Poverty Line Forecasting Model Using Double Exponential Smoothing Holt’s Method

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Abstract. The research aims to forecast the Poverty Line, to help a government obtain accurate and fast information. The method used in this research is Double Exponential Smoothing Holt’s Method. This method is a part of the data based on time series analysis. The research applies the forecasting theory to produce a poverty line forecast for the coming year. Next, this research is analyzing data patterns and determine the best parameter values. Double Exponential Smoothing Holt’s method uses the parameters Alpha (α) and Gamma (γ). To determine the best parameter value is to use the trial and error method. The best parameter value produces the smallest value of MAPE (Mean Absolute Percentage Error). The data pattern shows the trend, meaning that the Double Exponential Smoothing Holt’s method is appropriate to be used in this research. The parameter values generated from the trial and error methods are Alpha (α) of 0.7 and Gamma (γ) of 0.1, which produced the smallest measure of accuracy, in this research using MAPE. By observing the results of the forecasting that has been done, this forecasting model has a very good performance. Poverty Line value will keep increasing, in accordance with increasing consumption patterns and rising prices of basic necessities.

1. Introduction
Poverty is a complex multidimensional problem, not only measured by income but also involves vulnerability and vulnerability of people or groups of people both men and women to be poor [1]. To measure poverty, Statistics of Indonesia (BPS) uses the ability to meet basic needs. Poverty is seen as an economic inability to fulfil basic food and non-food needs as measured by expenditure. Reducing poverty and inequality in income distribution is the core of all development problems and is the main goal of development policies in many countries [2]. The problem of poverty is one of the fundamental issues that are the center of attention of the government in any country. International commitments in poverty reduction are contained in the Sustainable Development Goals (SDGs) as a continuation of the Millennium Development Goals (MDGs) agreed upon by 193 countries in September 2015. Many poverty alleviation programs have been carried out, such as cash assistance for communities “top-down” to empowerment programs in other communities [3]. One important aspect to support the poverty reduction strategy is the availability of accurate data and information about poverty. Measuring poverty that can be trusted can be a powerful instrument for policymakers in focusing attention on the living conditions of the poor. A good poverty rate can be used to evaluate government policies in efforts to reduce poverty, compare poverty between time and region, and determine the target of poor people with the aim of improving their condition.
There are many methods used to measure poverty in an area. According to BPS, the poor are residents who have an average per capita expenditure per month below the poverty line [4]. To measure poverty in Indonesia, BPS uses the concept of basic need approach. With this approach, poverty is seen as an economic inability to meet basic needs for both food and non-food measured in terms of expenditure [5]. The World Bank in measuring poverty is the achievement of a decent life with an income of US $1 per day per capita.

The poverty line is a representation of the minimum amount of Rupiah (IDR) needed to meet the minimum basic food needs which is equivalent to 2100 kilos of calories per capita per day and non-food staples [6].

One reason is the lack of prevention of poverty in an area due to a lack of information about poverty. For this reason, a method is needed to determine the existence of poverty in the future, as an effort to reduce poverty in an area. Based on the background above, research on forecasting Poverty Lines for the future is needed, as an early warning of the government in overcoming the problem of poverty, because the Poverty Line is a variable used to calculate the number of poor people. The purpose of this research is "Forecasting the Poverty Line using the Double Exponential Smoothing Holt’s method". The method used is for data that has a linear trend that shows straight line equations that are formed based on scatter diagram points of data over a period of time. Trend models are usually used to predict a long-term forecast.

Forecasting is the art and science of predicting future events. Forecasting may involve taking historical data and projecting them into the future with some sort of mathematical model. It may be a subjective or intuitive prediction [7].

This forecasting model uses the Double Exponential Smoothing Holt’s method. The first step in forecasting with the Double Exponential Smoothing Holt’s method is to plot the data first to find out the data pattern. The second step is the estimation or determination of parameters namely alpha (α) and gamma (γ). The alpha parameter (α) is used to smooth the original data periodically while smoothing the trend. This method uses two alpha and gamma parameters. In this research, the best parameter values produced were alpha = 0.7 and gamma 0.1 which produced the smallest MAPE value. The next step is to forecast data for the coming year. The Poverty Line forecasting results will keep increasing due to changes in consumption patterns and increases in prices of basic necessities. The forecasting model can be used as a tool for the government and other stakeholders in planning and policy in reducing short-term and long-term poverty. The purpose of this research to predict the Poverty Line in West Java using the Double Exponential Smoothing Holt ‘s method as a reference data and information for planning in order to alleviate poverty and determine the performance of the Poverty Line forecasting model using the Double Exponential Smoothing Holt’s method.

2. Methods
The method used in this writing is descriptive method, which is a method that focuses on solving problems. In this research, the author uses a quantitative research approach method. Quantitative methods that present data mostly in the form of numbers and data analysis used are statistics. With a statistical approach, in this research using the Double Exponential Smoothing method. This method is used when data shows trends. Exponential leveling with trends functions like simple leveling except that two components must be updated at each period and trend level. The estimated level of estimated data is refined at the end of each period. This trend is an estimate of smooth average growth at the end of the period [8]. There are two methods in double exponential smoothing, namely Double Exponential Smoothing Brown’s method and Double Exponential Smoothing Holt’s method.

3. Result and Discussion
This research uses the Double Exponential Smoothing Holt’s method. This method does not use the multiple smoothing formulae directly, instead, Holt smoothes the trend value with different parameters from the two parameters used in the original series [9].
In this research, the data used for forecasting is secondary data, namely the Poverty Line data for 2005 - 2017 in West Java, the data was obtained from the BPS of West Java Province. Data can be seen in Table 1.

| Period | Poverty Line (IDR) |
|--------|--------------------|
| 2005   | 133,701            |
| 2006   | 149,673            |
| 2007   | 165,734            |
| 2008   | 190,788            |
| 2009   | 220,068            |
| 2010   | 201,138            |
| 2011   | 226,097            |
| 2012   | 242,104            |
| 2013   | 276,825            |
| 2014   | 291,474            |
| 2015   | 306,876            |
| 2016   | 324,992            |
| 2017   | 344,427            |

Source: BPS of West Java Province (processed)

Table 1 is the poverty line data of West Java Province 2005 - 2017 which is a recapitulation and the average value of Poverty Lines from 27 Regencies and Cities in West Java Province. Judging from these data, it is suspected that the Poverty Line data pattern has a trend data pattern, so researchers used the Double Exponential Smoothing method in this research.

The method used in forecasting uses the Double Exponential Smoothing Holt’s method. The first step in forecasting with the Double Exponential Smoothing Holt’s method is to plot the data first to find out the data pattern. This step aims to determine the trend, cycle, seasonal, random or stationary components.

The results of the data series pattern from the actual data are plotted and the results are presented in Figure 1. The data plot of the Poverty Line in West Java in 2005-2017.

Figure 1 shows that the Poverty Line pattern shows the data pattern is a linear trend, so a good and appropriate method to use is the Double Exponential Smoothing Brown’s method and Double
Exponential Smoothing Holt’s method. The method to be used is Double Exponential Smoothing Holt’s method. This method uses two smoothing parameters alpha (\( \alpha \)) and gamma (\( \gamma \)), in smoothing out linear trend data. The Double Exponential Smoothing Holt’s method does not use the multiple smoothing formulae directly.

The second step is the estimation or determination of parameters namely alpha (\( \alpha \)) and gamma (\( \gamma \)). The alpha parameter (\( \alpha \)) is used to smooth the original data periodically while smoothing the trend. Parameter values between 0 and 1 [10]. Determining the value of these parameters can be done by means of trial and error. This parameter determines the difference between the forecasting value and the actual data. When the alpha value approaches 1, the weight given to the latest data is greater so the smoothing effect is small. Conversely, when the alpha value approaches 0, it will give a small response to the latest data, so that the smoothing effect is large.

Determination of alpha (\( \alpha \)) and gamma (\( \gamma \)) parameters in practice only takes a limited range of values, although theoretically alpha (\( \alpha \)) and gamma (\( \gamma \)) can be considered to be worth 0 and 1. Because of the choice of alpha (\( \alpha \)) and gamma (\( \gamma \)), this narrowed, the Double Exponential Smoothing method is usually seen as a more easily implemented method [11]. The gamma parameter (\( \gamma \)) is used to eliminate a bit of flexibility in the data generated during forecasting. Using the trial and errors method in determining the optimal alpha (\( \alpha \)) and gamma (\( \gamma \)) parameter values produce alpha = 0.7 and gamma 0.1 which produces the smallest MAPE value of 3.005 % [12, 13, 14]. In this research, measurement of forecasting accuracy uses MAPE values. MAPE value is a measure of relative accuracy to determine the percentage deviation of forecasting results, it shows that the MAPE value produces a percentage of errors from forecasting results [15].

The third step is processing the Poverty Line data in Table 1. The results of processing data produce forecast values can be seen in Table 2.

**Table 2. Poverty Line Data Processing Results using Double Exponential Smoothing Holt’s Method (IDR), 2005 – 2017**

| Time  | Poverty Line | Smooth | Predict | Difference |
|-------|--------------|--------|---------|------------|
| 2005  | 133,701      | 133,254| 132,210 | 1,4910     |
| 2006  | 149,673      | 149,991| 150,732 | -1,0590    |
| 2007  | 165,734      | 166,232| 167,395 | -1,6609    |
| 2008  | 190,788      | 188,608| 183,520 | 7,2678     |
| 2009  | 220,068      | 215,969| 206,404 | 13,6637    |
| 2010  | 201,138      | 211,213| 234,722 | -33,5840   |
| 2011  | 226,097      | 226,553| 227,615 | -1,5184    |
| 2012  | 242,104      | 242,327| 242,848 | -0,7445    |
| 2013  | 276,825      | 271,349| 258,571 | 18,2538    |
| 2014  | 291,474      | 290,693| 288,870 | 2,6035     |
| 2015  | 306,876      | 307,332| 308,397 | -1,5208    |
| 2016  | 324,992      | 324,973| 324,930 | 0,0624     |
| 2017  | 344,427      | 343,871| 342,575 | 1,8519     |

Table 2 shows the results of the Poverty Line forecasting for the period 2005 - 2017 where the forecasting value in each period shows an increasing trend, but the accuracy of the forecasting value can be seen forecasting value that is close to its actual value. The forecasting value that is closest to the
actual value is in 2016 which is IDR 62.4, while the forecasting value with a large difference is in 2010 where the error value or the difference in the calculation is IDR (33.580).

While the forecasting value for the future, namely forecasting for the period 2018 - 2020, can be seen in Table 3.

| Period | Forecasting Result (IDR) | Lower (IDR) | Upper (IDR) |
|--------|--------------------------|-------------|-------------|
| 2018   | 361,603                  | 345,531     | 377,675     |
| 2019   | 379,334                  | 359,043     | 399,625     |
| 2020   | 397,66                   | 372,189     | 421,942     |

Table 3 shows the results of forecasting for the coming year, where the Poverty Line continues to increase every year, this is because the Poverty Line is influenced by the amount of public consumption and the increase in commodity prices, so the value of expenditure will continue to increase. The next step is to make the Poverty Line forecasting plot shown in Figure 2.

Figure 2, shows the actual variables, fits, forecast, and 95% PI. This graph reflects smoothing constant Alpha (α) of 0.7 and Gamma (γ) of 0.1. Accuracy Measure values from MAPE, MAD, and MSD are also presented. The accuracy of MAPE 3.005%, MAD 6,650 and MSD 132.469 [16, 17]. A model has a very good performance if the MAPE value is below 10%, and has a good performance if the MAPE value is between 10% and 20% [18].

Analysis of forecasting models this poverty line is a data pattern that has a trend linear, so the Double Exponential Smoothing Holt’s method is very appropriate to be used. The optimal parameters generated using the trial and error method are alpha = 0.7 and gamma = 0.1 with the results of the MAPE value of 3.005%. The MAPE value shows the percentage of forecasting errors of 3.005%, with MAPE values below 10%, this forecasting model has a very good performance. The Poverty Line value for the coming year continues to show an increase in value every year and the data pattern is trend linear. The factors that influence the value of the increase in the poverty line are the consumption patterns of the people, the high rate of inflation due to rising prices especially commodities for basic needs, and the phenomenon of government policies in the economic field. This forecasting model can be used for the long term because this model produces a forecast error of 3.005% according to the MAPE value. The
forecasting model is expected to be used as a tool for the government and other stakeholders in planning and policy in reducing poverty in the short and long term.

4. Conclusion
Utilization of information systems is required to process data and information that helps the government and stakeholders in the context of poverty alleviation. Poverty Line forecasting is very useful for knowing the future situation regarding poverty, so that the government and stakeholders can anticipate phenomena that can affect the increase in the poverty line. This model is the right model used in poverty line forecasting where forecasting deviations are very small, which is below 10%. This shows a very good performance.

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