248%
Februari	224265	246434	-22169	22169	491464600	9,885%
Maret	256543	240100	16443	16443	270372300	6,409%
April	246052	241358,3	4693,656	4693,656	22030410	1,908%
Mei	160880	242286,7	-81406,67	81406,67	6627046000	50,601%
Juni	242301	221158,3	21142,67	21142,67	447012600	8,726%
Juli	236589	216411	20178	20178	407151700	8,529%
Agustus	242302	213256,7	29045,33	29045,33	843631100	11,987%
September	247032	240397,3	6634,656	6634,656	44018660	2,686%
TOTALS	2761537		17059,97	224211,3	9658904000	109,979%
AVERAGE	230128,1		1895,552	24912,37	1073212000	12,22%
Next period forecast		241974,3	(Bias)	(MAD)	(MSE)	(MAPE)
				Std err	37146,24	

Figure 5 Single moving average details and error

The output above shows that data processing result details regarding Demand (y), Forecast, and Error per month.

b) Weighted Moving Average

Forecasting/Time Series Analysis Results

1000 Solution

Measure	Value
Error Measures	
Bias (Mean Error)	1177,773
MAD (Mean Absolute Deviation)	24587,23
MSE (Mean Squared Error)	1099377000
Standard Error (denom=n-2=7)	37596,35
MAPE (Mean Absolute Percent Error)	12,124%
Forecast	
next period	243012,1

Figure 6 Weighted moving average solution

The output above shows that data processing result Bias (Mean Error), MAD (Mean Absolute Deviation), MSE (Mean Squared Error), Standard Error, MAPE (Mean Absolute Percent Error), and Forecast in the next period.

DOI: https://doi.org/10.35261/barometer.v8i2.7702
ISSN: 1979-889X (cetak), ISSN: 2549-9041 (online)
http://www.journal.unsika.ac.id

	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
Oktober	166271					
November	243267					
Desember	252768					
Januari	243267	228968,4	14298,59	14298,59	204449800	5,878%
Februari	224265	246307,3	-22042,31	22042,31	485863600	9,829%
Maret	256543	237186,4	19356,64	19356,64	374679600	7,545%
April	246052	243027,8	3024,203	3024,203	9145805	1,229%
Mei	160880	244180,2	-83300,23	83300,23	6938929000	51,778%
Juni	242301	211094,2	31206,84	31206,84	973867100	12,879%
Juli	236589	217146,5	19442,48	19442,48	378010200	8,218%
Agustus	242302	220246,7	22055,33	22055,33	486437500	9,102%
September	247032	240473,6	6558,406	6558,406	43012690	2,655%
TOTALS	2761537		10599,95	221285,0	9894397000	109,113%
AVERAGE	230128,1		1177,773	24587,23	1099377000	12,124%
Next period forecast		243012,1	(Bias)	(MAD)	(MSE)	(MAPE)
				Std err	37596,35	

Figure 7 Weighted moving average details and error

The output above shows that data processing result details regarding Demand (y), Forecast, and Error per month.

c) Single Exponential Smoothing

Forecasting/Time Series Analysis Results

1000 Solution

Measure	Value
Error Measures	
Bias (Mean Error)	13674,95
MAD (Mean Absolute Deviation)	31051,28
MSE (Mean Squared Error)	1668557000
Standard Error (denom=n-2=9)	45159,14
MAPE (Mean Absolute Percent Error)	14,302%
Forecast	
next period	241483,2

Figure 8 Single Exponential Smoothing Solution

The output above shows that data processing result Bias (Mean Error), MAD (Mean Absolute Deviation), MSE (Mean Squared Error), Standard Error, MAPE (Mean Absolute Percent Error), and Forecast in the next period.

	Demand(y)	Forecast	Error	|Error|	Error^2	|Pct Error|
Oktober	166271					
November	243267	166271	76996	76996	5928384000	31,651%
Desember	252768	204769	47999	47999	2303904000	18,989%
Januari	243267	228768,5	14498,5	14498,5	210206500	5,96%
Februari	224265	236017,8	-11752,75	11752,75	138127100	5,241%
Maret	256543	230141,4	26401,63	26401,63	697045800	10,291%
April	246052	243342,2	2709,813	2709,813	7343084	1,101%
Mei	160880	244697,1	-83817,09	83817,09	7025305000	52,099%
Juni	242301	202788,5	39512,45	39512,45	1561234000	16,307%
Juli	236589	222544,8	14044,22	14044,22	197240100	5,936%
Agustus	242302	229566,9	12735,11	12735,11	162183000	5,256%
September	247032	235934,4	11097,56	11097,56	123155900	4,492%
TOTALS	2761537		150424,4	341564,1	18354130...	157,324%
AVERAGE	230128,1		13674,95	31051,28	1668557000	14,302%
Next period forecast		241483,2	(Bias)	(MAD)	(MSE)	(MAPE)
				Std err	45159,14	

Figure 9 Single exponential smoothing details and error

The output above shows that data processing result details regarding Demand (y), Forecast, and Error per month.

B. Discussion Analysis

TABEL II
RESULT COMPARISON

Measure	Single Moving Average	Weighted Moving Average	Single Exponential Smoothing
Mean Error	1895.552	1177.773	13674.95
MAD	24912.37	24587.23	31051.28
MSE	107323000	1099377000	1668557000
MAPE	12.22%	12.124%	14.302%
Next Period	241974.3	243012.1	241483.2

In the results of data processing using the Single Moving Average method at details and errors, forecasts were generated for the January it was 220769 units, in February it was 246334 units, in March of 240100 units, in April it was 241359 units, in May it was 242287 units, in June it was 221159 units, in July it was 216411 units, in August it was 213357 units, and in September it was 240398 units. The resulting data results are error values in Bias (mean error) it was 1895.552, on MAD (Mean Absolute Deviation) it was 24912.37, on MSE (Mean Squared Error) it was 1073212000, on the Standard Error it was 37146.24, on MAPE (Mean Absolute Percent Error) it was 12.22%, and for the forecast in the next period it was 241975 units.

In the results of data processing using the Weighted Moving Average method with a weight of W1 = 0.24; W2 = 0.32; W3 = 0.44 in details and errors resulted in forecasts in the January it was 228969 units, in February it was 246308 units, in March it was 237187 units, in April it was 243028 units, in May it was 244181 units, in June it was 211095 units, in July it was 217147 units, in August it was 220247 units, and in September it was 240474 units. The resulting data result is an error value in Bias (mean error) it was 1177.773, on MAD (Mean Absolute Deviation) it was 24587.23, on MSE (Mean Squared Error) it was 1099377000, on the Standard Error it was 37596.35, on MAPE (Mean Absolute Percent Error) it was 12.124%, and for forecasting in the next period of 243013 units.

In the results of data processing using the Single Exponential Smoothing method with $\alpha = 0.5$ in details and errors, forecasts are generated in November it was 166271 units, in December it was 204769 units, in January it was 228769 units, in February it was 236018 units, in March it was 230142 units, in April it was 243343 units, in May it was 244698 units, in June it was 202789 units, in July it was 222545 units, in August it was 229567 units, and in September it was 235935 units. The resulting data result is an error value in Bias (mean error) it was 13674.95, at MAD (Mean Absolute Deviation) it was 31051.28, on the MSE (Mean Squared Error) it was 1668557000, on the Standard Error it was 45159.14, in MAPE (Mean Absolute Percent Error) it was 14.302%, and for forecasting in the next period it was 241484 units.

Based on the results of the description above, it can be concluded that the appropriate method to be applied in this study is the Weighted Moving Average because the lowest MAPE (Mean Absolute Percent Error) error value is 12.124%, and forecast value in the next period of 243013 units.

IV. CONCLUSION

Forecasting demand assists management in managing the scheduling of production processes and reducing waste in all areas of the business. Waste that can be streamlined, such as waste in inventory, is needed because production results in the form of wheels take up a lot of space when stored for too long in the warehouse. Reducing movement waste due to the transportation of finished products in the form of wheels using a forklift will increase transportation costs, so forecasting is needed. In addition, it also aims to implement the concept of lean manufacturing to increase company profits. The use of POM-QM software in the

DOI: https://doi.org/10.35261/barometer.v8i2.7702
ISSN: 1979-889X (cetak), ISSN: 2549-9041 (online)
http://www.journal.unsika.ac.id

demand forecasting analysis process at PT. In the upcoming XX period, the preparation of raw materials and the production of car wheels has several advantages, such as knowing the values of Bias (Mean Error), MAD (Mean Absolute Deviation), MSE (Mean Squared Error), Standard Error, MAPE (Mean Absolute Percent Error). and Forecast in the next period. Based on POM-QM software calculations, it can be concluded that the appropriate method to be applied in this study is the Weighted Moving Average for the reason that the smallest % MAPE (Mean Absolute Percent Error) error value is obtained, which is 12.124% with a forecast value in the next period of 243013 units.

For further research, based on data that has been collected using forecasting methods such as single moving forecasting, weighted moving forecasting, and single exponential forecasting, it can be further investigated using POMQM software in order to find out the comparison regarding the smallest % MAPE (Mean Absolute Percent Error) in order to be able to obtain the forecast value for the next period correctly so that you know the method that is appropriate to use as a solution to demand problems at PT. XX. In addition, it is hoped that further researchers will be able to detail the efficiency of the waste that occurs and explain the types of cloud computing services that can be applied to PT. XX.

REFERENCES

[1] A. S. Wijianto, Mulyadi, and Iswanto, "Simulasi Numerik Velg After Market Untuk Mendapatkan Nilai Tegangan dan Deformasi Maksimum," *J. Rekayasa Energi Manufaktur*, vol. 7, no. 2, pp. 23–28, 2022.

[2] S. Usmangani, M. Kale, and K. Laxman, "manufacturing Planning of EV Wheel Rim," *Int. Res. J. Mod. Eng. Technol. Sci.*, vol. 03, no. 08, pp. 1034–1045, 2021.

[3] V. Maghfiroh, Y. Amrozi, Q. B. Prakoso, and M. A. Aliansyah, "Analisis Model Manajemen Permintaan Scm Network Dan Peramalan Permintaan Pada Penjualan Busana Muslim Menggunakan Metode Linear Regression," *METHOMIKA J. Manaj. Inform. dan Komputerisasi Akunt.*, vol. 5, no. 1, pp. 28–32, 2021, doi: 10.46880/jmika.vol5no1.pp28-32.

[4] J.-S. J. Song, Z. Xue, and X. Shen, "Demand Management and Inventory Control for Substitutable Products," *SSRN Electron. J.*, 2021, doi: 10.2139/ssrn.3866775.

[5] H. Q. Karima, M. Aji, and F. Romadlon, "Analisis Kapasitas Produksi dan Pemenuhan Permintaan dengan Model Sistem Dinamis pada Industri Semen," *Pendidik. dan Softw. Ind.*, vol. 9, no. 1, pp. 11–18, 2022.

[6] S. Shofiyah *et al.*, "Pengelolaan Permintaan dan Kapasitas Produksi pada UMKM Sektor Jasa di Kota Batam," *J. Ilm. Manaj. dan Kewirausahaan*, vol. 2, no. 2, pp. 375–382, 2022, doi: 10.54082/jupin.88.

[7] L. Sucipto and S. Syaharuddin, "Konstruksi forecasting system multi-model untuk pemodelan matematika pada peramalan indeks pembangunan manusia provinsi nusa tenggara barat," *Regist. J. Ilm. Teknol. Sist. Inf.*, vol. 4, no. 2, pp. 114–124, 2018, doi: 10.26594/register.v4i2.1263.

[8] P. Al Zukri, S. N. Widyaningrum, and Q. Aini, "Forecasting Permintaan Pompa Air Dangkal SHimizu Menggunakan Metode Time Series," *Sist. J. Sist. Inf.*, vol. 9, no. 2, pp. 226–234, 2020.

[9] P. R. Hakim and H. Prastawa, "FORECASTING DEMAND &USULAN SAFETY STOCK PASIR SILIKA DENGAN METODE TIME SERIES PADA PT SOLUSI BANGUN INDONESIA Tbk. PABRIK …," *Ind. Eng. Online J.*, vol. 11, no. 4, 2022, [Online]. Available: https://prosiding.seminar-id.com/index.php/sainteks.

[10] R. A. Maulana, D. Herwanto, and K. Kusnadi, "Analisis Perencanaan Persediaan Suku Cadang dengan Metode ABC dan Metode Min-Max di Bagian Fields Service Engineer PT. Merck Chemicals and Life Science," *Barometer*, vol. 6, no. 1, pp. 295–300, 2021, doi: 10.35261/barometer.v6i1.4480.

[11] Ri. Yudaruddin, *Forecasting Untuk Kegiatan Ekonomi dan Bisnis*. RV Pustaka Horizon, 2019.

[12] W. B. Ruamiana, J. Nangi, and L. M. Tajidun, "Aplikasi Forecasting Jumlah Frekuensi Penumpang Pesawat Terbang Lion Air Pada Bandar Udara Halu Oleo Dengan Menggunakan Metode Least Square," *semanTIK*, vol. 4, no. 1, pp. 151–160, 2018, [Online]. Available: http://ojs.uho.ac.id/index.php/semantik/article/view/4468.

[13] M. S. Putra and I. Solikin, "Aplikasi Peramalan Stok Alat Tulis Kantor (Atk) Menggunakan Metode Single Moving Average (SMA)Pada Pt. Sinar Kencana Multi Lestari," *CESS (Journal Comput. Eng. Syst. Sci.*, vol. 4, no. 2, pp. 236–241, 2019.

[14] M. H. Lubis, D. Martina, and A. A. Tanjung, "Prediksi permintaan Ayam Pedaging Broiler dengan Single Moving Average," *J. Teknol. Komput. dan Sist. Inf.*, vol. 2, no. 1, pp. 16–22, 2022, doi: 10.15797/concom.2019..23.009.

[15] E. Tjandra, S. Limanto, and Liliana, "Modified Moving Average (MoMoA) Untuk Peramalan Penjualan Dengan Studi Kasus Sistem Retail," *Teknika*, vol. 10, no. 1, pp. 27–36, 2021, doi: 10.34148/teknika.v10i1.310.

[16] M. W. Rini and N. Ananda, "Perbandingan Metode Peramalan Menggunakan Model Time Series," *J. Ilm. Tek. Ind. dan Inf.*, vol. 10, no. 2, pp. 88–101, 2022.

[17] R. Sutjiadi and P. Santoso, "Sistem Informasi Inventori dan Optimasi Pengiriman Stok Produk Menggunakan Metode Weighted Moving Average," *Smatika J.*, vol. 10, no. 02, pp. 64–70, 2020, doi: 10.32664/smatika.v10i02.481.

[18] V. W. Nirmala, D. Harjadi, and R. Awaluddin, "Sales Forecasting by Using Exponential Smoothing Method and Trend Method to Optimize Product Sales in PT. Zamrud Bumi Indonesia During the Covid-19 Pandemic," *Int. J. Eng. Sci. Inf.*

.

DOI: https://doi.org/10.35261/barometer.v8i2.7702
ISSN: 1979-889X (cetak), ISSN: 2549-9041 (online)
http://www.journal.unsika.ac.id

Technol., vol. 1, no. 4, pp. 59–64, 2021, doi: 10.52088/ijesty.v1i4.169.

[19] F. Sukmana, N. F. Saragih, and I. S. Simamora, "Prediksi Biaya Perbaikan Kendaraan Perusahaan Dengan Menggunakan Metode Single Exponential Smoothing Berbasis Web," *METHOSISFO J. Ilm. Sist. Inf. e-ISSN*, vol. 2, no. 2, pp. 12–18, 2022.

[20] R. Badi'ah, E. maya Odelia, and R. Effendi, "Forecasting National People's Salt Production with Time Series Model Using POM-QM for Windows," *J. Ilm. Poli Bisnis*, vol. 14, no. 2, pp. 191–206, 2022.

[21] E. B. Kurniawan and N. L. P. Hariastuti, "Implementasi Lean Manufacturing pada Proses Produksi untuk Mengurangi Waste Guna Lebih Efektif dan Efisien," *J. Senopati*, vol. 1, no. 2, pp. 85–95, 2020, [Online]. Available: https://doi.org/10.1016/j.jnc.2020.125798%0Ahttps://doi.org/10.1016/j.smr.2020.02.002%0Ahttp://www.ncbi.nlm.nih.gov/pubmed/810049%0Ahttp://doi.wiley.com/10.1002/anie.197505391%0Ahttp://www.sciencedirect.com/science/article/pii/B9780857090409500205%0Ahttp:

[22] F. A. Cahya and W. Handayani, "Minimasi Waste Melalui Pendekatan Lean Manufacturing pada Proses Produksi di UMKM Nafa Cahya," *Al-Kharaj J. Ekon. Keuang. Bisnis Syariah*, vol. 4, no. 4, pp. 1199–1208, 2022, doi: 10.47467/alkharaj.v4i4.904.

[23] M. S. Rumetna, T. N. Lina, T. P. Sari, P. Mugu, A. Assem, and R. Sianturi, "Optimasi Jumlah Produksi Roti Menggunakan Program Linear Dan Software Pom-Qm," *Comput. Based Inf. Syst. J.*, vol. 9, no. 1, pp. 42–49, 2021, doi: 10.33884/cbis.v9i1.3645.

[24] F. Pulansari and I. Nugraha, "Optimasi Biaya Distribusi Perusahaan Pestisida Dengan Kombinasi Metode Transportasi North West Corner Method Dan Modified Distribution Method Berbasis Pom-Qm," *Waluyo Jatmiko Proceeding*, vol. 15, no. 1, pp. 198–204, 2022, doi: 10.33005/waluyojatmiko.v15i1.44.

[25] F. Gunadi and S. R. Widianto, "Perbandingan Data Warehouse Cloud Computing Menggunakan Konvensional Berbasis Kriptografi," *Semin. Nas. Teknol. Komput. Sains*, pp. 69–73, 2020, [Online]. Available: https://prosiding.seminar-id.com/index.php/sainteks.

[26] B. Alouffi, M. Hasnain, A. Alharbi, W. Alosaimi, H. Alyami, and M. Ayaz, "A Systematic Literature Review on Cloud Computing Security: Threats and Mitigation Strategies," *IEEE Access*, vol. 9, pp. 57792–57807, 2021, doi: 10.1109/ACCESS.2021.3073203.

[27] I. Permatahati and Muqorobin, "Computer Sales Forecasting System Application Using Web-Based Single Moving Average Method," *Int. J. Comput. Inf. Syst.*, vol. 3, no. 2, pp. 56–63, 2022, doi: 10.29040/ijcis.v3i2.68.

[28] A. Fitri, R. Yesputra, and A. Nasution, "Pendekatan Metode Weighted Moving Average Untuk Meramal Jumlah Penjualan Keripik," *Indones. J. Comput. Sci.*, vol. 11, no. 1, pp. 566–576, 2022.

[29] R. Adrianto and M. D. Jyoti, "Analsis Peramalan Penjualan Tepung Tapioka di CV. XYZ Lampung," *Maj. TEGI*, vol. 12, no. 2, pp. 40–46, 2020, doi: 10.46559/tegi.v12i2.6203.

[30] A. Purwanto, M. Asbari, and T. I. Santoso, "Analisis Data Penelitian Marketing: Perbandingan Hasil antara Amos, SmartPLS, WarpPLS, dan SPSS untuk Jumlah Sampel Besar," *J. Ind. Eng. Manag. Res.*, vol. 2, no. 4, pp. 216–227, 2021.

.

DOI: https://doi.org/10.35261/barometer.v8i2.7702
ISSN: 1979-889X (cetak), ISSN: 2549-9041 (online)
http://www.journal.unsika.ac.id