FORECASTING ANALYSIS OF HEAVY EQUIPMENT REPAIR SERVICES USING THE TIME SERIES METHOD AT PT PUTRA JAWAMAS

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Abstract

Forecasting is the art and science of predicting future events. Forecasting is an important thing to do research in companies, especially at PT Putra Jawamas, to provide ease in estimating resources and service needs. In companies engaged in the field of repair and fabrication, there are resource needs and service needs that must be prepared to maintain the stability and quality of services. Forecasting is a theory for estimating future events by involving the historical past retrieval. This company uses forecasting to estimate the demand for heavy equipment repair services in the future using the time series method, which is part of several methods, including single exponential smoothing, weighted moving average, and moving average. The research methods used are interviews, observations, historical data collection and literature studies related to this discussion. The results of this study indicate that the best research method of the weighted moving average and exponential smoothing methods for the demand for heavy equipment repair services at PT Putra Jawamas is exponential smoothing with $\alpha = 0.2$ and the forecast for October 2023 is 4 units.

Keywords: Forecasting, Time Series, Repair, Fabrication

INTRODUCTION

Forecasting is the process of projecting the value of one or more variables into the future. Good forecasting is needed in all organizations to drive analysis and decisions related to operations. Forecasting is a key component in many types of integrated operating systems, such as supply chain management, customer relationship management, and revenue management systems (Sutisna, 2015).

In addition, the role of forecasting is not only limited to estimating the future, but also helps organizations develop mitigation plans to deal with worst-case scenarios. In the context of the supply chain, for example, the use of probabilistic models allows companies to prepare for unexpected spikes or drops in demand, so that the risk of excess stock or shortages can be minimized (Chopra & Meindl, 2022).

Based on the forecast time, forecasts can be grouped into 3 (three) according to their respective periods, namely as follows:

- Long-term forecasting generally ranges from 2 to 10 years. This forecast can be used for production planning and resource planning.
- Medium-term forecasting, generally from 1 to 24 months. This forecast is used to determine cash flow, production planning, and production cost budgets.
- Short-term forecasting, generally starting from 1 to 5 weeks. This forecast is used to make decisions regarding the need for overtime hours, work scheduling. (Yani, 2020)

Thus, forecasting becomes an integral component in strategic decision making that not only helps organizations survive in the midst of uncertainty but also creates a sustainable competitive advantage. So the researcher decided to conduct research at PT. Putra Jawamas. The reason for conducting this research is to provide proper resource control to be able to meet fluctuating consumer demand every month. This creates problems in the running of the company, so that it does not achieve the company's target. Therefore, by taking data from the previous period and the second using the available capacity optimally. An alternative way that can be done to determine the amount of consumer demand products desired, so that there is no shortage or excess in production, one of which is by knowing the application of forecasting methods, it is expected that the forecast results in the next period will be more accurate. To minimize production costs and get big profits.

REVIEW OF LITERATURE

Forecasting is one of the core processes in strategic decision-making that aims to predict future events based on historical data, patterns, and current information. In the context of business, economics, and management, forecasting is used to anticipate uncertainty, reduce risk, and improve operational efficiency (Hyndman & Athanasopoulos, 2021). In addition, forecasting also plays a key role in the public sector, such as in transportation planning, public health, and disaster mitigation (Petropoulos et al., 2022).

More complex forecasting methods, such as ARIMA, have been used in various studies to handle non-stationary data. Supuwiningsih et al. (2022) emphasized that this method provides high accuracy in long-term forecasting, especially on data that shows seasonal patterns. On the other hand, qualitative methods such as expert opinion also remain relevant, especially in situations where historical data is not available. Hassyddiqy and Hasdiana (2023) stated that the Delphi method, which involves consensus from experts, can be used to predict demand in the context of new products or situations with high uncertainty.

The Single Exponential Smoothing (SES) method is a simple forecasting method that is often used for stable, trendless, or seasonal data. This method gives greater weight to the latest data, so that the forecasting results are more responsive to recent changes (Supuwiningsih et al., 2022).

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

- Ft+1: Forecast for the next period
- XtX_tXt: Actual data for the current period
- FtF_tFt: Forecast for the current period
- α\alpha: Smoothing factor ($0 < \alpha \leq 1$)

Weighted Moving Average (WMA) is a forecasting method that assigns different weights to historical data. More recent data is usually given a higher weight to reflect its higher relevance to current conditions (Lusiana & Yuliarty, 2020).

$$WMA = \frac{\sum(weight\ on\ period\ n)(previous\ period\ of\ n\ request)}{\sum weight}$$

- Ft+1F_{t+1}Ft+1: Forecast for the next period
- Wn: Weight for the Nth data

- Xt−i+1X_{t-i+1}Xt−i+1: Actual data in period (t-i+1)
- n: Number of periods used

Moving Average (MA) is a simple and frequently used forecasting method to smooth fluctuations in data, so that major trends can be more easily identified. This method calculates the average of historical data over a certain number of periods (Supuwiningsih et al., 2022).

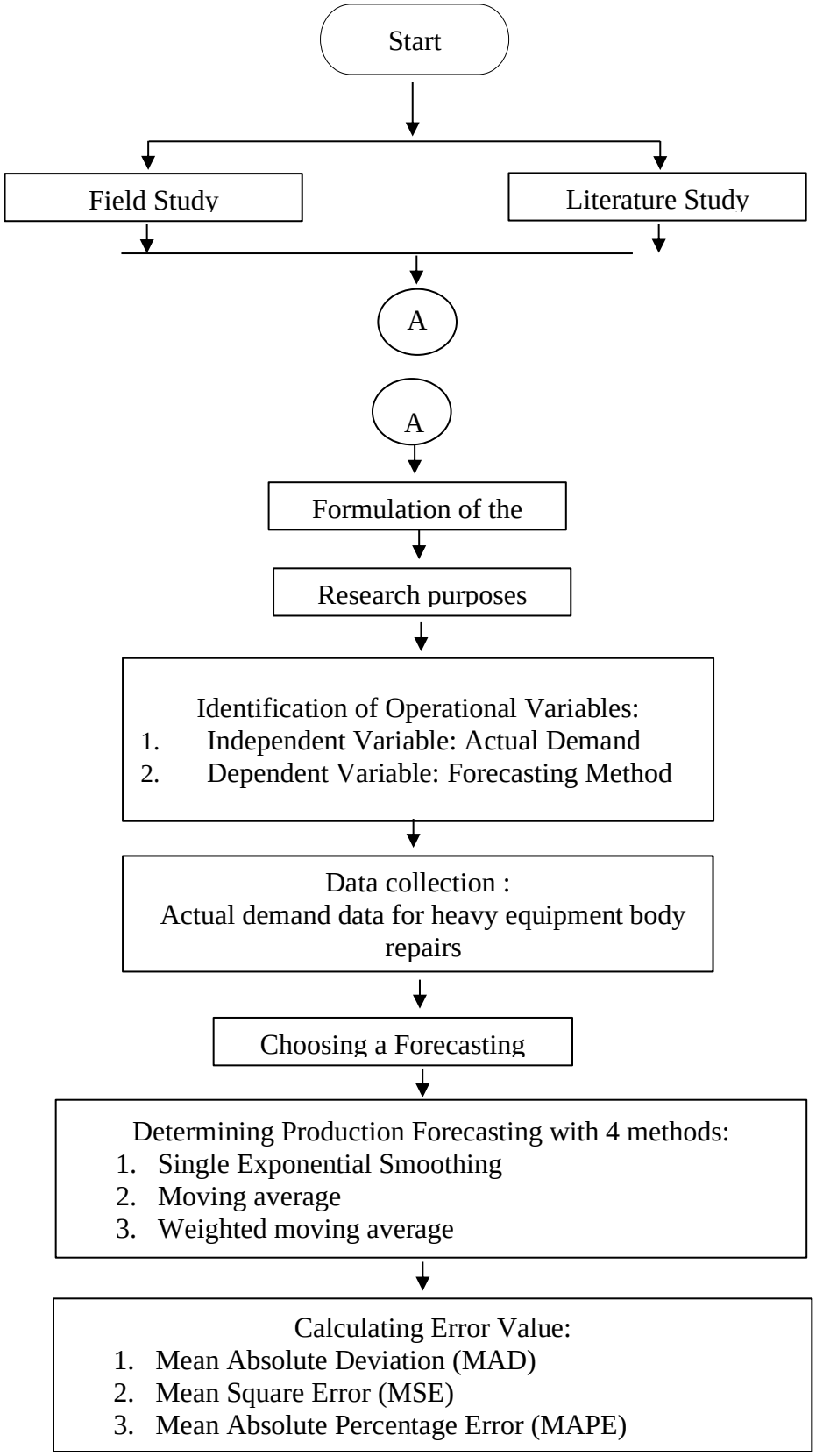
$$\text{MA} = \frac{\sum previous\ period\ of\ n\ request}{\text{n}}$$

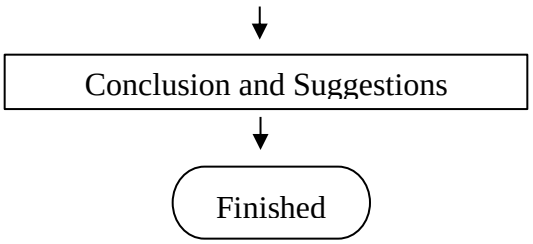
- Ft+1: Forecast for the next period
- Xt−n+1X_{t-n+1}Xt−i+1: Actual data at period (t-n+1)
- n: Number of periods used

RESEARCH METHOD

This research was conducted at PT Putra Jawamas. Jl. Kutisari Utara 1/56 D, Kec. Tenggilis Mejoyo, Surabaya City, East Java, Indonesia. The time carried out in this study started from September 2024 to December 2024. The research method used was a quantitative approach. From the process of collecting information and data, researchers conducted interviews with business owners and conducted direct observations. Before conducting interviews with company owners, researchers prepared questions in advance so that the information obtained could be structured and maximized according to the problems experienced by the company.

This study aims to determine the amount of demand in the coming month and determine the most appropriate forecasting method in knowing sales demand at PT Putra Jawamas. This study tries to consider 3 forecasting methods, namelysingle exponential smoothing, weight moving average, and moving average.


Start
Field Study
Literature Study
A
A
Formulation of the
Research purposes
Identification of Operational Variables:
1. Independent Variable: Actual Demand
2. Dependent Variable: Forecasting Method
Data collection :
Actual demand data for heavy equipment body repairs
Choosing a Forecasting
Determining Production Forecasting with 4 methods:
1. Single Exponential Smoothing
2. Moving average
3. Weighted moving average
Calculating Error Value:
1. Mean Absolute Deviation (MAD)
2. Mean Square Error (MSE)
3. Mean Absolute Percentage Error (MAPE)



RESULTS AND DISCUSSION

Data collection aims to obtain the information needed to achieve research objectives. This process includes several aspects as support or reference in the research conducted, namely:

Table 1
Actual Request Data

Period	Month	Actual Demand (Units)
1	Dec-22	5
2	Jan-23	4
3	Feb-23	4
4	Mar-23	4
5	Apr-23	3
6	May-23	2
7	Jun-23	2
8	Jul-23	3
9	Aug-23	4
10	Sep-23	5
TOTAL		36

Single Exponential Smoothing

Table 2
Single Exponential Smoothing Forecast Data

Period	Month	Actual Demand (Units)	Predictions Based on Singles Exponential Smoothing
1	Dec-22	5	
2	Jan-23	4	5
3	Feb-23	4	5
4	Mar-23	4	5
5	Apr-23	3	5

Period	Month	Actual Demand (Units)	Predictions Based on Singles Exponential Smoothing
6	May-23	2	5
7	Jun-23	2	4
8	Jul-23	3	4
9	Aug-23	4	4
10	Sep-23	5	4
11	Oct-23		4
TOTAL		36	45.00

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

$SES = (0{,}2 \times 4) + (0{,}8)5$

$SES = 5$

Based on the above request data plot image, the data plot image matches the horizontal data pattern. So, the methods that are suitable for horizontal data are the Single Exponential Smoothing method, the Moving average method, and the Weighted moving average method.

Table 3
Single Exponential Smoothing Forecasting Error Data

Period	Actual Demand (Units)	Forecast	Error	|Error|	Squired	% Error	|% Error|
1	5						
2	4	5	-1	1	1	-25.00	25.00
3	4	5	-1	1	1	-25.00	25.00
4	4	5	-1	1	1.00	-25.00	25.00
5	3	5	-2.00	2.00	4.00	-66.67	66.67
6	2	5	-3.00	3.00	9.00	-150.00	150.00
7	2	4	-2.00	2.00	4.00	-100.00	100.00
8	3	4	-1.00	1.00	1.00	-33.33	33.33
9	4	4	0.00	0.00	0.00	0.00	0.00
10	5	4	1.00	1.00	1.00	20.00	20.00
11		4					
TOTAL	36	45	-10.00	12.00	22.00	-405.00	445.00

$MAD = \Sigma \left| \frac{At - Ft}{n} \right|$

$= \frac{12}{10}$

$= 1.2$

$$MSE = \Sigma \frac{(At - Ft)^2}{n}$$
$$= \frac{22}{10}$$
$$= 2.2$$
$$MAPE = \left(\frac{100}{n}\right) \Sigma \left|\frac{At - Ft}{n}\right|$$
$$= \frac{445}{10}$$
$$= 44.5\%$$

Based on the calculation of the forecast error above using the Single Exponential Smoothing method, the MAD value is 1.2, the MSE value is 2.2, and the MAPE value is 44.5%.

Weighted Moving Average

Table 4
Weight Moving Average Forecasting Data

Period	Month	Actual Demand (Units)	Prediction Based on Weighted Moving Average
1	Dec-22	5	
2	Jan-23	4	
3	Feb-23	4	
4	Mar-23	4	4
5	Apr-23	3	4
6	May-23	2	4
7	Jun-23	2	3
8	Jul-23	3	2
9	Aug-23	4	3
10	Sep-23	5	3
11	Oct-23		4
TOTAL		36	27

$$WMA = \frac{\sum(weight\ on\ period\ n)(previous\ period\ of\ n\ request)}{\sum weight}$$
$$= \frac{\sum(3 \times 3) + (2 \times 4) + (1 \times 5)}{6}$$
$$= 4$$

Based on the calculation of the forecast error above using the weighted moving average method, the result of the WMA value is 4 in October 2023.

Table 5
Weighted Moving Average Forecast Error Data

Period	Actual Demand (Units)	Forecast	Error	|Error|	Squired	% Error	|% Error|
1	5						
2	4						
3	4						
4	4	4	0	0	0	0.00	0.00
5	3	4	-1	1	1	-33.33	33.33
6	2	4	-2	2	4	-100.00	100.00
7	2	3	-1	1	1	-50.00	50.00
8	3	2	1	1	1	33.33	33.33
9	4	3	1	1	1	25.00	25.00
10	5	3	2	2	4	40.00	40.00
11		4					
TOTAL	36	27	0	8	12	-85.00	281.67

$$MAD = \Sigma \left| \frac{At - Ft}{n} \right|$$

$$= \frac{8}{10}$$

$$= 0.8$$

$$MSE = \Sigma \frac{(At - Ft)^2}{n}$$

$$= \frac{12}{10}$$

$$= 1.2$$

$$MAPE = \left(\frac{100}{n}\right) \Sigma \left| \frac{At - Ft}{n} \right|$$

$$= \frac{281.67}{10}$$

$$= 28.17\%$$

Based on the calculation of the forecast error above using the Weight Moving Average method, the MAD value is 0.8, the MSE value is 1.2, and the MAPE value is 28.17%.

Moving Average

Table 6
Moving Average Forecast Data

Period	Month	Actual Demand (Units)	Prediction Based on Moving Average
1	Dec-22	5	
2	Jan-23	4	
3	Feb-23	4	
4	Mar-23	4	4.00
5	Apr-23	3	4.00
6	May-23	2	4.00
7	Jun-23	2	3.00
8	Jul-23	3	2.00
9	Aug-23	4	2.00
10	Sep-23	5	3.00
11	Oct-23		4.00
TOTAL		36	26.00

$$MA = \frac{\sum previous\ period\ of\ n\ request}{n}$$

$$= \frac{\sum 4 + 4 + 5}{3}$$

$$= 4$$

Based on the results of forecasting heavy equipment repair services using the Moving Average model, it can be seen that the production forecast in October 2023 is 4 units.

Table 7
Moving Average Forecast Error Data

Period	Actual Demand (Units)	Forecast	Error	|Error|	Squired	%Error	|%Error|
1	5						
2	4						
3	4						
4	4	4.00	0.00	0.00	0.00	0.00	0.00
5	3	4.00	-1.00	1	1	-33.333	33.33
6	2	4.00	-2.00	2.00	4.00	-100,000	100.00
7	2	3.00	-1.00	1.00	1.00	-50,000	50.00

Period	Actual Demand (Units)	Forecast	Error	|Error|	Squired	%Error	|%Error|
8	3	2.00	1.00	1.00	1.00	33.333	33.33
9	4	2.00	2.00	2.00	4.00	50,000	50.00
10	5	3.00	2.00	2	4	40,000	40.00
11		4.00					
TOTAL	36	26.00	1.00	9.00	15.00	-60.00	306.67

$$MAD = \Sigma \left| \frac{At - Ft}{n} \right|$$

$= \frac{9}{10}$

$= 0.9$

$$MSE = \Sigma \frac{(At - Ft)^2}{n}$$

$= \frac{15}{10}$

$= 1.5$

$$MAPE = \left(\frac{100}{n}\right) \Sigma \left| \frac{At - Ft}{n} \right|$$

$= \frac{306,67}{10}$

$= 30.66\%$

Based on the calculation of forecasting errors above using the method of Moving Average, the MA value obtained is in the period October 20234,00.

CONCLUSION

Analyzing historical data on heavy equipment repair requests from December 2022 to October 2023 (10 months), we can see that the data fluctuations move around the average so the author chooses the weighted moving average method with a value of α = 0.2..By using the calculation results of Single Exponential Smoothing, the value of α = 0.2 gets the forecast results of 3 units in October 2023..The results of this study provide a higher level of forecasting accuracy and ease in applying the method for operational management at PT Putra Jawamas. With the increase in forecasting accuracy, this will have a positive impact on

management and the company to be able to better plan the supply chain, human resources, and also tools that support the quality of fulfilling consumer demand.

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