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IMPLEMENTATION OF EXPONENTIAL SMOOTHING METHOD IN THE NUMBER OF DIVORCE RATE IN INDONESIA

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ABSTRACT

The divorce rate in Indonesia from 2007 to 2020 has increased. The increase in the divorce rate in Indonesia has an impact on the mental condition of children. The purpose of this study is to find out the results of the number of divorce rates in Indonesia in 2021-2022 and to see which accuracy is more accurate between the Double Exponential Smoothing Method and the Triple Exponential Smoothing Method. Comparison between the Double Exponential Smoothing Method and the Triple Exponential Smoothing Method which has more accurate forecasting, namely the Double Exponential Smoothing Method with parameter values $\alpha = 0,4$ and the MAPE value of 14.27%, the equation for forecasting the divorce rate in Indonesia is $F_{t+m} = 303156,03 - 17253,47(m)$. The results of the study show that the divorce rate in Indonesia will increase in 2021 with 285,903 cases and decrease in 2022 with 268,649 cases.

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1. INTRODUCTION

Divorce is the end of a marital relationship that is no longer harmonious between husband and wife. Arguments 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, the occurrence of domestic violence (KDRT) which resulted in shaking up marriages. That's when the marriage begins to falter, and if the husband and wife cannot maintain their marriage, it will end in divorce.

In the case of divorce in Indonesia, the divorce rate changes every year. Based on data from the Central Statistics Agency of the Republic of Indonesia (BPSI), every year the divorce rate in Indonesia has increased. This shows that many married couples decide to divorce due to several factors. To know the development of divorce in the future, forecasting is needed to find out when an increase in the divorce rate will occur, so it is necessary to prepare to deal with the surge in the divorce rate in the future. 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 the forecasting of the latest observational data.

2. RESEARCH METHODE

2.1 Data collection technique

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 Indonesia.

2.2 Data analysis technique

2.2.1 Double Exponential Smoothing

The stagesDouble Exponential Smoothingthe calculation procedure is:

1)Parameter Value Determination

2)Calculating single exponential smoothing value

$$S_t^{'} = \alpha X_t + (1-\alpha) S_{t-1}^{'} \tag{1}$$

3)Calculating the double exponential smoothing value

$$S_t^{''} = \alpha S_t^{''} + (1-\alpha) S_{t-1}^{''} \tag{2}$$

4) Determine the value of constants (at) and (bt)

$$a_t = 2S_t^{'} - S_t^{''}$$

$$b_t = \frac{\alpha}{1-\alpha}\left(S_t^{'} - S_t^{''}\right) \tag{3}$$

5) Determine the forecast value calculated using the equation

$$F_{t+m} = a_t + b_t m \tag{4}$$

2.2.2 Triple Exponential Smoothing

The stagesTriple Exponential Smoothingthe calculation procedure is:

1)Parameter Value Determination

2)Calculate the triple exponential smoothing value

$$S_t^{'''} = \alpha S_t^{''} + (1-\alpha) S_t^{'''} \tag{5}$$

3)Determine the constant values (at), (bt) and (ct)

$$a_t = 3S_t^{'} - 3S_t^{''} + S_t^{'''} \tag{6}$$

$$b_t = \frac{\alpha}{2(1-\alpha)^2}\left[(6-5\alpha) S_t^{'} - (10-8\alpha) S_t^{''} + (4-3\alpha) S_t^{'''}\right] \tag{7}$$

$$c_t = \frac{\alpha^2}{(1-\alpha)^2}\left[S_t^{'} - 2S_t^{''} + S_t^{'''}\right] \tag{8}$$

4)Determine the forecast value calculated using the equation

$$F_{t+m} = a_t + b_t m + \frac{1}{2} c_t m^2 \tag{9}$$

2.2.3 Determine the magnitude of the forecast error percentage

Determine the percentage of forecasting errors from the double exponential smoothing method and the triple exponential smoothing method with the following equation:

$$MAPE = \frac{1}{n}\left(\sum_{t=1}^{n}\frac{\left|X_t - F_t\right|}{X_t}\right)\times 100\% \quad (10)$$

2.2.4 Predicting double exponential smoothing and double exponential smoothing

Forecasts for the future on the double exponential smoothing method are calculated by equation (4) and for the future on the double exponential smoothing method are calculated by equation (9).

3 RESULT AND ANALYSIS

3.1 Data collection

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

Table 3.1 Data on Divorce Rates in Indonesia for 2007-2020

Year	Divorce Data (case)
2007	175,713
2008	193.189
2010	285,184
2011	276,791
2012	346,480
2013	324,247
2014	344,237
2015	347,256
2016	365,633
2017	374,516
2018	408.202
2019	439,002
2020	219,677

3.2 Double Exponential Smoothing

In calculating the smoothing value, the initial value is determined using equations (1), (2), and (3). So that the initial value of the period is obtained as follows:

Determination of the initial smoothing value $S_1^{'}$ and $S_1^{''}$

$$S_1^{'} = S_1^{''} = X_t$$

$$S_1^{'} = S_1^{''} = 175.713$$

Determination of initial values of constants (at) and (bt) Determination of initial values of constants (at) and (bt)

$$\begin{aligned} a_1 &= 2S_t^{'} - S_t^{''} \\ &= \left(2\times 175.713\right) - 175.713 \\ &= 175.713 \end{aligned}$$

After getting the initial value results, then for the next calculation do the same calculation until t = 14. The following is the calculation of the double exponential smoothing in period 2 to get the double exponential smoothing value in the 14th period.

$$\begin{aligned} S_2^{''} &= \left(0{,}1\times S_2^{'}\right) + \left(1-0{,}1\right) S_1^{''} \\ &= \left(0{,}1\times 177460{,}60\right) + \left(1-0.1\right) 175.713 \\ &= \left(0{,}1\times 177460{,}60\right) + \left(0{,}9\times 175.713\right) \\ &= 175.887{,}76 \end{aligned}$$

After obtaining the smoothing value, then calculate the constant value (at) and (bt) from period 2 to get the constant value in period 14.

For constants (on):

$$\begin{aligned} a_2 &= 2S_t^{'} - S_t^{''} \\ &= \left(2 \times 177460,60\right) - 175887,76 \\ &= 179.033,44 \end{aligned}$$

For constants (bt):

$$\begin{aligned} b_2 &= \frac{0,1}{1-0,1}\left(S_2^{'} - S_2^{''}\right) \\ &= \frac{0,1}{0,9}\left(177460,60 - 175887,76\right) \\ &= 174,76 \end{aligned}$$

After getting the smoothing and constant values, then calculate the forecast value using equation (5).

For t = 1 (Year 2008)

$$\begin{aligned} F_{1+1} &= a_1 + \left(b_1 \times 1\right) \\ F_2 &= 175.713 + \left(0 \times 1\right) \\ F_2 &= 175.713 \end{aligned}$$

For t = 2 (Year 2009)

$$\begin{aligned} F_{2+1} &= a_2 + \left(b_2 \times 1\right) \\ F_3 &= 179033,44 + \left(174,76 \times 1\right) \\ F_3 &= 179208,20 \end{aligned}$$

Until the calculation, for t = 3 to t = 13 using the same calculation.

3.3 Triple Exponential Smoothing

In calculating the smoothing value, the initial value is determined using equations (6), (7), (8) and (9). So that the initial value of the period is obtained as follows:

Determination of the initial smoothing value, $S_1^{'}$, $S_1^{''}$ and $S_1^{'''}$

$$S_1^{'} = S_1^{''} = S_1^{''} = X_t$$

$$S_1^{'} = S_1^{''} = S_1^{''} = 175.713$$

Determination of the initial values of constants (at), (bt) and (ct)

$$\begin{aligned} a_1 &= 3S_1^{'} - 3S_1^{''} + S_1^{'''} \\ &= \left(3 \times 175.713\right) - \left(3 \times 175.713\right) + 175.713 \\ &= 175.713 \end{aligned}$$

$$b_1 = \frac{0,1}{2\left(1-0,1\right)^2}\left[\left(6-5\times 0,1\right)175.713 - \left(10-8\times 0,1\right)175.713 + \left(4-3\times 0,1\right)175.713\right]$$

$$= 0$$

$$\begin{aligned} c_1 &= \frac{\alpha^2}{\left(1-\alpha\right)^2}\left[S_1^{'} - 2S_1^{''} + S_1^{'''}\right] \\ &= \frac{\left(0,1\right)^2}{\left(1-0,1\right)^2}\left[175.713 - \left(2 \times 175.713\right) + 175.713\right] \\ &= 0 \end{aligned}$$

After getting the initial value results, then for the next calculation perform the same calculation until t = 14. The following is the calculation of the triple exponential smoothing in period 2 to get the triple exponential smoothing value in the 14th period.

$$\begin{aligned} S_2^{'''} &= \alpha S_2^{''} + \left(1-\alpha\right)S_1^{'''} \\ &= \left(0,1 \times 175887,76\right) + \left(0,9 \times 175.713\right) \\ &= 175.730,48 \end{aligned}$$

After obtaining the smoothing value, then the constant values (at), (bt) and (ct) from period 2 are calculated to get constant values in the 14th period.

For constants (on):

$$\begin{aligned} a_1 &= 3S_1' - 3S_1'' + S_1''' \\ &= \left(3\times 175.713\right) - \left(3\times 175.713\right) + 175.713 \\ &= 175.713 \end{aligned}$$

For constants (bt):

$$b_2 = \frac{0,1}{2\left(1-0,1\right)^2}\left[\left(6-5\times 0,1\right)177460,60 - \left(10-8\times 0,1\right)175887,76 + \left(4-3\times 0,1\right)175730,48\right]$$

$$= 498,07$$

For constants (ct):

$$\begin{aligned} c_3 &= \frac{\alpha^2}{\left(1-\alpha\right)^2}\left[S_3' - 2S_3'' + S_3'''\right] \\ &= \frac{\left(0,1\right)^2}{\left(1-0,1\right)^2}\left[182051,64 - \left(2\times 176504,15\right) + 175807,84\right] \\ &= 59,89 \end{aligned}$$

After getting the smoothing and constant values, then calculate the forecast value using equation (10).

For t = 1 (Year 2008)

$$F_{1+m} = a_1 + b_1 m + \frac{1}{2}c_1 m^2$$

$$F_{1+1} = 175.713 + \left(0\times 1\right) + \frac{1}{2}\left(0\times 1^2\right)$$

$$F_2 = 175.713$$

For t = 2 (Year 2009)

$$F_{2+m} = a_2 + b_2 m + \frac{1}{2}c_2 m^2$$

$$F_{2+1} = 180449,00 + \left(498,07\times 1\right) + \frac{1}{2}\left(17,48\times 1^2\right)$$

$$F_3 = 180.955,80$$

3.4 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 parameter to parameter $\alpha = 0,9$ with the Double Exponential Smoothing Method contained in table 2.

Table 3.2

Parameter	MAPE(Mean Absolute Percentage Error)
0.1	23.19%
0.2	16.11%
0.3	14.36%
0.4	14.27%
0.5	14.49%

0.6	14.73%
0.7	14.99%
0.8	15.63%
0.9	16.45%

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

Table 3.3

Parameter	MAPE(Mean Absolute Percentage Error)
0.1	18.44%
0.2	15.33%
0.3	15.36%
0.4	15.22%
0.5	15.35%
0.6	15.95%
0.7	17.16%
0.8	18.86%
0.9	21.21%

Based on the table above, it can be seen that the parameter value that has the smallest MAPE value is $\alpha = 0,4$ is a parameter with value $MAPE = 14,27\%$ for the Double Exponential Smoothing Method while the parameter with a value for the Triple Exponential Smoothing Method, so that forecasting can be done using the Double Exponential Smoothing Method with parameters $\alpha = 0,4$.

3.5 Forecasting the number of divorce rates in Indonesia with

The following is a complete way of forecasting the divorce rate in Indonesia using the Double Exponential Smoothing Method in 2021 and 2022.

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

$$F_{t+m} = a_t + b_t m$$
$$F_{2020+1} = 303.156,03 + (-17.253,47 \times 1)$$
$$F_{2021} = 303.156,03 - 17.253,47$$
$$F_{2021} = 285.902,56 \approx 285.903$$

2. Forecasting for period 16 (Year 2022) $(m) = 2$

$$F_{t+m} = a_t + b_t m$$
$$F_{2020+2} = 303.156,03 + (-17.253,47 \times 2)$$
$$F_{2022} = 303.156,03 - (17.253,47 \times 2)$$
$$F_{2022} = 268.649,09 \approx 268.469$$

The following is a complete way of forecasting the number of divorce rates in Indonesia with the Triple Exponential Smoothing Method in 2021 and 2022.

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

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

$$F_{2020+1} = 271.792,39 + (-66.041,36)(1) + \frac{1}{2}(-13.939,40)(1^2)$$

$$F_{2021} = 271.792,39 - 66.041,36(1) - \frac{1}{2} \times 13.939,40(1^2)$$

$$F_{2021} = 198.781,33 \approx 198.781$$

2. Forecasting for period 16 (Year 2022) $(m)=2$

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

$$F_{2020+2} = 271.792,39 + (-66.041,36)(2) + \frac{1}{2}(-13.939,40)(2^2)$$

$$F_{2022} = 271.792,39 - 66.041,36(2) - \frac{1}{2} \times 13.939,40(2^2)$$

$$F_{2022} = 111.830,87 \approx 11.831$$

4 CONCLUSION

Based on the results obtained in the discussion chapter that has been carried out by researchers regarding the application of the Exponential Smoothing Method to Divorce Rates in Indonesia, the authors draw a conclusion, namely the calculation of the Double Exponential Smoothing Method which produces the best parameter values obtained for forecasting the number of divorce rates in Indonesia. Indonesia with a MAPE value of 14.27% and the equation for forecasting the divorce rate in Indonesia is: . The results of forecasting the divorce rate in Indonesia in 2021-2022 are:

Table 4.1 Results of Forecasting the Number of Divorce Rates in Indonesia

Year	Divorce Data (case)
2021	285,903
2022	268,649

The results of forecasting the number of divorce rates in Indonesia obtained using the Double Exponential Smoothing Method will increase in 2021 and decrease in 2022.

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