

Comparison of Accuracy and Predictive Results of ES-Holt Method and ANN-Back Propagation Method: Case Study of Number of Tourists

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ABSTRACT

The COVID-19 pandemic has weakened many sectors, one of which is tourism. Almost all priority tourism locations of the government experience a significant decrease in the number of foreign and domestic visitors. This also impacts the level of welfare of the community around the tourism area. This study is conducted to compare the Exponential Smoothing (ES) Holt and Artificial Neural Network (ANN) Back Propagation methods. That aims to see how the effectiveness and accuracy of both methods to be applied to the predictive process of the number of tourist visits in North Maluku Province using the G-MFS-based MATLAB application. The data on the number of tourists were taken from the Central Statistics Agency of North Maluku Province in 2008-2019. The accuracy parameter indicates that the error for the Holt method has a MAPE value of 9.2976. As for the Back Propagation method, the error is smaller, with a MAPE value of 1.2585. From the results, in 2020 the number of tourists visiting North Maluku should have been around 13,868 people per month. This result can at least be compared to the number of real visitors in 2020 during the COVID-19 outbreak. There is a very high difference between what was predicted and what happened in the field. From the results of this research, it is expected that tourism-related parties or institutions can conduct further research and studies so that they can know the policies to be taken in order to increase the number of tourists visiting North Maluku Province.

Keywords: Forecasting, ES-Holt Method, ANN-Back Propagation Method, Number of Tourists

1. INTRODUCTION

In forecasting, there are terms known as forecasts and predictions. A forecast is defined as the forecasting process of an event in the future based on the data of the previous event. The past data is systematically processed together with a specific method to obtain forecasts of future events. Meanwhile, prediction is the process of forecasting a variable in the future based on intuition. Although it is more based on intuition considerations, predictions are often used as quantitative data as a complement to information in forecasting [4].

There are several methods of forecasting, including qualitative forecasting based on the opinion of experts and quantitative forecasting using statistical methods.

Quantitative forecasting commonly uses statistical methods, some of which are based on the Exponential Smoothing concept [2]. One of the developments of the exponential smoothing concept is the Holt method. The advantage of this method is analyzing two components of the data pattern in order to provide a greater weighting of the latest data, to estimate the trend patterns or trends of the data, and to estimate seasonal patterns from the data so that it will result in forecasting with the smallest error rate [4].

In addition to the statistical methods, there is an artificial neural network (computer artificial intelligence) that can analyze data patterns and predict further forecasting using certain algorithms which also can minimize the level of forecasting errors [3]. One of the

neural network methods that have a relatively short learning speed, a simple analysis stage, and a good level of accuracy is the Back Propagation method [6]. This study utilizes these two methods (the conventional Holt Exponential Smoothing and the Back Propagation method) to compare the results of time series data forecasting.

A review of related literature has been done to see the relationship between the previous research and this current study as well as to find the contribution of this research to the development of science. The following explains some research related to the analysis of ES-Holt and ANN-Back Propagation.

Maricar (2019) conduct research on Moving Average Accuracy Value Comparison and Exponential Smoothing for Revenue Forecasting System at XYZ Company. In forecasting, many methods can be used, but not all methods can fit the existing case. The exponential smoothing method with a value of $\alpha = 0.1$ is better used in this case when compared to the values $\alpha = 0.5$ and 0.9 [7]. Habibi (2017) uses the Back Propagation method in his research article that analyzes student Twitter, the conclusion is that Back Propagation can recognize the sentiment of students' Twitter [6]. Lestari (2019) observes the application of the Back Propagation method to estimate the number of tourist visits to West Nusa Tenggara province", the result is to use a maximum iteration of 1500, 0.3 learning rate, and 21 hidden layers with MSE 0.003901 to predict the cases [7].

The Holt smoothing method has the advantage of being able to analyze three components of the data pattern, namely providing greater weighting of the latest data, estimating trend patterns, and estimating seasonal patterns from the data so that it will produce forecasting with the smallest error rate [8]. Also, the Holt method can be used to predict the next few periods [9], unlike the Single Exponential Smoothing forecasting method that can only be used to forecast one period.

Meanwhile, the Artificial Neural Network Back Propagation (ANN-BP) method can acquire knowledge even though there is no certainty. This method is able to generalize and extract a certain pattern [10]. However, the drawback of this method is that it is less able to perform numerical operations with high precision. When analyzing data with large data inputs, the process of training will take a longer time. Although it has some drawbacks, the Back Propagation method has great benefits in everyday life, such as recognizing the patterns on radar, face, or any other object. In the field of diagnosis, this method can be used to detect a disease early such as cancer [11].

Therefore, this article discusses (1) the accuracy of the ES-Holt method and the ANN-Back Propagation method to predict the number of tourists, (2) the number of tourists visiting North Maluku Province, Indonesia, both foreign and domestic; (3) the most appropriate method to forecast the number of tourist visits. North Maluku Province is chosen because this area is one of the priority tourism areas. The data used are collective; the domestic and foreign tourists are not separated due to the availability of the data sources.

2. RESEARCH METHODS

This research is quantitative using two different methods, namely ES-Holt method and ANN-Back Propagation method with the stem (G-MFS) MATLAB-based. The ES-Holt method can overcome trends and seasonal factors that appear simultaneously in time series data. This forecasting is classified as a controlled type wherein it uses a weight adjustment pattern to achieve a minimum error value between the estimated and the real outputs [12]. It is expected that with the use of this method, the results will be obtained as desired.

The data on the number of tourists in North Maluku Province during 2008-2019 were obtained from the Central Bureau Statistics (BPS) of North Maluku Province (<https://malut.bps.go.id/>). The number of tourists is quite varied. It experienced decreasing between 2008 and 2010 and began to increase in 2010 until the next two years. There was another decrease from 2013 to 2017, but between 2017 and 2019, there was a very significant increase. However, due to the Covid-19 pandemic, it seemed that in 2020 the number of tourist visits was very less.

The steps in this study are as follows: (1) collect data from North Maluku BPS website; (2) do the simulation of data by GUI Multimodel Forecasting System (G-MFS), it is an application developed using the GUI of Matlab to make data simulation easier; (3) determine and record the predictive results of each of the methods; (4) compare the results between the two methods used, comparison based on the prediction results and error parameters such as Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Presentation Error (MAPE) generated; and (5) interpret and make conclusions based on the results of research.

3. RESULT AND DISCUSSION

The number of tourists visiting North Maluku can be seen in the following Figure 1.

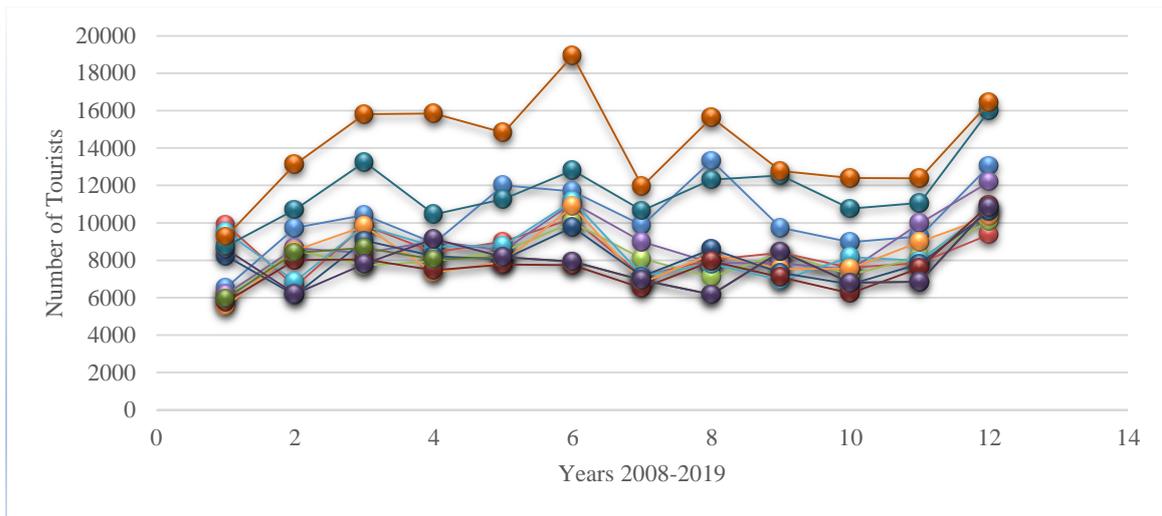


Figure 1 Number of Tourists

It can be seen from Figure 1 that the number of tourists in North Maluku has decreased significantly. One way to increase it is to estimate the tourists who come to North Maluku in the future. The results can later be considered for the North Maluku regional government in making policies to attract tourists. Estimation is very important to minimize the impact that will occur in the future. It is the process of estimating future needs, including needs in quantity, quality, time, and location sizes. One good technique to use is neural networks using the Back-Propagation method. While the ES-Holt method is commonly used to predict single data such as the number of annual tourists visiting a place, the ANN-Back Propagation method is usually used for non-linear data such as the fluctuating number of tourist visits per month. The results obtained are:

1.1 The ES-Holt Method

The simulation of single data or annual tourist number data with ES-Holt method and G-MFS MATLAB application was conducted 9 times with different alpha and beta ranging from 0.1-0.9. In this case, the research team inputted alpha values equal to beta values. The results obtained are presented in the following Table 1.

Table 1. The Results of Analysis Training Data of the ES-Holt Method

No.	Parameter Value	Predicted Results	MAPE
1	0.1	75,224	21.1776
2	0.2	106,005	18.7662
3	0.3	133,079	15.6212
4	0.4	152,789	12.6154
5	0.5	170,382	11.1329
6	0.6	184,983	10.2177
7	0.7	196,555	10.1342

No.	Parameter Value	Predicted Results	MAPE
8	0.8	203,204	9.2976
9	0.9	204,077	9.5499

From Table 1, it can be seen that the results of MAPE values are different in different alpha-beta values. The researchers then took the smallest alpha-beta value of 0.8 and used it for further analysis since it was considered to result in the smallest error when making a prediction. The result can be seen in the following Figure 2.

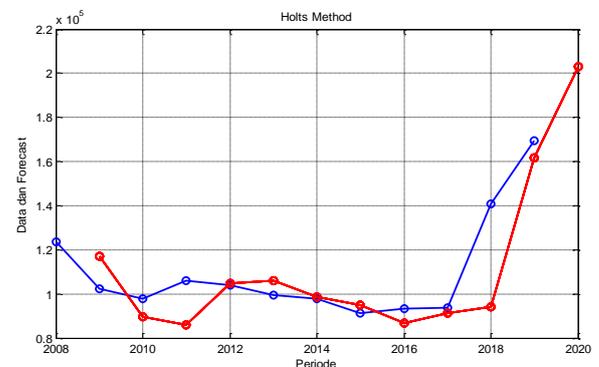


Figure 2 Actual Approach (Blue) and Forecast Data (Red) with the Holt Method

The MAD value is 108,236. MAD is used to calculate the average of absolute errors and also it is used if an analyst wants to measure forecasting errors in the same unit of measure as the original data. The smallest MSE value is 27,432.8. MSE is used to calculate the average rank error. It is applied because it generates a moderate error preferred by a forecaster which usually results in a smaller error, but sometimes it also results in a very large error. The last is the MAPE value of 9.2976. MAPE is used to calculate the average percentage of absolute errors and it is used if the size of the forecasting variable is an important factor in evaluating the accuracy of the forecasting. MAPE provides clues about how big the

forecasting error is compared to the actual value of the series. The smaller the MAPE value, the better the forecasting method.

1.2 The ANN-Back Propagation Method

The simulation of compound data or monthly data on the number of visitors to North Maluku Province was conducted using the ANN-Back Propagation with several experiments and different learning rate values ranging from 0.1-0.9. The results obtained are presented in Table 2.

Table 2. The Results of Analysis Training Data of the ANN-Back Propagation Method

No.	Learning Rate	Predicted Results (Average)	MAPE
1	0.1	8,228	44.709
2	0.2	10,782	1.3290
3	0.3	9,299	1.3193
4	0.4	14,467	1.3571
5	0.5	15,142	1.4412
6	0.6	14,669	1.4182
7	0.7	14,686	1.4445
8	0.8	13,868	1.2585
9	0.9	15,579	1.2672

The above results in Table 2 were obtained by network architecture with the number of input layers = 144, the number of hidden-1 layers = 10, the number of hidden-2 layers = 5, the number of output layers = 1. The activation function is LOGSIG for each layer, the training method is TRAINRP, the maximum epoch = 1000, and goals = 0.0001. From Table 2, we can see that the smallest MAPE value is in the data with a learning rate of 0.8. The value was taken and used for further analysis. To get the results of the analysis we can look at the following Figure 3.

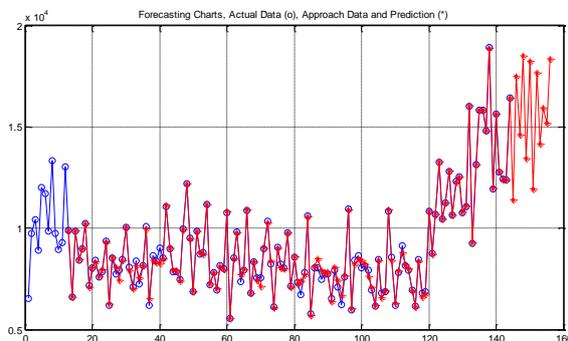


Figure 3 Actual Approach (Blue) and Forecast Data (Red) with Back Propagation Method

Figure 3 above is a graphic form of data simulation with the ANN-Back Propagation method. The MAPE value is 1.2585. The result shows the ANN-Back

Propagation method is very good at predicting the number of annual tourist visits to North Maluku Province.

1.3 Method Comparison

This study used two methods so it is necessary to compare the results to get the most appropriate method used for forecasting. It was conducted by comparing the MAD, MSE, and MAPE values in each method. Note the following Table 3.

Table 3. Comparison of MAD, MSE, and MAPE Each Method

Methods	MAD	MSE	MAPE
ES-Holt	108.236	27,432.8	9.2976
ANN-Back Propagation	93.6977	27,299.5	1.2585

From Table 3 above, it is clear that the MAPE of the ANN-Back Propagation method is 1.2585. This value is smaller than the ES-Holt method with the MAPE of 9.2976. It implies that the ANN-Back Propagation method is more accurate in predicting tourist visit data. This is in accordance with the results of Aris Gunaryati's (2018) research entitled 'Comparison of Exponential Smoothing forecasting method and Artificial Neural Network method for broadband user data in Indonesia'. Based on the results of the study, the architecture of Artificial Neural Networks with hyperbolic tangent activation functions is more suitable and accurate [13]. These two studies are only different in terms of using the activation function namely LOGSIG by this present study. We used the LOGSIG activation function because during the data training and testing process, this function was able to produce better results compared to PURELIN and TANSIG functions.

The government can make the results of forecasting and predictions from this present research as a reference to carry out new policies in preparing the arrival of tourists to the region. Not only that, the results of these forecasts and predictions can also be used as reference material to conduct further research, such as research and calculation of regional revenues from the tourism sector. Using the data, the government can also see which areas are the main destinations for tourists, so that the government is expected to pay more attention and develop it to become a new sector in regional tourism that can attract tourists both domestic and foreign. The tourism sector can bring benefits to areas that have assets in the form of tourist attractions that are in demand by the public [14]. Tourist attractions bring great benefits to surrounding areas. In the economic aspect, tourism development has a significant role, especially for people who do business around the tourist attraction. Also, tourists can get to know more about the city visited. Automatically, the revenue or cash of the area can

increase as various tourist attractions in the area grow. The development of tourist attractions in an area will drive the demand for tourism.

4. CONCLUSION

The number of visitors to North Maluku Province every year experiences ups and downs. The existing data show that North Maluku experienced a rapid increase in the number of visitors in 2017-2019, but got lower since the pandemic happened. A single (annual) data analysis for forecasting and predicting the number of tourist visits to North Maluku Province using the ES-Holt method shows the MAPE value of 9.2976. This indicates that this method cannot provide accurate results or it can be said that this method does not have a high level of accuracy. Meanwhile, the value for the analysis of compound data (monthly) using the ANN-Back Propagation method shows the MAPE value of 1.2585. It means that the ANN-Back Propagation method can give very accurate analysis results or it can be said that this method has a very high level of accuracy. Therefore, this method is the most appropriate to be used to analyze the number of tourist visits, especially in North Maluku Province. From the data and predictions obtained, it is expected that the government can make policies that can advance tourism in North Maluku. From the results, the number of tourists visiting North Maluku on average monthly in 2020 should have been as many as 13,868 people. However, due to the condition of COVID-19, there has been a drastic decrease.

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