

Forecasting Raw Material Inventory Using Exponential Smoothing and Moving Average Methods

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ABSTRACT

The production process is carried out to convert raw materials into finished products. One factor that influences the smooth running of production is the availability of sufficient raw materials. PT X, which produces carton boxes, currently needs help predicting production needs. This research aims to determine the appropriate raw material forecasting method by comparing two methods, namely exponential smoothing and moving average. The moving value used in the moving average method is 2, while the alpha (α) value used in the exponential smoothing method is 0.1. The forecasting results using these two methods were then tested for error levels. The forecast error level test results show that the exponential smoothing forecasting method with a value of $\alpha = 0.1$ has the lowest error value compared to the moving average method.

Keywords: Forecasting, Moving Average, Exponential Smoothing, Carton Box

A. INTRODUCTION

In the production process of a manufacturing company, there are activities to change raw materials into finished products according to consumer demand. Production is one of the stages in the industry whose role is to change something through various processes until it reaches a certain quality and has added value (Soeltanong & Sasongko, 2021). A company's production planning begins with forecasting demand and determining the number of products that need to be produced to meet customer demand and establish close relationships with consumers (Salsavira & Yuliawati, 2023). The forecasting method used in the planning section can be an alternative consideration in the decision making process (Ayuni & Fitriana, 2019).

One factor in smooth production is influenced by the optimal availability of raw materials (Yulianto & Alhamdi, 2022). A common problem in planning and controlling raw materials is inaccurate quantities of raw materials, if natural materials are provided in too high

amounts and require storage for an extended period before being processed into packaging, it can damage the raw materials, resulting in losses for the company (Zulkaranain & Salsabila, 2022). One way to overcome the problem of raw material quantities is through product forecasting. Forecasting is done by predicting future consumer demand to estimate a company's sales so that companies can better plan raw material supplies (Hernadewita et al., 2020).

In this research, an appropriate forecasting analysis was carried out to forecast raw materials for the Carton Box production process of PT and electronics. Carton boxes can also protect products, make product identification and display easier, make product counting more accessible, and make transportation easier (Sugiantini et al., 2022). The methods analyzed in this research are the Exponential Smoothing and Moving Average methods.

B. MATERIALS AND METHODS

Forecasting is a technique used to predict or predict the future using historical datasets created mathematically (Christi & Yuliawati, 2018). The quantitative production forecasting process can be carried out using historical data collection on raw material supplies. This historical data is presented in graphic format which makes it easy to identify data patterns in historical data. This process is the first step in determining the best prediction method for the type of data pattern obtained.

This research uses time series data which is used to study patterns of raw material usage in each period, so that the reference can be used to forecast the amount of raw material needed. The time series model is a method used to analyze a series of data which is a function of time. Forecasting time series data requires paying attention to the type or pattern of data in a certain period. In general, there are four types of time series data patterns, namely horizontal, trend, seasonal and cyclical. Some examples of methods in time series analysis are the moving average method, exponential smoothing, decomposition, Holt winter method, Fouries series and box Jenkins-ARIMA (Simanjuntak & Wicaksono). In this research, the data used is horizontal type data, so several methods that are suitable for horizontal data are the moving average & exponential smoothing methods.

The exponential smoothing method is used for short-term forecasting by assuming that the data fluctuates around a fairly stable average (Lusiana & Yuliarty, 2020). The exponential smoothing method is carried out by smoothing using a constant value (α) with a range of 0 to

1. The moving average method is a forecasting method that uses a moving average of the last several periods as forecast data for the next period (Arisoma et al, 2020)

Measurement of forecasting error values can be calculated using the Mean Absolute Deviation (MAD), Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE) values. MAD (Mean Absolute Deviation) is an error test based on the average absolute error in a certain period and has no connection between forecasting results and reality (Ahmad, 2020). The value of the error test results using MAD is influenced by the number of products predicted (Pratama et al., 2020). MSE (Mean Squared Error) is an error test based on the average squared error which can provide a penalty for larger differences rather than smaller differences through square calculations (Lusiana & Yuliarty, 2020). The results of the MSE error test on forecasting results can be interpreted as having a low error rate according to the value results, this is because MSE is a gradient-based error test (Ayuni & Fitrihanah, 2019). MAPE (Mean Absolute Percentage Error) is an error test based on the average absolute error in percent form during a certain period (Lusiana & Yuliarty, 2020). In the MAPE error test the forecasting results carried out will be said to be good if the results are less than 10% (Ayuni & Fitrihanah, 2019).

This research was conducted using a quantitative approach. The stages carried out in this research are as follows.

1. Problem Identification Stage. Identifying problems can start from direct observation at the research location to analyze problems/obstacles that often occur. The identification results will be linked to literature studies obtained such as books, the internet and previous research in order to determine the objectives of the research carried out
2. Data Collection Stage. The next stage is the data collection process by interviewing and recording historical data on the supply of raw materials received for 1 year, namely January 2022 to December 2023.
3. Data Processing Stage. The data that has been collected will be processed into graphic form in order to identify historical data patterns so that we can determine a suitable method for forecasting. Data processing used to predict the amount of raw materials is obtained using QM for Windows software.
4. Analysis and Discussion Stage. After getting the data processing results, the most optimal method can be determined by comparing the error test results between one

method and another. The method with the smallest error value is the method that will be applied to determine optimal raw material inventory forecasting.

5. Conclusion Stage. The analysis results that have been obtained will reach a conclusion regarding the most optimal method that can be used to predict the amount of raw materials and suggestions that can be used by the company in the decision making process.

C. RESULTS AND DISCUSSION

In this research, the data used is historical data on the demand for paper roll materials in the period January 2022 to December 2022. Data on demand for raw materials can be seen in Table 1.

Table 1. Historical Data of Paper Roll Usage

Month	Paper Roll Usage (MT)	Month	Paper Roll Usage (MT)
Jan- 22	32329	Jul- 22	29748
Feb- 22	29847	Aug- 22	30237
Mar- 22	34530	Sep- 22	32288
Apr- 22	30329	Oct-22	30743
May- 22	27684	Nov-22	32093
Jun- 22	29849	Dec-22	32121

The pattern of the historical data above can be analyzed using graphs so that the shape of the data pattern can be seen as in Figure 1.

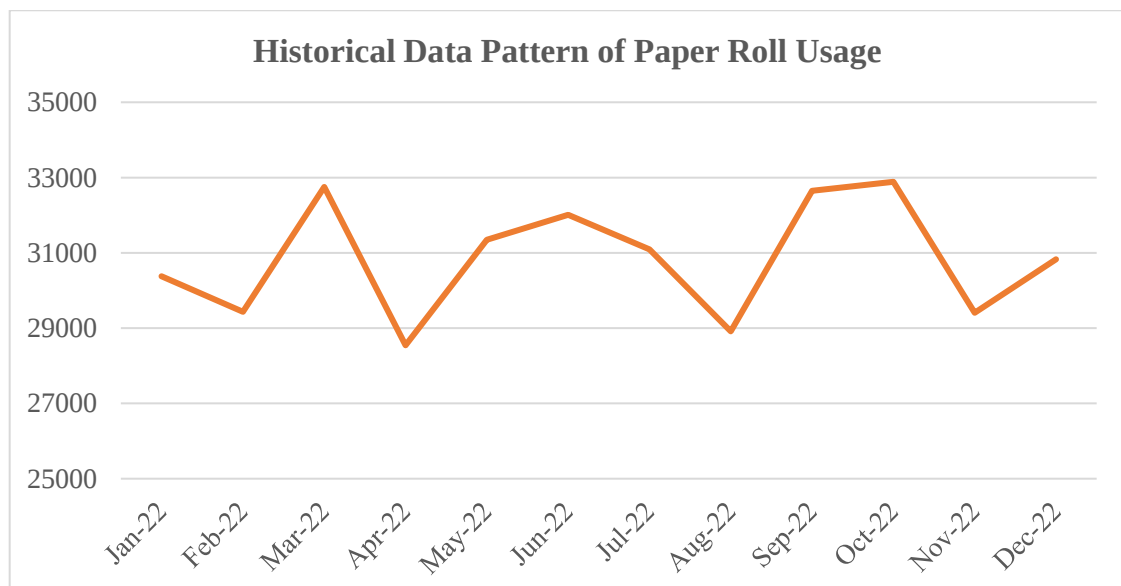


Figure 1. Historical Data Pattern of Paper Roll Usage

Based on the form of the data pattern formed, it can be said that the historical data on the need for paper roll materials is classified as a horizontal seasonal data pattern or that there is no particular trend. So data processing can be done using the moving average & exponential smoothing method approach.

Forecasting using the moving average method with the help of QM for Windows software is shown in Table 2.

Table 2. Moving average forecasting error values

Error Parameters	Error Value
Mean Absolute Deviation (MAD)	1979,8
Mean Squared Error (MSE)	4938945
Mean Absolute Percentage Error (MAPE)	6,42%

Next, the forecasting of raw material requirements is analyzed using the exponential smoothing method which is almost in accordance with the Moving Average approach because it involves processing actual past production data which is supplemented by a smoothing process. The α range (Smoothing Constant) in the exponential smoothing method processing can be done through a trial and error approach to get the minimum error result. Furthermore, after processing the data to vary α from 0.1 to 0.9, it is known that an α value of 0.1 is the optimum value. So you can see the value of the exponential smoothing error test results in Table 3.

Table 3. Exponential smoothing forecasting error values

Error Parameters	Error Value
Mean Absolute Deviation (MAD)	1469,192
Mean Squared Error (MSE)	2681042
Mean Absolute Percentage Error (MAPE)	4,738%

A comparison of the calculation results of forecasting error values including MAD, MSE and MAPE values which have been carried out using the exponential smoothing and moving average methods is shown in Table 4.

Table 4. Comparison of forecasting error values

Forecasting Methods	MAD	MSE	MAPE
Moving Average	1979,8	4938945	6,42%
Exponential Smoothing	1469,19	2681042	4,74%

Based on the comparison of forecasting method error values in Table 4,d, it can be seen that the exponential smoothing method with a value of $\alpha = 0.1$ has the lowest forecasting error value compared to the moving average method with an error value in the exponential smoothing method, namely MAD of 1469.19 with an MSE of 2681042 and a value of MAPE is 4.74%. Therefore, the exponential smoothing method is used to forecast the need for production raw materials in the next period. Forecasting carried out using the exponential smoothing method with a value of $\alpha = 0.1$ resulted in forecasting the need for paper roll materials for carton box production of 30762 MT in the next period.

D. CONCLUSION

Based on the results of the discussion of raw material demand forecasting methods, it can be concluded that the exponential smoothing approach is more optimal than the moving average method with a higher error rate. In this research, the forecasting results with exponential smoothing were 30762 MT in the next period.

Further research can be carried out using other different forecasting approaches according to historical data patterns so that it can show the results of the most optimal forecasting approach. It is hoped that the implementation of this research can help companies carry out production planning optimally and in accordance with needs and can be used as a reference or point of reference in further research in other forecasting case studies.

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