



Implementation of Triple Exponential Smoothing Method In The Number Of Divorce Rate In North Sumatra

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ABSTRACT

The number of divorce rates in North Sumatra from 2007 to 2020 has increased. The increase in the number of divorce rates in North Sumatra which has an impact on the mental condition of children is disturbed, so forecasting is carried out in order to reduce the number of future divorce rates in North Sumatra. The purpose of this study is to find out the results of the number of divorce rates in North Sumatra in 2021-2023 and to see which accuracy is more accurate between the Triple Exponential Smoothing Method. The comparison between Triple Exponential Smoothing Method which has more accurate forecasting, namely Triple Exponential Smoothing Method with parameter values $\alpha = 0,5$ and MAPE values of 10,21%, obtains the equation for forecasting the number of divorce rates in North Sumatra is

$$F_{t+m} = 13.440,56 + (-485,42)(m) + \frac{1}{2}(-380,79)(m^2).$$

The results of the study, the number of divorce rates in North Sumatra increased in 2021 with 12.765 cases and decreased in 2022 and 2023 with 11.708 cases and 10.271 cases respectively.

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1. INTRODUCTION

Divorce is the end of a marital relationship that is no longer harmonious between husband and wife. Debates between husband and wife often lead to quarrels between them in the household. The debate arose because of problems in the household, such as infidelity, unfulfilled economic problems, child problems, no sense of responsibility from the husband to the wife or from the wife to the husband and the occurrence of domestic violence (KDRT), which resulted in rocked a marriage. When a marriage is shaken, that's when a husband and wife are faced with a difficult decision, namely to keep their marriage or divorce.

In the case of divorce in North Sumatra, the divorce rate changes every year. Based on data from the Central Statistics Agency of the Republic of North Sumatra (BPSI), every year the divorce rate in North Sumatra has increased. This shows that there are many husband and wife couples who decide to divorce due to several factors. To find out the development of divorce in the future, forecasting is needed to determine when an event will occur an increase in the divorce rate, so that it can prepare what will be done to overcome the spike in the divorce rate. One method for forecasting is the Exponential Smoothing method. The Exponential Smoothing method is a moving average forecasting technique that weighs past

data by making continuous improvements to forecasting the latest observational data. This study aims to determine the results of forecasting the number of divorce rates in North Sumatra in 2021 to 2023 using the Double Exponential Smoothing Method and Triple Exponential Smoothing Method and to find out the MAPE value of each method and which is more accurate.

2. RESEARCH METHODE

2.1 Data Collection Techniques

In this study, the data obtained by the researcher is secondary data, this data is obtained from the statistical results of the Central Statistics Agency of the Republic of North Sumatra.

2.2 Data Analysis Techniques

2.2.1 Triple Exponential Smoothing

The stages of the Double Exponential Smoothing calculation procedure are:

- 1) Determination of Parameter Value
- 2) Calculating the single exponential smoothing value

$$S'_t = \alpha X_t + (1 - \alpha) S'_{t-1} \quad (1)$$

- 3) Calculating the single exponential smoothing value

$$S''_t = \alpha S'_t + (1 - \alpha) S''_{t-1} \quad (2)$$

- 4) Calculating the triple exponential smoothing value

$$S'''_t = \alpha S''_t + (1 - \alpha) S'''_{t-1} \quad (3)$$

- 5) Determine the values of constants (*a*), (*b*) and (*c*)

$$a_t = 3S'_t - 3S''_t + S'''_t \quad (4)$$

$$b_t = \frac{\alpha}{2(1-\alpha)^2} \left[(6-5\alpha)S'_t - (10-8\alpha)S''_t + (4-3\alpha)S'''_t \right] \quad (5)$$

$$c_t = \frac{\alpha^2}{(1-\alpha)^2} \left[S'_t - 2S''_t + S'''_t \right] \quad (6)$$

- 6) Determine the forecast value that is calculated using equation

$$F_{t+m} = a_t + b_t m + \frac{1}{2} c_t m^2 \quad (7)$$

2.2.2 Determine the magnitude of the forecasting percentage error

Determine the magnitude of the forecasting percentage error of the double exponential smoothing method and triple exponential smoothing method with the equation:

$$MAPE = \frac{1}{n} \left(\sum_{t=1}^n \frac{|X_t - F_t|}{X_t} \right) \times 100\% \quad (8)$$

2.2.3 Forecasting triple exponential smoothing

Forecast for the future on the triple exponential smoothing method is calculated by the equation (7).

2.2.4 Make data conclusions

3. RESULT AND ANALYSIS

3.1 Data Collection

The data to be analyzed in this study is the number of divorce rates in North Sumatra from 2007 to 2020 obtained from data from the North Sumatra Central Statistics Agency. The data obtained are as follows:

Table 3.1 Data on the Number of Divorce Rates in North Sumatra for 2007-2020

Tahun	Data Perceraian
tahun 2007	3.309
tahun 2008	4.187
tahun 2009	4.845
tahun 2010	5.579
tahun 2011	6.684
tahun 2012	8.985
tahun 2013	7.806
tahun 2014	8.757
tahun 2015	9.603
tahun 2016	10.412
tahun 2017	11.415
tahun 2018	13.767
tahun 2019	15.651
tahun 2020	12.809

3.2 Triple Exponential Smoothing

In calculating the smoothing value, the initial value is determined by using equations (4), (5), (6) and (7). So that the initial value of the period is obtained as follows:

Determination of the initial smoothing value, S_1' , S_1'' and S_1'''

$$S_1' = S_1'' = S_1''' = X_t$$

$$S_1' = S_1'' = S_1''' = 3.309$$

Determination of the initial values of constants (a), (b) and (c)

$$\begin{aligned} a_1 &= 3S_1' - 3S_1'' + S_1''' \\ &= (3 \times 3.309) - (3 \times 3.309) + 3.309 \\ &= 3.309 \end{aligned}$$

$$\begin{aligned} b_1 &= \frac{0,1}{2(1-0,1)^2} [(6-5 \times 0,1)3.309 - (10-8 \times 0,1)3.309 + (4-3 \times 0,1)3.309] \\ &= 0 \end{aligned}$$

$$\begin{aligned} c_1 &= \frac{\alpha^2}{(1-\alpha)^2} [S_1' - 2S_1'' + S_1'''] \\ &= \frac{(0,1)^2}{(1-0,1)^2} [3.309 - (2 \times 3.309) + 3.309] \\ &= 0 \end{aligned}$$

After obtaining the initial value results, then for the next calculation perform the same calculation up to $t = 14$. The following is the calculation of the triple exponential smoothing in the 2 and 3 periods to get the triple exponential smoothing value in the 14 period.

$$\begin{aligned} S_2'' &= \alpha S_2'' + (1-\alpha)S_1'' & S_3'' &= \alpha S_3'' + (1-\alpha)S_2'' \\ &= (0,1 \times 3.317,78) + (0,9 \times 3.309) & &= (0,1 \times 3.340,62) + (0,9 \times 3.309,88) \\ &= 3.309,88 & &= 3.312,91 \end{aligned}$$

After obtaining the smoothing value, then calculating the constant value (a), (b) and (c) from periods 2 and 3 to get the constant value in the 14th period.

For constant (a):

$$\begin{aligned} a_1 &= 3S_1' - 3S_1'' + S_1''' & a_2 &= 3S_2' - 3S_2'' + S_2''' \\ &= (3 \times 3.309) - (3 \times 3.309) + 3.309 & &= (3 \times 3.396,80) - (3 \times 3.317,78) + 3.309,88 \\ &= 3.309 & &= 3.546,94 \end{aligned}$$

For constant (b):

$$\begin{aligned} b_2 &= \frac{0,1}{2(1-0,1)^2} [(6-5 \times 0,1)3.396,80 - (10-8 \times 0,1)3.17,78 + (4-3 \times 0,1)3.309,88] \\ &= 25,02 \end{aligned}$$

$$\begin{aligned} b_3 &= \frac{0,1}{2(1-0,1)^2} [(6-5 \times 0,1)3.541,62 - (10-8 \times 0,1)3.340,16 + (4-3 \times 0,1)3.312,91] \\ &= 62,17 \end{aligned}$$

For constant (c):

$$\begin{aligned} c_3 &= \frac{\alpha^2}{(1-\alpha)^2} [S_3' - 2S_3'' + S_3'''] \\ &= \frac{(0,1)^2}{(1-0,1)^2} [3.541,62 - (2 \times 3.340,16) + 3.312,91] \\ &= 2,15 \end{aligned}$$

After obtaining smoothing values and constants, then calculate the forecast value using equation (8).

For $t = 1$ (Year 2008)	For $t = 2$ (Year 2009)
$F_{1+m} = a_1 + b_1 m + \frac{1}{2} c_1 m^2$	$F_{2+m} = a_2 + b_2 m + \frac{1}{2} c_2 m^2$
$F_{1+1} = 3.309 + (0 \times 1) + \frac{1}{2} (0 \times 1^2)$	$F_{2+1} = 3.546,94 + (25,02 \times 1) + \frac{1}{2} (0,88 \times 1^2)$
$F_2 = 3.309$	$F_3 = 3.572,40$

3.3 Finding errors in forecasting

The following are the results of the complete calculation of the MAPE (Mean Absolute Percentage Error) value $\alpha = 0,1$ from parameters to parameters $\alpha = 0,9$ with the Triple Exponential Smoothing Method contained in table 3.

Table 3.2

Parameter	MAPE (<i>Mean Absolute Percentage Error</i>)
0,1	19,91%
0,2	12,01%
0,3	11,65%
0,4	10,61%
0,5	10,21%
0,6	11,20%
0,7	12,72%
0,8	14,12%
0,9	16,21%

Based on the table above, it can be seen that the parameter value that has the smallest MAPE value $\alpha = 0,5$ the value $MAPE = 10,21\%$, so that forecasting can be done with the Double Exponential Smoothing Method with the parameter $\alpha = 0,5$.

3.4 Forecasting the number of divorce rates in North Sumatra with

Here is how to complete forecasting the number of divorce rates in North Sumatra using the Double Exponential Smoothing Method in 2021, 2022 and 2023.

1. Forecasting for the 15 period (Year 2021) (m) = 1

$$F_{t+m} = a_t + b_t m$$

$$F_{2020+1} = 12.998,80 + (-1.129,99 \times 1)$$

$$F_{2021} = 12.998,80 - 1.129,99$$

$$F_{2021} = 11.868,81 \approx 11.869$$

2. Forecasting for the 16 period (Year 2021) (m) = 2

$$F_{t+m} = a_t + b_t m$$

$$F_{2020+2} = 12.2998,80 + (-1.129,99 \times 2)$$

$$F_{2022} = 12.998,80 - (1.129,99 \times 2)$$

$$F_{2022} = 10.738,82 \approx 10.739$$

3. Forecasting for the 16 period (Year 2021) (m) = 3

$$F_{t+m} = a_t + b_t m$$

$$F_{2020+3} = 12.998,80 + (-1.129,99 \times 3)$$

$$F_{2023} = 12.998,80 - (1.129,99 \times 3)$$

$$F_{2023} = 9.608,83 \approx 9.609$$

Here's how to complete forecasting the number of divorce rates in North Sumatra with the Triple Exponential Smoothing Method in 2021, 2022 and 2023.

1. Forecasting for the 15 period (Year 2021) (m) = 1

$$F_{t+m} = a_t + b_t m + \frac{1}{2} c_t m^2$$

$$F_{2020+1} = 13.440,56 + (-485,42)(1) + \frac{1}{2}(-380,79)(1^2)$$

$$F_{2021} = 13.817,18 - 485,42(1) - \frac{1}{2} \times 380,79(1^2)$$

$$F_{2021} = 12.764,74 \approx 12.765$$

2. Forecasting for the 16 period (Year 2021) (m) = 2

$$F_{t+m} = a_t + b_t m + \frac{1}{2} c_t m^2$$

$$F_{2020+2} = 13.440,56 + (-485,42)(2) + \frac{1}{2}(-380,79)(2^2)$$

$$F_{2022} = 13.817,18 - 485,42(2) - \frac{1}{2} \times 380,79(2^2)$$

$$F_{2022} = 11.708,14 \approx 11.708$$

3. Forecasting for the 16 period (Year 2021) (m) = 3

$$F_{t+m} = a_t + b_t m + \frac{1}{2} c_t m^2$$

$$F_{2020+3} = 13.440,56 + (-485,42)(3) + \frac{1}{2}(-380,79)(3^2)$$

$$F_{2023} = 13.817,18 - 485,42(3) - \frac{1}{2} \times 380,79(3^2)$$

$$F_{2023} = 10.270,74 \approx 10.271$$

4 CONCLUSION

Based on the results obtained in the discussion chapter that has been carried out by researchers regarding the Application of the Triple Exponential Smoothing Method in the Number of Divorce Rates in North Sumatra, the authors draw a conclusion, namely the calculation of the Triple Exponential Smoothing Method which produces the best parameter values obtained for forecasting the number of divorce rates in North Sumatra. North Sumatra is with a MAPE value of 10,21% and the equation for forecasting the number of divorce rates in North Sumatra is: . The results of forecasting the number of divorce rates in North Sumatra from 2021-2023 are:

Table 4.1 of Forecasting Results of the Number of Divorce Rates in North Sumatra

Year	Divorce Data (case)
2021	12.765
2022	11.708
2023	10.271

The results of forecasting the number of divorce rates in North Sumatra obtained using the Triple Exponential Smoothing Method have increased in 2021 and decreased in 2022 and 2023.

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