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# SUGAR DEMAND FORECASTING IN PT XYZ WITH WINQSB SOFTWARE

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## ABSTRACT

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*Make to stock*

*PT XYZ is a manufacturing company engaged in the production of sugar and its by-products. Currently, the determination of the amount of production at PT XYZ has not been adjusted to meet customer demand, which may continue to decrease or increase for each period. If there is a condition that the amount of production is greater than demand, it will increase the cost of storage due to accumulation. Meanwhile, if the amount of production is smaller than demand, there will be an out-of-stock condition that can reduce consumer confidence. These problems can be solved by forecasting Tambora Sugar demand at PT XYZ to meet consumer demand using the forecasting method (forecasting) with the help of WinQsb software with input, namely sugar demand data from 2021 PT SMS. The request data will later be analyzed from the request using a scatter diagram. Furthermore, after the pattern is known, the appropriate forecasting method will be determined and inputted into the WinQsb software. Based on the calculation results, it is known that the demand pattern from last year tends to trend down so the chosen method is the Double Exponential Smoothing (DES), Single Exponential Smoothing (SES), and Linear Regression (LR) method, with the best method being Linear Regression which produces the smallest error. The output is in the form of a Master Production Schedule (MPS), namely in the 13th to 18th periods, respectively 2142; 1757; 1373; 989; 604; 220 sacks.*



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## 1. INTRODUCTION

Sugar is a food ingredient that is often used by humans, for various purposes, ranging from cooking spices to making drinks and foods. In Indonesia, sugar has become one of the main ingredients traded in the market. As one of the main ingredients, sugar has a high demand by the people of Indonesia. It was recorded that in 2021 the Ministry of Industry stated that the total national demand for sugar reached 6 million tons per year [1]. Therefore, this large market opportunity should be put to good use by sugar companies in Indonesia.

PT XYZ is a subsidiary company that started production in 2016 and is located in West Nusa Tenggara. PT XYZ itself is a company engaged in sugar production. In this case, the raw materials used in producing sugar from sugar cane are taken from plantations managed by the company or by partners as well as from raw sugar materials to be marketed in several regions in Indonesia. PT XYZ currently only uses sugar production target setting based on an amount adjusted for assumptions or the same as previous production. It can be said that the determination of the amount of production has not been adjusted according to customer demand, which may continue to increase or decrease for each period. This resulted in two possible conditions, namely out of stock and accumulation of sugar which could be detrimental to the company. Therefore, it is necessary to determine the amount of demand for sugar in the company for the coming periods.

Based on this background, the research question in this research is (1) what is the pattern of sugar demand that will occur in 2021 at PT XYZ; (2) what method is suitable for forecasting according to the demand patterns formed in the 2021 period; (3) How many requests for Tambora Sugar products at PT XYZ for the coming period to meet consumer demand according to the forecasting results with the help of the WinQsb software that was carried out. WinQSB (Windows-Based Quantitative System in Business) is Windows-based software used for quantitative analysis in various areas of business, including demand forecasting. This software has a more historical and descriptive analysis focus.

Some of the most recent studies have been conducted. In 2017 research was carried out in the form of forecasting techniques with Double Exponential Smoothing at the PTB Larasati Sugar distributor which is located in the Denpasar area. In this research, it had compared the results of procuring sugar stocks which were previously done manually and only in estimation, which caused an out-of-stock in the company with the results of forecasting using the Double Exponential Smoothing method. Based on this research, the existence of this forecasting method can assist companies in determining the amount of production that is considered better [2]. In 2020, a forecasting analysis of sugar demand will be carried out at PT. XYZ which is located in Lampung. The method used the method of Linear Regression, Moving Average, Weighted Moving Average, Single Exponential Smoothing, and Double Exponential Smoothing with Trend. The values used as a reference are the results of the smallest MAD, MSE, and MAPE of the methods used. The research results showed that the best forecasting method was Linear Regression with a downward trend in demand patterns [3].

Research on forecasting the number of patient visits using the Arima and Holwinters method at the health center has been carried out [4]. Both of these methods can be used for short-term forecasting by providing complete information about the size of the error [5]. In addition, forecasting can also be used to see the price of electricity [6], mixed martial arts contests [7], market returns of crude oil [8], UK GDP growth [9], food inflation with a large number of prices online [10], Bitcoin [11], and demand in a dyeing company [12] in the future. Forecasting becomes very interesting when used in a competition such as M3, M4, and M5. The M3 competition was a prediction competition organized by statistics and management scientists from the State University of New York. The M4 competition was a prediction competition organized by statistics and management scientists from the State University of New York. The M5 competition is a prediction competition hosted by the US retailer Walmart. According to the literature, many papers have inspected the predictability of those competitions [13]–[23]. Then there are also various types of research about forecasting using Linear Regression, Single Exponential Smoothing, and Double Exponential Smoothing [24]–[33].

In this study, an analysis of demand patterns from the previous period in the company will be carried out first, then a suitable forecasting method will be selected based on the existing pattern. After obtaining a suitable method, a verification test is carried out to obtain output in the form of Master Production Schedule data for the coming period. A time series analysis will be carried out which will involve analyzing historical data on sugar demand to identify patterns and trends in the data. Techniques such as exponential smoothing are used to model and forecast sugar demand based on historical data.

## 2. RESEARCH METHODS

The object used in this research is the production planning section of PT XYZ. In this case, the focus is on the Supply Chain Management division of the PPIC section. In this PPIC section, detailed planning has not been carried out, especially in planning the amount of production, so it only relies on the amount of production from previous data.

The data obtained are in the form of primary data and secondary data. Primary data is data obtained directly which can be done by collecting data in the field. This data was obtained by conducting interviews with PT XYZ's PPIC division. In addition, primary data can also be obtained from direct observation of the PPIC at PT XYZ. Secondary data is data obtained from company documents taken at the Supply Chain Management division at PT XYZ. This data is in the form of demand data at PT XYZ in 2021.

After the required data is collected, data processing is carried out with the following stages (see **Figure 1**):

a. Make a scatter diagram of the requested data

b. b. Do forecasting with the help of software and choose a suitable method based on the 3 methods used. Determination of the method is done by looking at the scatter diagram pattern obtained from the request data.

c. Calculate the error value of the selected method with the smallest error results.

d. Make a Moving Range Chart (MRC) to see the spread of the data that has been generated for later verification tests.

e. Look for the resulting value in the form of a Master Production Schedule (MPS).

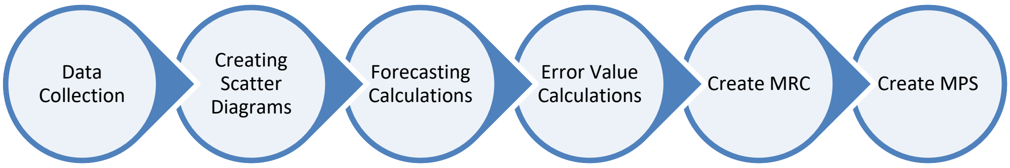


**Figure 1. Research Phase**

Forecasting aims to reduce uncertainty or errors that may occur. Therefore, the chosen forecasting method must have the smallest error value. The smaller the error value, the higher the accuracy of the forecast, and vice versa. The amount of forecasting error can be calculated using several calculation methods, namely: Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE). MAD is the average of absolute errors over a certain period that does not consider forecasting results to be greater or smaller than reality. This method can measure the accuracy of forecasts by finding the average guess error that occurs [30]. MSE is the average difference squared of the error between the predicted values and the observed values. MAPE is the average percentage of absolute errors over a certain period. The MAPE value will determine the accuracy of the forecast.

The research method contains explanations in the form of paragraphs about the research design or descriptions of the experimental settings, data sources, data collection techniques, and data analysis conducted by the researcher. This guide will explain writing headings. If your headers exceed one, use the second level of headings as below.

## 3. RESULTS AND DISCUSSION

The data used in this study is in the form of historical data from the demand for sugar at PT XYZ in 2021. This data can be seen in **Table 1**. The graph of PT XYZ's sugar product demand data for 2021 can be seen in **Figure 2**.

**Table 1.** **PT XYZ Sugar Demand Data For 2021**

| Month | Demand (Sack) |
|---|---|
| January | 227 |
| February | 4693 |
| March | 11602 |
| April | 9672 |
| May | 6087 |
| June | 4987 |
| July | 3942 |
| August | 4908 |
| September | 2738 |
| October | 3809 |
| November | 2258 |
| December | 753 |

The forecasting method that was used in this study is the time series forecasting method which uses a mathematical model from past data. Based on the data that has been input into the WinQsb software, Figure 3 shows the results for the LR, SES, and DES methods.

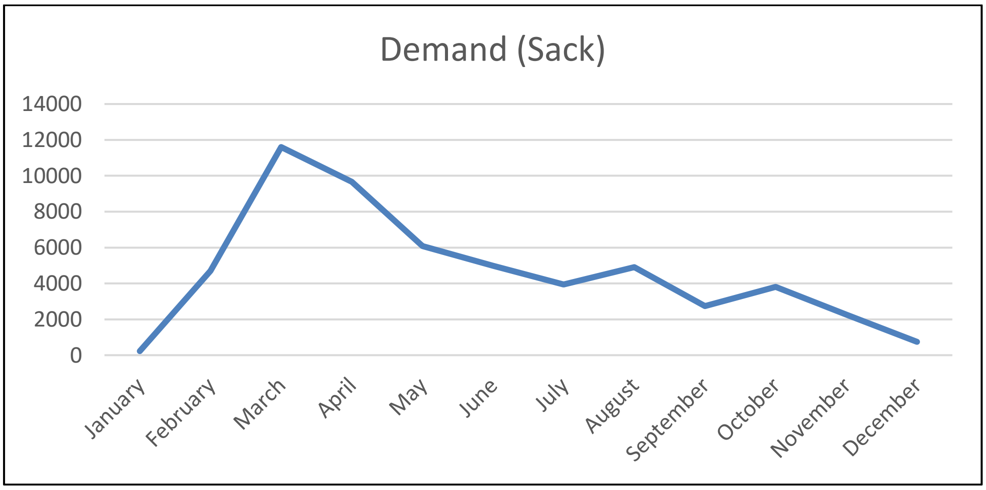


**Figure 2. The graph of PT XYZ's sugar product demand data for 2021**

Forecasting is the activity of estimating future conditions based on existing historical data. This time series-type historical forecasting model has the smallest error rate to obtain estimates that are close to real conditions and can anticipate the effects of changing uncertain market conditions. Based on the calculations that have been made and the graphs made, the data obtained has a pattern in the form of a downward trend. This pattern illustrates a decrease in product demand from time to time. From Figure 2, it can be seen if the data obtained has a pattern in the form of a downward trend. This pattern illustrates a decrease in product demand from time to time. If the demand pattern experiences a downward trend, this can have various implications and impacts depending on the sector or industry involved. The impact that will be felt if there is a decrease in demand is a decrease in revenue for the company. This decrease in income can affect the company's ability to generate profits and affect overall financial performance. Then it can also be seen from the stock side of the goods. In a situation of reduced demand, the company may experience an increase in the stock of unsold goods. This can result in high storage costs and potential losses due to expired goods.

For trend data patterns the selected forecasting methods with the help of WinQsb software are the Double Exponential Smoothing (DES), Single Exponential Smoothing (SES), and Linear Regression (LR) methods. These three methods were chosen because they have the smallest MAD, MAPE, and MSE values compared to other methods that can be used in the WinQsb software. In addition, these three methods are also suitable for use for downward trending data request patterns based on previous research [3].

| 08-23-2022 Month | Actual Data | Forecast by LR | Forecast Error | CFE | MAD | MSE | MAPE (%) | Tracking Signal | R-square |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 226,5 | 6753,494 | -6526,994 | -6526,994 | 6526,994 | 4,260165E+07 | 2881,675 | -1 | |
| 2 | 4692,9 | 6369,129 | -1676,229 | -8203,223 | 4101,611 | 2,27057E+07 | 1458,697 | -2 | |
| 3 | 11602 | 5984,766 | 5617,234 | -2585,988 | 4606,819 | 2,56549E+07 | 988,6031 | -0,5613393 | 3,842859E-02 |
| 4 | 9671,5 | 5600,402 | 4071,098 | 1485,11 | 4472,889 | 2,338464E+07 | 751,9758 | 0,3320248 | 0,0163918 |
| 5 | 6087 | 5216,038 | 870,9624 | 2356,072 | 3752,503 | 1,885943E+07 | 604,4423 | 0,6278668 | 3,280718E-02 |
| 6 | 4986,5 | 4831,674 | 154,8262 | 2510,898 | 3152,891 | 1,572018E+07 | 504,2195 | 0,7963798 | 4,507338E-02 |
| 7 | 3942 | 4447,31 | -505,3101 | 2005,588 | 2774,665 | 1,351092E+07 | 434,0193 | 0,7228219 | 5,537096E-02 |
| 8 | 4908 | 4062,946 | 845,054 | 2850,642 | 2533,464 | 1,191132E+07 | 381,9191 | 1,125196 | 8,403625E-02 |
| 9 | 2738 | 3678,582 | -940,582 | 1910,06 | 2356,477 | 1,068614E+07 | 343,3007 | 0,8105577 | 9,854317E-02 |
| 10 | 3809 | 3294,218 | 514,7817 | 2424,842 | 2172,307 | 9644025 | 310,3221 | 1,116252 | 0,1324982 |
| 11 | 2258 | 2909,854 | -651,8542 | 1772,988 | 2034,084 | 8805924 | 284,7354 | 0,8716394 | 0,158015 |
| 12 | 752,5 | 2525,49 | -1772,99 | -2,441406E-03 | 2012,326 | 8334055 | 280,6419 | -1,213226E-06 | 0,1744023 |
| 13 | | 2141,126 | | | | | | | |
| 14 | | 1756,762 | | | | | | | |
| 15 | | 1372,399 | | | | | | | |
| 16 | | 988,0347 | | | | | | | |
| 17 | | 603,6708 | | | | | | | |
| 18 | | 219,3068 | | | | | | | |
| 19 | | -165,0571 | | | | | | | |
| 20 | | -549,421 | | | | | | | |
| 21 | | -933,7849 | | | | | | | |
| 22 | | -1318,149 | | | | | | | |
| 23 | | -1702,513 | | | | | | | |
| 24 | | -2086,877 | | | | | | | |
| CFE | | -2,441406E-03 | | | | | | | |
| MAD | | 2012,326 | | | | | | | |
| MSE | | 8334055 | | | | | | | |
| MAPE | | 280,6419 | | | | | | | |
| Trk.Signal | | -1,213226E-06 | | | | | | | |
| R-square | | 0,1744023 | | | | | | | |
| | | Y-intercept=7137,857 | | | | | | | |
| | | Slope=-384,3639 | | | | | | | |

**(a)**

| 08-23-2022 Month | Actual Data | Forecast by SES | Forecast Error | CFE | MAD | MSE | MAPE (%) | Tracking Signal | R-square |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 226,5 | | | | | | | | |
| 2 | 4692,9 | 226,5 | 4466,4 | 4466,4 | 4466,4 | 1,994873E+07 | 95,17356 | 1 | |
| 3 | 11602 | 226,5 | 11375,5 | 15841,9 | 7920,95 | 7,467537E+07 | 96,61066 | 2 | |
| 4 | 9671,5 | 226,5 | 9445 | 25286,9 | 8428,967 | 7,951958E+07 | 96,9598 | 3 | |
| 5 | 6087 | 226,5 | 5860,5 | 31147,4 | 7786,85 | 6,822606E+07 | 96,78959 | 4 | |
| 6 | 4986,5 | 226,5 | 4760 | 35907,4 | 7181,479 | 5,911236E+07 | 96,52322 | 5 | |
| 7 | 3942 | 226,5 | 3715,5 | 39622,9 | 6603,816 | 5,156112E+07 | 96,14505 | 6 | |
| 8 | 4908 | 226,5 | 4681,5 | 44304,4 | 6329,2 | 4,732617E+07 | 96,03648 | 7 | |
| 9 | 2738 | 226,5 | 2511,5 | 46815,9 | 5851,987 | 4,219885E+07 | 95,49786 | 8 | |
| 10 | 3809 | 226,5 | 3582,5 | 50398,4 | 5599,822 | 3,893613E+07 | 95,33738 | 9 | |
| 11 | 2258 | 226,5 | 2031,5 | 52429,9 | 5242,99 | 3,545521E+07 | 94,80054 | 10 | |
| 12 | 752,5 | 226,5 | 526 | 52955,9 | 4814,172 | 3,225716E+07 | 92,53689 | 11 | |
| 13 | | 226,5 | | | | | | | |
| 14 | | 226,5 | | | | | | | |
| 15 | | 226,5 | | | | | | | |
| 16 | | 226,5 | | | | | | | |
| 17 | | 226,5 | | | | | | | |
| 18 | | 226,5 | | | | | | | |
| 19 | | 226,5 | | | | | | | |
| 20 | | 226,5 | | | | | | | |
| 21 | | 226,5 | | | | | | | |
| 22 | | 226,5 | | | | | | | |
| 23 | | 226,5 | | | | | | | |
| 24 | | 226,5 | | | | | | | |
| CFE | | 52955,9 | | | | | | | |
| MAD | | 4814,172 | | | | | | | |
| MSE | | 3,225716E+07 | | | | | | | |
| MAPE | | 92,53689 | | | | | | | |
| Trk.Signal | | 11 | | | | | | | |
| R-square | | | | | | | | | |
| | | Alpha=0 | | | | | | | |
| | | F(0)=226,5 | | | | | | | |

**(b)**

| 08-23-2022 Month | Actual Data | Forecast by DES | Forecast Error | CFE | MAD | MSE | MAPE (%) | Tracking Signal | R-square |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 226,5 | | | | | | | | |
| 2 | 4692,9 | 226,5 | 4466,4 | 4466,4 | 4466,4 | 1,994873E+07 | 95,17356 | 1 | |
| 3 | 11602 | 4692,894 | 6909,106 | 11375,51 | 5687,753 | 3,384224E+07 | 77,36227 | 2 | |
| 4 | 9671,5 | 11601,99 | -1930,49 | 9445,016 | 4435,332 | 2,380376E+07 | 58,22838 | 2,129495 | |
| 5 | 6087 | 9671,502 | -3584,502 | 5860,514 | 4222,625 | 2,106498E+07 | 58,39325 | 1,387884 | |
| 6 | 4986,5 | 6087,005 | -1100,505 | 4760,009 | 3598,201 | 1,709421E+07 | 51,12853 | 1,322886 | |
| 7 | 3942 | 4986,501 | -1044,501 | 3715,508 | 3172,584 | 1,4427E+07 | 47,02324 | 1,17113 | |
| 8 | 4908 | 3942,001 | 965,9985 | 4681,506 | 2857,357 | 1,249931E+07 | 43,11736 | 1,638404 | |
| 9 | 2738 | 4907,999 | -2169,999 | 2511,507 | 2771,438 | 1,152551E+07 | 47,63455 | 0,9062111 | |
| 10 | 3809 | 2738,003 | 1070,997 | 3582,504 | 2582,5 | 1,037234E+07 | 45,466 | 1,387224 | |
| 11 | 2258 | 3808,999 | -1550,999 | 2031,506 | 2479,349 | 9575669 | 47,7883 | 0,8193706 | |
| 12 | 752,5 | 2258,002 | -1505,502 | 526,0039 | 2390,818 | 8911203 | 61,63179 | 0,22001 | |
| 13 | | 752,502 | | | | | | | |
| 14 | | 752,502 | | | | | | | |
| 15 | | 752,502 | | | | | | | |
| 16 | | 752,502 | | | | | | | |
| 17 | | 752,502 | | | | | | | |
| 18 | | 752,502 | | | | | | | |
| 19 | | 752,502 | | | | | | | |
| 20 | | 752,502 | | | | | | | |
| 21 | | 752,502 | | | | | | | |
| 22 | | 752,502 | | | | | | | |
| 23 | | 752,502 | | | | | | | |
| 24 | | 752,502 | | | | | | | |
| CFE | | 526,0039 | | | | | | | |
| MAD | | 2390,818 | | | | | | | |
| MSE | | 8911203 | | | | | | | |
| MAPE | | 61,63179 | | | | | | | |
| Trk.Signal | | 0,22001 | | | | | | | |
| R-square | | | | | | | | | |
| | | Alpha=1 | | | | | | | |
| | | F(0)=226,5 | | | | | | | |
| | | F'(0)=226,5 | | | | | | | |

**(c)**

**Figure 3. Forecasting results with WinQSB Software**
**(a) linear regression method, (b) single exponential smoothing, (c) double exponential smoothing**

Figure 3 is the result of forecasting calculations using WinQsb software with the linear regression (LR) method, single exponential smoothing (SES), and double exponential smoothing (DES). The value used in those three methods is historical data from the demand for sugar at PT XYZ in 2021. This belongs to secondary data which is related to the past. Based on the calculation, in the SES method, the forecast value is all the same in every period. This indicates that the SES method may not be suitable for data that has a more complex pattern, such as data with a steep trend in this research. So, evaluating the forecasting accuracy must be conducted to prove this issue.

There are differences in forecasting results from the three existing methods, so it is necessary to evaluate forecasting accuracy. Evaluation of forecasting accuracy is important to evaluate the extent to which forecasting is done according to actual data. Data processing that has been done using existing forecasting software, obtained 3 error indicators taken, these three indicators namely MAD, MSE, and MAPE with the smallest values. MAD was chosen because later this method can calculate the average absolute error over a certain period regardless of whether the forecasting results are greater or smaller than reality. Then in MSE the squared forecasting errors obtained will be summed up and divided based on the number of forecasting periods.

**Table 2. Selection of Forecasting Methods Based on Software**

| Forecasting Method | Error MAD | Error MSE | Error MAPE | Selected Method |
|---|---|---|---|---|
| LR | 2012.3 | 833055 | 280.6419 | |
| SES | 41814 | 32257160 | 91.53689 | LR |
| DES | 2390.8 | 8911203 | 61.63179 | |

Table 2 is a comparison of the MAD, MSE, and MAPE software values of the three selected methods showing that the LR method has the lowest MAD and MSE values when compared to other methods. Even though the MAPE value of the LR method is not the smallest value, the LR method is superior and has the smallest value for MAD and MSE. The SES method has the highest error, this proved that the method is not suitable for the data. So, the LR method was chosen as the best method with the smallest error value. In addition, the results of manual calculations also show that the Linear Regression method has the smallest error results compared to the other two methods, even though it shows different MAD, MSE, and MAPE numbers. This difference may occur because of the error value calculation parameter when using software, while the manual method only uses data for each period and the results of its forecasting.

Based on the calculation of the upper and lower control limits and the moving range, the data can be plotted in the graph in Figure 4.

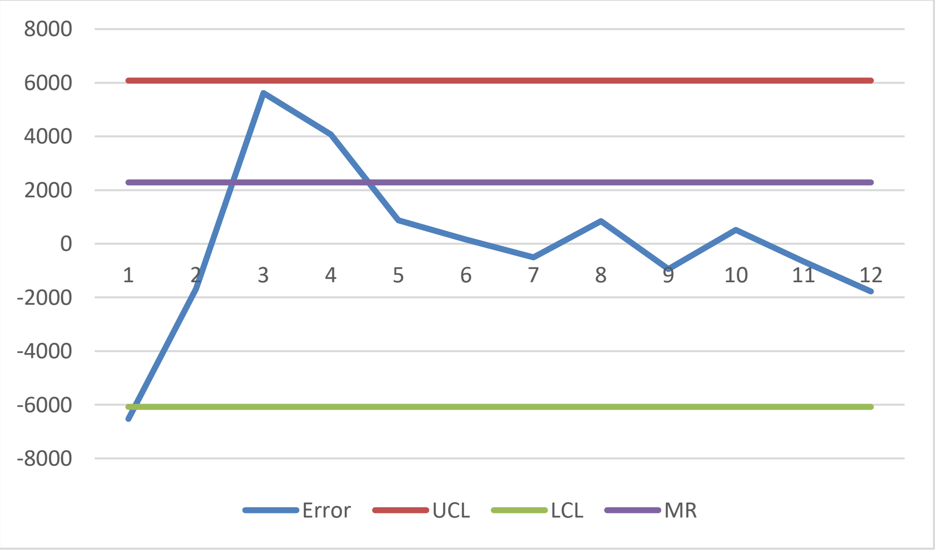


**Figure 4. Moving Range Chart**

Master Production Schedule (MPS) is a detailed plan regarding the types and quantities of products that must be produced by a company in a certain period for each production item. MPS will always be rearranged or revised every month, with the aim of meeting service level targets for consumers, achieving efficiency in the use of production resources, and achieving target production levels [34]. This MPS is the output of the forecasting activities that have been carried out. The functions of the MPS itself are:

1. The MPS can schedule production and purchase orders for each item needed.
2. MPS can be used as input for the material requirements planning system.
3. MPS is the basis for determining the company's resource needs and production capacity.
4. MPS is the basis for setting delivery time promises to customers

Based on the results of the calculation of the Moving Range Chart (MRC), the UCL value is 6080.737656 and the LCL value is -6080.737656, as in Figure 4. The error value in the period 2 to 12 can be said to be still between the UCL and LCL so that it is still within the controlled range (in control). This is because there is no error verification test graph that exceeds the UCL and LCL. While in period 1 the error value is still below the lower control limit. Then do an analysis of the causes of the occurrence of these errors. After being analyzed, it is known that this period is the company's initial production period after the shutdown, so it is necessary to do setup and preparation so that the demand that occurs is small compared to other periods. In addition, PT XYZ is still counted as a branch company that is still just producing in 2016. The out-of-control data does not need to be removed because the causes can be clearly identified, and if it is removed, forecasts will only be obtained for the next 11 months. Meanwhile, forecasting is generally done for one full period in a company.

**Table 3. Master Production Schedule (MPS)**

| Period | MPS |
|---|---|
| 13 | 2142 |
| 14 | 1757 |
| 15 | 1373 |
| 16 | 989 |
| 17 | 604 |
| 18 | 220 |
| 19 | 0 |
| 20 | 0 |
| 21 | 0 |
| 22 | 0 |
| 23 | 0 |
| 24 | 0 |

Table 3 is the output of the calculations that have been done in the form of Master Production Schedule data. MPS in the period 13 to 18 respectively 2142; 1757; 1373; 989; 604; 220 sacks, while for the 19-24 period the company's MPS forecast value is 0. MPS themselves need to be considered in the production plan to complete the final product on time according to consumer demand. In addition, to avoid overloading or underloading production equipment so that production capacity and utilization rates become more effective, and lower production costs.

The MPS results for periods 19-24 are 0, indicating that for the coming period, there are conditions where it is better for the company not to produce. This is due to the continued decline in customer demand at PT SMS in each period. There are several things that companies need to evaluate to increase demand. First, the marketing section needs further analysis. Currently, PT SMS's marketing of sugar is only limited to eastern Indonesia and a small part of Java. Companies can place advertisements to introduce Tambora Sugar to the wider community. Second, in terms of the quality of the sugar produced by PT SMS itself, is it able to compete with other sugar companies in Indonesia, such as from the color to the packaging. Third, companies need to conduct a customer satisfaction survey of the sugar products they receive and consume. With this survey, it is possible to have results that need to be evaluated by the company.

## 4. CONCLUSIONS

Based on the calculations that have been done can be obtained several conclusions:

a. The demand for sugar in 2021 has a downtrend pattern.

b. With the help of WinQsb software, three suitable methods were chosen, namely Double Exponential Smoothing (DES), Single Exponential Smoothing (SES), and Linear Regression (LR). Furthermore, after the three methods were compared, the best forecasting method was obtained, namely Linear Regression (LR) because it had the smallest MAD and MSE values. This smallest value is to minimize errors in forecasting. In the LR method, the MAD, MSE, and MAPE values are 2012.3, 833055, and 280.64 respectively. In the SES method, the MAD, MSE, and MAPE values are 41814, 32257160, and 91.53689 respectively. In the DES method, the MAD, MSE, and MAPE values are 2390.8, 8911203, and 61.63 respectively.

c. Obtained output in the form of a Master Production Schedule (MPS), namely in the period 13 to 18 in a row of 2142; 1757; 1373; 989; 604; 220 sacks, while for the 19-24 period the company's MPS forecast value is 0. This MPS can later be used to determine the sugar production master schedule.

Future research that might be possible is to develop an advanced forecasting model which combines traditional statistical methods with artificial intelligence techniques. This model can help overcome uncertainty and complexity in forecasting sugar demand.

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