Forecasting the Amount of Cough Drug Productions using Double Exponential Smoothing Brown Method in PT Mutiara Mukti Farma 2019

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Abstract: Forecasting is an important first step in making planning for each business organization and for any significant management decision making. Double Exponential Smoothing Brown forecasting method is one of the time series forecast data models that is designed for a data that contains trend elements. In this study data on the amount of drug production at P.T. Mutiara Mukti Farma from 2006 to 2018 indicated a trend data as time goes on. The data obtained is then analyzed using a scatter diagram to determine the pattern then analyzed using the Double Exponential Smoothing Brown method, to find the smallest forecast error based on the smallest Mean Absolute Percentage Error (MAPE). The best α parameter value used to forecast the amount of drug production is 0,5 with percentage error 0,08% with the form of the forecasting equation $F(t + m) = 425.194,8 + 3761,963m$.

1 INTRODUCTION

At this time almost all companies engaged in industry are faced with a problem that is an increasingly competitive level of competition. Therefore companies are required to plan or predict the right amount of production in order to meet market demand on time and with the appropriate amount and will be able to meet the needs of consumers. To be able to present the right amount of products to consumers, of course a company is required to have a good forecasting model.

P.T. Mutiara Mukti Farma is a manufacturing company engaged in the pharmaceutical processing sector. In conducting its production, the company does not have an objective forecasting model so that sometimes the company's product inventory is insufficient for consumer demand and at times experiences overstock.

There are two types of forecasting approaches: qualitative and quantitative. Some forecasting techniques try to project historical experience into the future in the form of time series. Exponential Smoothing is one of the time series predictions. Exponential smoothing was proposed in the work of Robert G. Brown as a research operations analyst for the US Navy during World War II. In 1950s, Brown modified exponential smoothing for discrete data and developed methods for trends and seasons. Now, this technique has been widely used for forecasting purposes (Karmaker et al., 2017).

A study using Double Exponential Smoothing Brown in predicting Turkey's dry wine (raisin) exports predicted that exports of dried grapes (raisins) would decrease in the coming years. A time series flow is made to determine the trend of the level of raisin exports from 1982 to 2015. Based on the analysis, raisin exports in the next five years will decrease by around 3611 tons. This study provides information for strategic planners, international executives and export management of traditional Turkish agricultural products (Uysal & Karabat, 2017).

2 LITERATURE REVIEW

2.1 Definition and Concepts of Forecasting

Forecasting is a calculation analysis technique that is carried out using both qualitative and quantitative approaches to estimate future events using reference data in the past. Forecasting (forecasting) is the art

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and science of predicting future events. This can be solved by involving historical data retrieval and projecting it into the future with a form of mathematical model (Heizer & Render, 2009).

2.2 Forecasting Functions and Purposes

The forecasting function is seen when making a decision. A good decision is a decision based on consideration of what will happen when the decision is implemented. If the prediction is not precise, then forecasting problems are also a problem that is always faced (Al Rahamneh, 2017). Forecasting has the objective to review current and past company policies and see the extent of influence in the future (Heizer & Render, 2009).

2.3 Forecasting Techniques

Qualitative forecasting is forecasting techniques used when past data are not available or available but the amount is not much. Qualitative techniques are based on a common sense approach in filtering information into useful forms. Quantitative forecasting methods are forecasting that is based on manipulating available historical data adequately and without intuition or subjective judgment of the person making the forecast (Makridakis et al., 2003).

2.4 Smoothing Method

Smoothing Method is the method of forecasting by smoothing past data, which is to take an average of several years take forecast value the next few years (Hyndman et al., 2002). The general formula of the exponential smoothing method is:

$$F_{t+1} = \alpha X_t + (i - \alpha) F_t \quad (1)$$

with:

F_{t+1}	=	forecast for the next period
X_t	=	actual data in *t* period
F_t	=	forecast *t* period
α	=	smoothing parameters

If the general formula is expanded it will change to:

$$F_{t+1} = \alpha X_t + (i - \alpha) X_{t-1} + \cdots + \alpha (i - \alpha)^N X_{t-(N-1)} \quad (2)$$

2.5 Brown's Double Exponential Smoothing

According to Makridakis et al., (2003) Brown's Double Exponential Smoothing is a linear model proposed by Brown. This method is used when data shows a trend. A trend is a smoothed estimate of the average growth at the end of each period (Makridakis et al., 2003).

The rationale for Double Exponential Smoothing from Brown is similar to Double Moving Average because both Single Smoothing and Double Smoothing values lag behind the actual data when there is an element of trend (Noeryanti et al., 2012). Difference between Single Smoothing value and Double Smoothing value ($S'_t - S''_t$) can be added with single smoothing value (S'_t) and adjusted for trend. This method uses two smoothing stages with the same parameter, that is α. α values is between 0 and 1. The steps in using Double Exponential Smoothing from Brown are as follows:

1. Determine single smoothing value (S'_t)
$$S'_t = \alpha X_t + (1 - \alpha) S'_{t-1} \quad (3)$$
2. Determine double smoothing value (S''_t)
$$S''_t = \alpha S'_t + (1 - \alpha) S''_{t-1} \quad (4)$$
3. Determine the smoothing constant value (a_t)
$$a_t = 2S'_t + S''_{t-1} \quad (5)$$
4. Determine the smoothing constant value (b_t)
$$b_t = \frac{\alpha}{1 - \alpha} S'_t - S''_{t-1} \quad (6)$$
5. Determine the forecast value for next period (F_{t+m})
$$F_{t+m} = a_t + b_t(m) \quad (7)$$
a_t and b_t values can be taken at the last observation value forecast calculation and m is the number of periods to be predicted.

To be able to use the formula, values S'_{t-1} and S''_{t-1} must be available. But when $t = 1$, these values are not available. Because these values must be determined at the beginning of the period, to solved this problem can be done by setting S''_1 and S''_1 same with X_1 value (actual data) (Makridakis et al., 2003).

2.6 Measuring Forecasting Accuracy Mean Absolute Percentage Error (MAPE)

MAPE or mean absolute percentage error is the average of the total error percentage (difference) between the actual data and the result forecasting data. The formula for calculating MAPE is as follows:

$$MAPE = \sum_{t=1}^{N} \frac{|PE_t|}{N} \quad (8)$$

Percentage error of forecast:

$$PE = \frac{X_t - F_t}{X_t} \times 100 \quad (9)$$

with:

e_t	=	error t period
X_t	=	actual data t period
F_t	=	forecast value t period
N	=	times period

3 METHODOLOGY

The type of data used in this study is premier data and secondary data. Premier data was obtained from interviews using a list of questions shown to the Production Manager. Secondary data were obtained from production data, the data on the amount of Omegrip cough production from 2006 to 2018. Then based on the amount of production data, the data was processed using quantitative forecasting methods, time series forecasting, namely Double Exponential Smoothing Brown, by looking at the value the resulting error is the Mean Absoute Percentage Error (MAPE) value. The smaller the MAPE value generated, the more accurate the forecast method.

4 RESULTS AND DISCUSSION

The data used in analyzing the data is the amount of production data of the Omegrip branded cough from 2006 to 2018 P.T. Mutiara Mukti Farma Medan.

Table 1: Amount of Production of Cough Omegrip P.T.Mutiara Mukti Farma Medan in 2006 to 2018.

Year	Amount of Production
2006	343.000
2007	352.000
2008	361.000
2009	339.000
2010	371.000
2011	406.000
2012	393.000
2013	408.000
2014	418.000
2015	429.000
2016	425.000
2017	404.000
2018	430.000

Source: P.T. Mutiara Mukti Farma

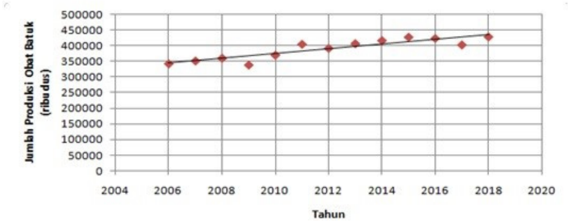

Figure 1: Data Plots for the Amount of Cough Drug Production from 2006 to 2018.

From the plot of Figure 1 it is known that the data obtained fluctuates. This shows that the data is not constant. In addition to the data plots that have been presented, it can be seen that the data has varying data peaks but tends to increase. This shows that the data contains trend elements, so that it can be analyzed using Brown's Double Exponential Smoothing Method (Padmanaban et al., 2015).

1. For the first year (2006):

   $S'_t =$ Determined by the amount of omegrip cough production in the first year (2006) that is 343,000 boxes

   $S''_t =$ Determined by the amount of omegrip cough production in the first year (2006), that is 343,000 boxes, because for $t - 1$ values not yet obtained.

2. For the second year (2007):

   $X_t = 352.000$

   Determine single exponential value S'_t

   $$S'_t = \alpha X_t + (1-\alpha)S'_{t-1}$$
   $$= 0{,}1(352.000) + (0{,}9)(343.000)$$
   $$= 343.900$$

   Determine double exponential value S''_t

   $$S''_t = \alpha S'_t + (1-\alpha)S''_{t-1}$$
   $$= 0{,}1(343.900) + (0{,}9)(343.000)$$
   $$= 343.090$$

   Determine a_t value

   $$a_t = 2S'_t + S''_{t-1}$$
   $$= 2(343.900) + 343.090$$
   $$= 344.710$$

   Determine b_t value

   $$b_t = \frac{\alpha}{1-\alpha} S'_t - S''_{t-1}$$
   $$= \frac{0{,}1}{0{,}9}(343.900 - 343.090)$$
   $$= 90$$

   Determine Mean Absolute Percentage Error value (MAPE)

   $$MAPE = \sum_{t=1}^{N} \frac{|PE_t|}{N}$$
   $$= 68{,}4316311\%$$
   $$= 6{,}22\%$$

4.1 The Best α Parameter Selection

Based on Table 2 it can be seen that the value of the α parameter which gives the smallest Mean Absolute Percentage Error (MAPE) value is a $\alpha = 0{,}5$, so that further forecasting can solved using Brown's Double Exponential Smoothing Brown method with the parameter $\alpha = 0{,}5$.

Table 2: MAPE Values for Parameters $\alpha = 0{,}1$ to $\alpha = 0{,}9$.

Parameter α	0,1	0,2	0,3	0,4	0,5
MAPE	6,22 %	2,72 %	1,08 %	0,36 %	0,08 %
Parameter α	0,6	0,7	0,8	0,9	
MAPE	0,92 %	0,95 %	0,09 %	1,11 %	

4.2 Forecast Result

Then to determine forecasting in the next year the formula is used $F_{t+m} = a_t + b_t(m)$ and b_t value can take 2018. Because the year to be predicted is 2019, the number of forecasting things to come is determined by the number of the previous year. The following are the steps for completing forecasting for 2019.

$$Ft+m = a_t + b_t(m)$$
$$F2018+1 = a2018 + b2018$$
$$F2019 = 425.194{,}8 + 3.761{,}963$$
$$F2019 \approx 428.957.$$

Based on the graph Figure 2 can be seen that after smoothing twice the actual data, the graph that will be generated will look more smoother than the actual data graph.

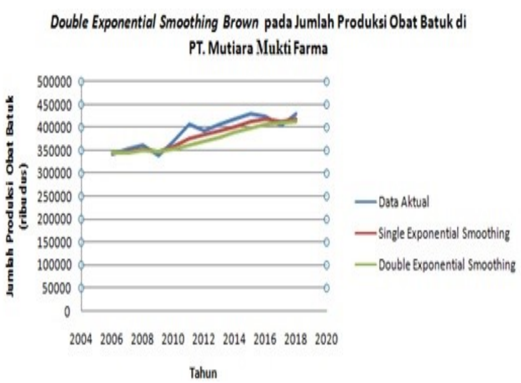

Figure 2: Graph of Brown's Double Exponential Smoothing with $\alpha = 0{,}5$, on the data of the amount of Cough production in P.T. Mutiara Mukti Farma.

5 CONCLUSION

5.1 Conclusion

Based on the analysis and discussion that has been done, it can be concluded that the best α parameter obtained for forecasting the amount of cough production in P.T. Mutiara Mukti Farma from 2006 to 2018 is $\alpha = 0{,}5$ with a percentage error of 0.08%, which results in a prediction equation $F_{(}t + m) = 425.194{,}8 + 3761{,}963m$.

5.2 Next Research

To further research in analyzing forecasting can be added other variables that support the forecasting of the amount of drug production, such as factors that affect the level of production so as to maximize the work of the analysis of this system.

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