Demand Forecasting Comparison of Softex 1400-M using Single Moving Average Method and Single Exponential Smoothing Method

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Abstract

As a company who excels in agriculture, nutrition & health, and home & personal care, it is important for BASF to have the ability to forecast future market conditions. One of which is forecasting customers' demand. Poor forecasting would create problems in the management of product availability, namely the lack of availability of stock quantities or the amount of excess product stocks. Lack of available stock quantities may result in unfulfilled requests from customers, while producing excess stocks may result in losses. Hence, the aim of this study is to compare the demand forecast for Softex 1400-M, a product manufactured by BASF, using the Single Moving Average and Single Exponential Smoothing method by applying Mean Absolute Deviation, Mean Square Error, and Mean Absolute Percentage Error. The method applied in this study is a quantitative method. Based on the testing result, the method which often depicts the best result is Single Moving Average Method with periods length is 5. The demand forecast can support BASF to prevent excess or shortage of product stocks.

Keywords
Demand Forecasting, Single Exponential Smoothing, Single Moving Average, and Quantitative Method.

1. Introduction
BASF (n.d.), the approximately 110,000 employees in the BASF Group work on contributing to the success of our customers in nearly all sectors and almost every country in the world. BASF portfolio is organized into six segments: Chemicals, Materials, Industrial Solutions, Surface Technologies, Nutrition & Care, and Agricultural Solutions. BASF generated sales of around €59 billion in 2020. BASF has been investing in Indonesia since 1976. Today, BASF solutions support Indonesia's key industries including agriculture, nutrition & health, and home & personal care such as Softex 1400-M. It is one of the many products being produced using BASF's chemical ingredients. This research is needed to help BASF forecast its future market conditions so that it can remain competitive in the global market. Thus, effective planning regarding scheduling, inventory, production, and so on is very crucial as it is considered to be the backbone of successful operations. (Karmaker, C. L., P. K. Halder, and E. Sarker, 2017). So, to ensure successful operations, forecasting plays a pivotal role in the company's decision to determine the number of chemical ingredients that must be distributed. Effective forecasting will help reduce unnecessary inventories, improve product availability, and level of customer satisfaction. (Karmaker, C. L, 2017).

1.1 Objectives
The aim of this study is to identify the most appropriate forecasting method for predicting the demand forecast for Softex 1400-M using the Single Moving Average and Single Exponential Smoothing method. This study also aims to measure the comparison of error values from the Single Moving Average and Single Exponential Smoothing method using Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percent Error (MAPE).

2. Literature Review
Forecasting is a common activity in many companies affecting operations, marketing, and planning. It involves predicting the amount customers will purchase, given the product's features and the condition of the sale. Forecasting

is vital to the efficient operation of the company and will aid managers in making decisions such as the size of a plant to build, the amount of inventory to carry, the number of workers to hire, the amount of advertising to place, and the proper price to charge. Business company's main goal is to gain profit and profitability depends on having a relatively accurate forecasting of sales and costs and properly using the forecast in the plant. In order to have an accurate estimated level of demand to avoid excesses and not less inventory quantities, forecasting needs to be done based on past sales. (J. Scott Armstrong, 1999) Many methods have been used for making such decisions, such as Single Moving Average and Single Exponential Smoothing. Both of these methods are often used to support decision making in forecasting past sales.

Single moving average is a commonly used forecasting method that is used for technical analysis in many companies. Single moving average is useful in forecasting when there is no trend in raw datas. However, if trends are present, usage of different estimates can take them into account. This method is called "moving" because as new data are available, the oldest used are no longer used (Makridakis et al., 1999) Single Moving Average is customizable because it can be calculated depending on the number of times periods desired. This method does not use weighting on each data to be calculated. Although this method is very simple and efficient, Single Moving Average is quite effective in determining trends that are happening in the market. This method has special characteristics:

1. Historical data sales for a certain period of time is required to undergo forecasting.
2. The longer the moving average is, the smoother the moving average results and the more visible the smoothing effect will be. A shorter-term moving average is more volatile, but its reading is closer to the source data.

Exponential Smoothing method is also a time series forecasting method. This method is a technique that makes use of a weighted moving average of past data as the basis for forecasting. The procedure results in heaviest weight to more recent observations and smaller weights to obserservation the more distant past (Hanke, Wichern, & Reitsch, 2001). The optimal value of alpha (α) strongly determines the accuracy of the exponential smoothing method. (Hanke et al., 2001). The α symbol can be determined freely which can reduce the burden of forecast error. The smoothing constant value can be determined with the conditions $0<\alpha<1$ (Ni and Igp, 2014:100). Large values of α make forecasting more responsive to more recent levels, whereas smaller values have a damping effect. (Ravinder, H. V., 2013)

Forecasting methods by exponential smoothing and moving average have been used in many studies. Different forecasting methods can result in different forecasting quality and accuracy. In order to estimate the quality and accuracy of forecasting done, some scientific measures are used such as Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percentage Error (MAPE). These measures of different methods can be compared to determine the most accurate result.

Out of the three scientific measures calculated, Mean Absolute Percentage Error (MAPE) is more valuable than Mean Absolute Deviation (MAD) and Mean Square Error (MSE). MAPE helps in providing information on whether the percentage error of calculated datas is too high or too low. This information can be seen on Table 1.

Table 1. MAPE Value Range

MAPE	**Forecasting Power**
< 10%	Highly accurate forecasting
10% - 20%	Good forecasting
20% - 50%	Reasonable forecasting
> 50%	Weak and inaccurate forecasting

In a study by Sahu and Kumar (2014) on their applications for sales forecasting of the sterilized flavoured milk in Chhattisgarh, few of forecasting models such as naive model, moving average, double moving average simple exponential smoothing, and semi average method have been used to compare the quality and accuracy of each method. The accuracy of the forecasting method was measured using Mean Forecast Error (MFE), Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Root Mean Squared Error (RMSE). The study identified the most appropriate forecasting method based on accuracy and simplicity is Simple Moving Average.

Similar research was done by Olaniyi, Adedotun, and Samuel (2018) for forecasting the 2018 demand for domestic air passenger in Nigeria by using two years single moving average and simple exponential smoothing with smoothing constant 0.9. The two methods of forecasting were evaluated and it was revealed that a single moving average method has better accuracy than simple exponential smoothing by calculating Mean Squared Deviations (MSD).

3. Methods

The method applied in this study is a quantitative method. Quantitative forecasting method is used to answer research problems related to numbers and statistics. The Single Moving Average and Single Exponential Smoothing are examples of time series methods. Time series method is a prediction approach based on the behaviour of historical data to be projected into the future by utilizing statistical and mathematical equations. This study starts with a research on literature for problem solving and ends with conclusion and suggestions, for more details, this information has been translated into the following flowchart (Figure 1):

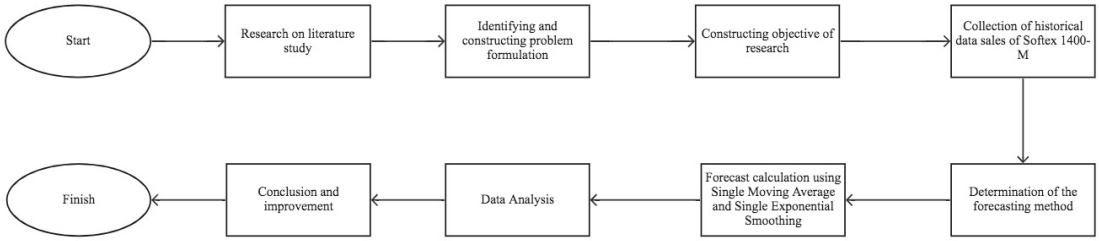

Figure 1. Flowchart of Study

4. Data Collection

The data we used for this study was collected directly from BASF company and has obtained permission to be published. In this study, the data taken to be processed is Demand data for Softex 1400-M from January 2021 to December 2021. This section will simulate the calculation of Single Moving Average and Single Exponential Smoothing for Softex 1400-M which will determine the best method to forecast Softex 1400-M so that BASF can remain competitive in the global market.

4.1 Data Used

Data was collected from BASF company. In this study, the data taken to be processed is Demand data for Softex 1400-M from January 2021 to December 2021. In this data, there is a period and number of demand for Softex 1400-M. This data can be seen in Table 2.

The data that has been obtained are then used to calculate forecast demand with 2 different methods, Single Moving Average and Single Exponential Smoothing. To determine the forecast for future periods using Single Moving Average, data collected will be divided into 5 periods thus calculating Moving Average (5) whereas for Single Exponential Smoothing method the value of α used is 0,6.

4.2 Single Moving Average Calculation for Ma(5)

The results of calculation using Single Moving Average method with the calculation of the error Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percentage Error (MAPE) are shown in Table 3.

Table 2. Demands of Softex 1400-M from January 2021 to December 2021

Month	Demands (kgs)
January	24,300
February	17,100
March	17,100
April	16,200
May	0
June	26,100
July	16,200
August	16,200
September	17,100
October	17,100
November	17,100
December	17,100

Table 3. Demands Forecasting Result of Softex 1400-M using the Single Moving Average method

Month	Demands (kgs)	Ma(5)	MAD(5)	MSE(5)	MAPE(5)
January	24,300				
February	17,100				
March	17,100				
April	16,200				
May	0	14,940	14,940		
June	26,100	15,300	10,800		41,38%
July	16,200	15,120	1,080		6,67%
August	16,200	14,940	1,260		7,78%
September	17,100	15,120	1,980	8,324	11,58%
October	17,100	18,540	1,440	5,007	8,42%
November	17,100	16,740	360	1,332	2,11%
December	17,100	16,920	180	1,244	1,05%
Average		15,952	4005	3,977	

Table 4. Accuracy Measures for Single Moving Average method

Accuracy Measures	
MAPE	12.8168
MAD	2.7257
MSE	19.6159

Table 5. Forecast Result for Single Moving Average method

Forecasts			
Period	Forecast	Lower	Upper
13	16,920	8,23935	25,6006

The result for forecasting the number of demands for the coming month by the Single Moving Average method is 16,920 kgs/month. This result can be seen on the second column of Table 5. The other results calculated are the number of errors, namely 2.7257 (MAD), 19.6159 (MSD), and 12.8168% (MAPE).

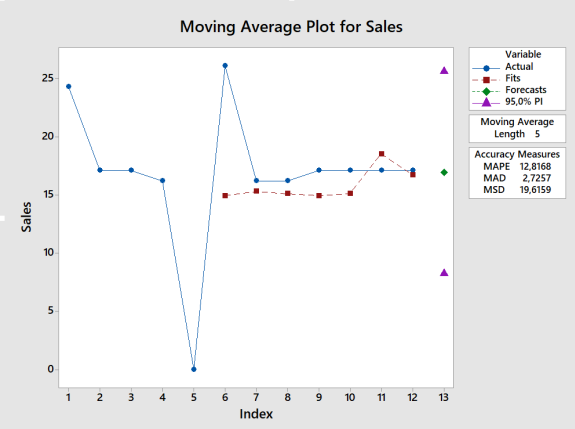

Figure 2. Moving Average Plot for Sales

Based on the Moving Average Plot for Sales in figure 2, it can be seen that forecasting demand is lower than the actual demand at the start of June to December. However, an anomaly can be seen in November as forecasting demand increases sharply from October.

4.3 Single Exponential Smoothing Calculation

The results of calculation using Single Exponential Smoothing method with the calculation of the error Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percentage Error (MAPE) are shown in Table 6.

Table 6. Demands Forecasting Result of Softex 1400-M using the Single Exponential Smoothing method

Month	Demands (kgs)	Ma	MAD	MSE	MAPE
January	24,300				
February	17,100	24,300	7,200		
March	17,100	21,420	4,320		
April	16,200	19,692	3,492		
May	0	18,295	18,295	5,250	
June	26,100	10,977	15,122	11,038	42,29%
July	16,200	17,026	826	13,851	85,50%
August	16,200	16,695	495	13,712	84,65%
September	17,100	16,497	602	8,748	51,16%
October	17,100	16,738	361	656	3,84%
November	17,100	16,883	216	496	2,90%
December	17,100	16,969	130	424	2,48%
Average		17,772	4,642	6,772	

Table 7. Accuracy Measures for Single Exponential Smoothing method

Accuracy Measures	
MAPE	15.731
MAD	4.5888
MSE	61.9394

Table 8. Forecast Result for Single Exponential Smoothing method

Forecasts			
Period	Forecast	Lower	Upper
13	17,0858	5,84351	2,83280

The result for forecasting the number of demands for the coming month by the Single Exponential Smoothing method is 17,0858 kgs/month. This result can be seen on the second column of Table 8. The other results listed are the number of errors, namely 4.5888 (MAD), 61.9394 (MSD), and 15.7311% (MAPE).

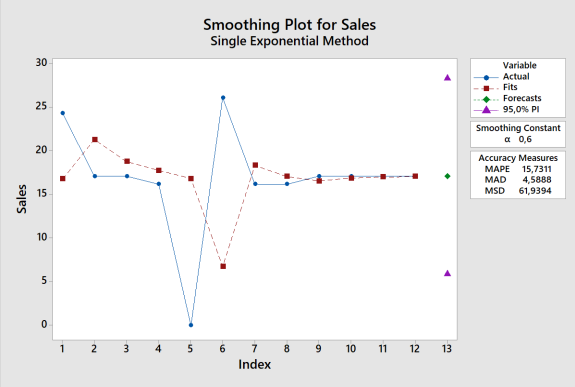

Figure 3. Smoothing Plot for Sales

Based on the Smoothing Plot for Sales in figure 3, it can be seen that forecasting demand is higher than actual demand from February to August except in June as the company made zero sales in May. However, during September forecasting demand levels down to the actual demand of the company.

5. Results

After finding the historical data, the data itself is processed to determine the forecasting number of demand Softex 1400-M has for the next period (month) using both Single Moving Average and Single Exponential Smoothing method. The data that is taken is the sales of the product, which is the BASF's Softex 1400-M sales. The amount of data that is used is 12 months, from January to December 2021. Here are the results of both forecasting methods: The Ft, MAD, MSE, and MAPE.

Table 9. Comparison of Demand Forecasting Result

Forecasting Method	Ft	MAD	MSE	MAPE
SMA	16,92	2,7257	19,6159	12,8168%
SES	17,0858	4,5888	61,9394	15,731%

From Table 9, it is shown that for the Single Moving Average method the forecasting for the 13th period is 16,92 with the error values 2,7257 (MAD), 19,6169 (MSE), and 12,8168% (MAPE). As for the Single Exponential Smoothing method, the forecasting for the 13th period is 17,0858 with error values 4,5888 (MAD), 61,9394 (MSE), and 15,731% (MAPE).

In this study, the writers try to find the smallest number of errors. According to the MAPE value range in table 1 and calculated datas, Single Moving Average and Single Exponential Smoothing are in the range 10%-20% which states that both methods have good forecasting model ability. Following that, when comparing the values of MAD and MSE of each method, the Single Moving Average method has the smallest error values for MAD (2,7257) and MSE (19,6169). Therefore, forecasting using the Single Moving Average method shows more accurate results than the Single Exponential Smoothing method.

We use the MAPE as the forecasting accuracy standard. It is true that the values of the MAD, MSE, and MAPE are used to state the forecasting deviations or errors. However, using MAD as a measure of accuracy can also present problems in this phase. This measure (MAD) does not facilitate comparisons between series of different scales and for different time intervals, because MAD is an absolute measure that is highly dependent on the scale of the time series data. For this reason, in relation to the limitations of MAD as a measure of forecasting accuracy. We often use an alternative measure for more accuracy, which is MAPE.

6. Conclusion

In conclusion, this study examined forecasting methods using single moving average (n=5) and exponential smoothing (α=0.6) to forecast demand sales for Softex 1400-M. Monthly data from January of 2021 to December 2021 were collected and used to forecast the month of 2022 customer of BASF demand. The study revealed that the five months single moving average has higher accuracy then the exponential smoothing with smoothing constant of 0.6. High level of accuracy has been proven through calculation of errors. The result for forecasting the number of demands for the coming month by the Single Moving Average method is 15,952 kgs/month with errors calculated, namely 2,7257 (MAD), 19,6159 (MSD), and 12,8168% (MAPE) whereas by Single Exponential Smoothing method The result for forecasting the number of demands for the coming month is 17,0858 kgs/month with errors calculated, namely 4,5888 (MAD), 61,9394 (MSD), and 15,7311% (MAPE). Therefore, it can be concluded that the five months single moving average method will give a better forecast for the demand in the year 2022 and subsequent months if adopted.

This study helps BASF to find out which forecasting method is the most accurate because demand forecasting plays an important role for any company to stay competitive and survive in the global business environment. Therefore, effective forecasting does not only play a crucial role in the production processes but also for suppliers and transports. With effective forecasting, this will help BASF reduce unnecessary inventories and focus on improving product availability and customer satisfaction.

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Biographies

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