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Utilizing Single Exponential Smoothing for Early Detection and Forecasting of Stunting Cases in Madura

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Abstract. Stunting is still a serious public health concern in Indonesia. Stunting can have a negative impact on children's health and development, as well as their productivity and learning abilities as adults. Efforts to eliminate stunting in Indonesia have been made in recent years, however there are still many cases that were not identified early and were not appropriately treated. Predicting the health of stunted individuals is thus one approach to this problem. Forecasting can benefit from the Single Exponential Smoothing technique. This method may be useful for diagnosing cases of stunting early and providing appropriate preventative actions. The purpose of this research is to create a prediction model for the number of stunted patients using the Single Exponential Smoothing method. This study relied on nutritional status data for children from 2018 to 2022. The Single Exponential Smoothing technique is used to anticipate future data by taking patterns in past data into consideration. The alpha value chosen was 0.5 by repeating the method and 0.1 as the second alpha value. This has caused the error value to drop by 10%. The outcomes of this study are expected to help connected parties design programs to address nutritional concerns more effectively and efficiently, enhance the quality of local community health, and aid in future planning and decision making in efforts to eliminate stunting.

INTRODUCTION

Madura is an archipelago in the Indonesian province of East Java, northeast of Java. Madurese people primarily engage in agriculture, fishing, and plantation industries, as well as salt processing and handicrafts. Tourists are drawn to Madura because of its distinct culture and traditions [1,2]. The evolution of Madurese society has been marked by several changes over time. In terms of economic development, the industrial and tourism industries are both expanding in this region. In terms of education, the government is working hard to increase educational quality in the Madura region. More and more high-quality schools are being created and supported by highly qualified teachers. The quality of human resources in the Madura region is predicted to improve as a result of this.

In the health sector, the government is likewise working to increase access and quality of care in this region. Various health activities, including as immunization and free treatment, are still being implemented to enhance the health of the Madurese people who are participating and still require attention [3]. In comparison to other regions in Indonesia, the level of health in the Madura region remains relatively poor [4]. According to Ministry of Health data, life expectancy in the Madura area would be about 71 years in 2020, which is lower than the national average of 72 years. Nutritional issues such as stunting, wasting, and underweight remain important public health concerns in this region. Aside from that, access to competent health care in various regions of Madura remains restricted. Efforts to

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promote health in the Madura area must include integrated and long-term health programs, as well as increased access to health services and nutrition education. Overall, the growth of Madurese society is keeping pace with the changes, and the government is working hard to enhance the quality of life for Madurese citizens via different programs and policies.

Stunting is a disorder in which children fail to develop as a result of chronic malnutrition that happens over time [5-7]. This disorder develops when children do not receive adequate nourishment between the ages of 0 and 2 years [8]. Stunting has a negative influence on future height, intellect, endurance, and productivity. Stunting prevention initiatives include ensuring enough nutritional intake during the child's growth phase, as well as treating stunted youngsters with proper health care and adequate nourishment. Stunting is a nutritional issue that persists in many nations, including Indonesia. In Indonesia, stunting is a severe nutritional concern, particularly in children under the age of five. Around 27.67% of Indonesian children are stunted, according to the 2019 Nutrition Status Survey. This figure is rather high, and it is a major source of concern for the government in its efforts to solve Indonesia's malnutrition problem [9-13].

Similar issues exist in the Madura area. Stunting frequency in the Madura area reached 31.68%, according to statistics from the East Java Provincial Health Service. This statistic is relatively high when compared to East Java Province's overall stunting prevalence rate of 27.87%. Lack of access to healthy food, poor levels of education and maternal nutrition expertise, and a lack of proper health facilities are all factors that contribute to the high frequency of stunting in the Madura area [14,15]. Stunting can also have a significant influence on children's health and development, as well as adult productivity and learning ability. As a result, measures are required to address the stunting issue in the Madura region. One solution to the challenge outlined above is to forecast the state of stunting in order to aid in planning and decision making in efforts to combat stunting in the region.

A stunting forecasting study was carried out using UNICEF prevalence data from 150 countries. The study estimates a decline in malnutrition cases to 21.7 million by 2030, with India accounting for 52% of this decline. This research uses forecasting to test the sensitivity of estimates to changes in statistical model assumptions. The results suggest that there may be little progress in reducing the burden on Social Affairs Management (SAM), with progress mainly concentrated in countries in transition [16]. The study examined global trends and forecasts of disability-adjusted life years (DALYs) and mortality from hunger and obesity until 2030. Data from the 2019 Global Burden of Disease research, spanning 204 countries and territories, was used to analyze trends from 2000 to 2019. Malnutrition was defined using the 10th version of the International Classification of Diseases, and countries were categorized into four SDI bands. Regression models were developed to forecast DALYs and mortality through 2030 [17]. In another hand, advances in remote sensing and machine learning are enabling increasingly accurate, inexpensive, and timely predictions of malnutrition indicators to drive development programs and humanitarian agencies. These can be used for mapping, geographic targeting, or monitoring and evaluation tasks, and can be input into early warning systems [18]. Predicting stunting is significant because it can assist identify children who are at risk and enable for early intervention to prevent stunting, build successful interventional trials, understand the underlying pathophysiology of stunting, and identify risk variables linked with stunting. Predicting stunting can assist identify children at risk and allow for early intervention to avoid stunting.

METHODS

The stage of designing a stunting status prediction system is by carrying out the literature study and observation stages, collecting the necessary data accompanied by data plots, forecasting models using Single Exponential Smoothing, ending with getting forecasting results, as in Figure 1.

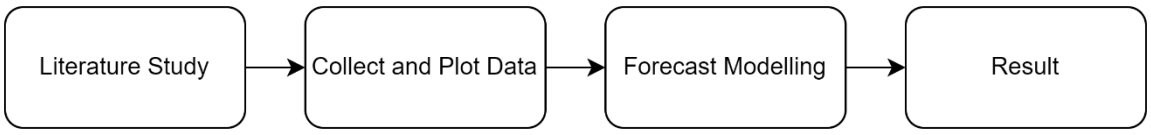


FIGURE 1. Research methodology

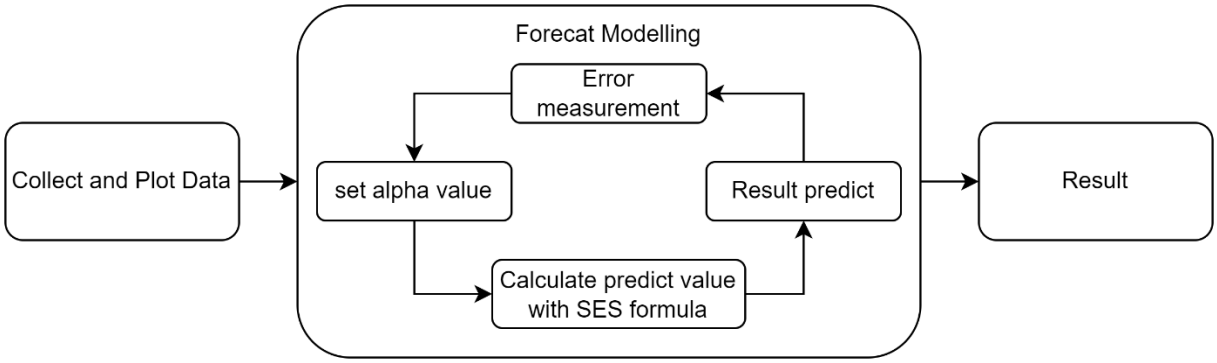


FIGURE 2. Diagram flow SES

The stage begins with a literature review in which we look at hypotheses about predicting stunting status, time series data, and the single exponential smoothing approach. Direct observations were made at the Madura region's Central Statistics Agency and the Health Service. The second stage is data collection for dataset requirements. The dataset utilized is the number of instances of stunting documented at the statistics data center and the health service. Stunting data from the past gives information about the nutritional status of children and toddlers throughout time. This data might be used to discover trends or patterns of increase or decrease in stunting status among children and toddlers. Historical data on stunting status is especially valuable as training data for prediction models in research on anticipating the condition of stunting patients.

Data plotting is compared to data distribution graphically. Plotting stunting status data is a graphical way of displaying historical stunting status data. This graph can help with quantitative and qualitative examination of stunting status data trends or patterns. This enables us to establish if stunting status increases or decreases over time, as well as whether there is a seasonal trend. Aside from that, displaying stunting status data can help in determining the appropriate forecasting method to use in projecting future stunting status. At the forecasting model stage, the single exponential smoothing technique is utilized to carry out the forecasting process or predict the number of stunting patients in the Madura region. For predicting, the Single Exponential Smoothing approach was employed.

The Single Exponential Smoothing (SES) technique is a forecasting approach that predicts values over a specific time period. This approach is excellent for predicting data with weak trend patterns and seasonal patterns [19]. The SES technique simply considers one variable, historical data, and does not include external influences or other variables that may impact the data. Future forecasting in this approach is based on a weighted average of prior data generated using a constant (alpha or α). The larger the alpha, the greater the weight of prior data and the greater the effect on predicting [20,21]. SES is a forecasting approach used to anticipate data with a weak trend and/or seasonality, as well as data with no trend or seasonality. The SES procedure is divided into five steps (Figure 2):

- The initiation process is where a baseline is taken. This initial value will be used as an initial forecast.
- The forecasting process uses the SES forecasting formula (Eq. 1).

$$F_t = \propto * \mathrm{Y}_t + (1 - \propto) * F_t - 1 \tag{1}$$

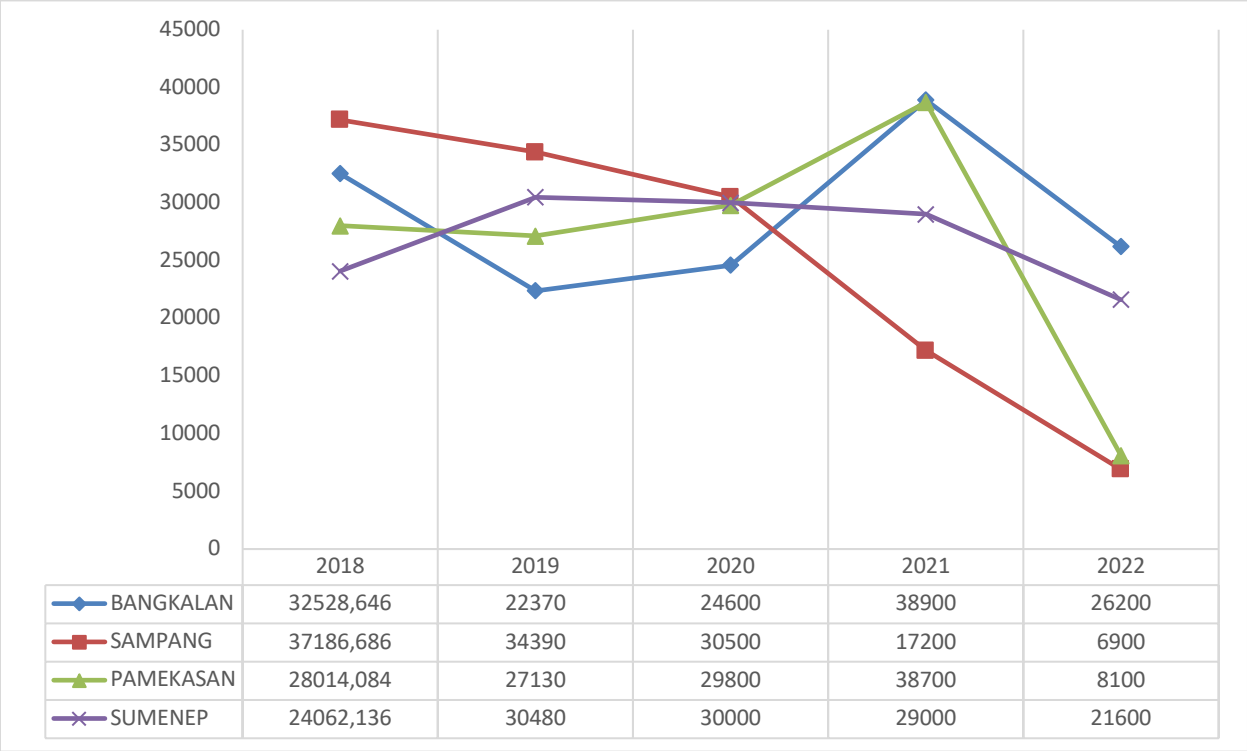
- The process of setting the α value by adjusting this value to obtain a more accurate forecasting value. A good α value is the value that produces the smallest error value between actual data and forecast data.
- The assessment process is to compare actual data to find out how accurate the forecasting is. calculations to describe data using error tests to provide an indication of how large the forecast error is compared to the actual value. The level of error testing used in this research is MAPE (Mean Absolute Percentage Error).
- Repetitive process, the SES process can be repeated by updating the alpha value and initial forecasting value at each iteration. This is done to get more accurate forecasting.

This calculating procedure will provide a time series of projected values for each future period. This time series may be analyzed and utilized to make decisions.

RESULTS

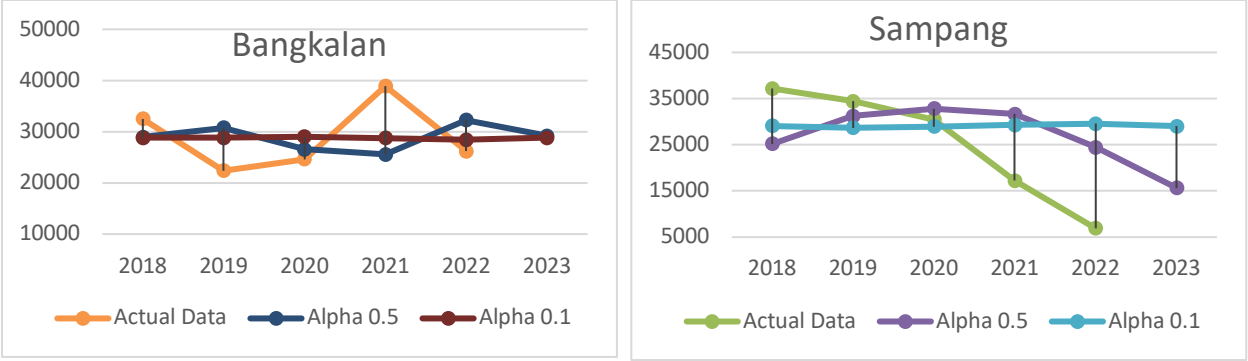
From 2018 to 2022, the data gathered during the data collecting stage is stunting statistics from each district in Madura. Data was obtained using survey and interview methods at the Central Statistics Agency and Health Service of each district. Stunting data prevalence and number of stunting numbers are acquired from both sources, as illustrated in Figure 3. Figure 3 shows that the average number of stunted children has decreased drastically, especially in the Pamekasan and Sumenep areas every year. On the other hand, Sampang can continuously lower the number of stunting every year. The SES technique is used as a forecasting approach based on the data and the data pattern depicted in Figure 3.

First, a baseline value is calculated based on the original data acquired. Entering a value of 0.5 into Equation 1 yields the result. This parameter governs how much previous data influences projections. The number is often between 0 and 1, with the higher the value, the greater the effect of prior data on the prediction. As a consequence of determining the initial average value and value, one may begin computing forecasts for the next period. This forecast is an estimate of the value for the upcoming period. In some circumstances, optimizing the exponential parameter (α) may be required to increase model performance. This may be accomplished by experimenting with several variables and selecting the one that produces the greatest results. Here, we set the second value, 0.1. The predicted results for each district are depicted in the Figure 4 dan Figure 5.



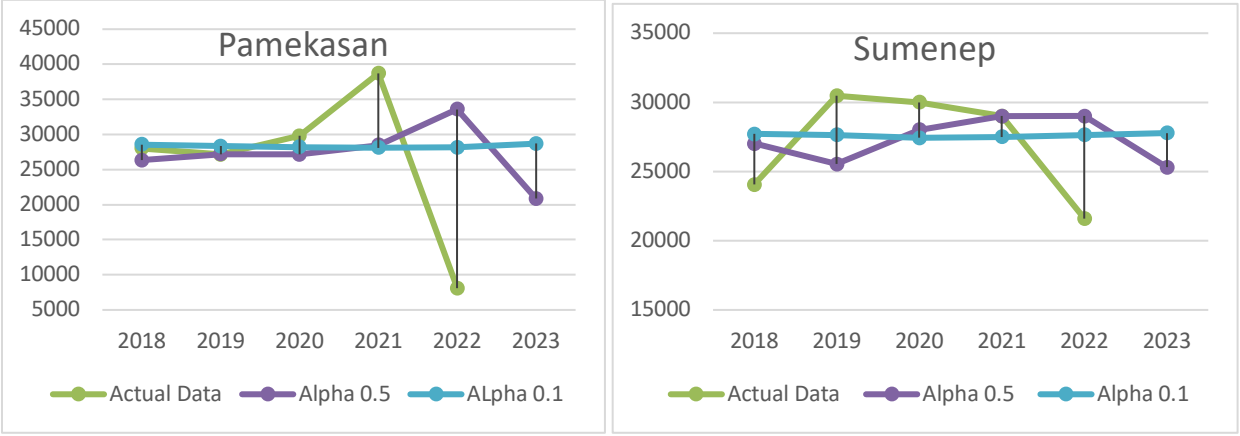
	2018	2019	2020	2021	2022
BANGKALAN	32528,646	22370	24600	38900	26200
SAMPANG	37186,686	34390	30500	17200	6900
PAMEKASAN	28014,084	27130	29800	38700	8100
SUMENEP	24062,136	30480	30000	29000	21600

FIGURE 3. Stunting dataset from 2018-2022



(a) (b)

FIGURE 4. Result predict: (a) Bangkalan district, (b) Sampang district



(a) (b)

FIGURE 5. Result predict: (a) Pamekasan district, (b) Sumenep district

From the prediction results image above, it shows the estimated number of stunting in 2023. This can be used as information and early intervention to prevent stunting, planning and decision making in efforts to combat stunting in the region. Graphs are used to evaluate the performance of a model by comparing predicted values with actual values. The resulting prediction analysis refers to the distribution of the points. Plots usually display point representations of original data and predicted results. This time it displays a comparison of 3 points for the original data, and 2 alpha values for the SES parameter. SES can be reproduced by calculating alpha values, as mentioned previously. SES may be reproduced by calculating the alpha value, as previously mentioned. When the alpha value of 0.5 was determined, the error value remained significant, exceeding 20%. This is the foundation for repeating with an alpha value of 0.1. As a consequence, up to 10% of the erroneous value can be lowered. Table 1 displays the results of determining the error value using the MAPE value.

TABLE 1. Error measurement

Alpha	MAPE			
	Bangkalan	**Sampang**	**Pamekasan**	**Sumenep**
0.5	22.73089	77.38516	71.21988	13.88757
0.1	8.023966	12.68439	6.796506	4.543483

CONCLUSION

Predicting stunting status using the Single Exponential Smoothing method is a forecasting methodology beneficial in projecting or predicting trends in stunting status development in a population in four districts in the Madura area. This strategy is based on an exponential approach, in which the most recent data in the time series is given more weight. The data utilized is a time series from 2018 to 2022 that forecasts data for 2023. Forecasting using the SES approach yields a significant error value with an alpha value of 0.5. On this basis, repetition was performed with an alpha value of 0.1. The error value can be lowered by up to 10% with this effort. This can be understood to suggest that the alpha value has a significant effect on the error outcomes. Additional ways will be used in future study to establish the optimal alpha value.

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