The Forecasting of Foreign Tourists Arrival in Indonesia based on the Supply Chain Management: an Application of Artificial Neural Network and Holt Winters Approaches

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Abstract- **Tourism plays crucial role for improving the social and economic development of a country through open employment opportunities in surrounding tourism area. The supply chain mangement strategy can be eefective in developing the turisim industry.The number of foreign tourists who come to Indonesia continues to increase from time to time. Therefore, tourist arrivals need to be forecasted to assist the government in providing optimal infrastructure and accommodation for tourists to avoid an imbalance between the number of tourists with the infrastructure and accommodation provided. The purpose of this study is to forecast the arrival of foreign tourists in Indonesia by using Artificial Neural Network and Holt-Winters approach esutilising the historical data from January 2011 to December 2017. From the calculation process, we found that MAPE (Mean Absolute Percentage Error) value of Artificial Neural Network and Holt-Winters approaches are 5.60% and 5.43%, respectively. So it can be concluded that the Holt-Winters approach is better than the Artificial Neural Network approaches in forecasting the foreign tourists arrival in Indonesia.**

Keywords-*Arrival of foreign tourists, Tourism Industry, Supply Chain Management, Artificial Neural Network, Holt-Winters.*

1. Introduction

Supply Chain Management strategy is covering all managerial aspects of the flow of materials and information from source to customer, across the entire range of materials handling and movement functions, and throughout an organization and its supply channels. In tourism, these are related to the process of supplying tourism services from sourcing of raw materials, products or different services) to supply and distribution, and SCM performance can ultimately be measured by customer satisfaction. Tourism is a series of activities for the movement of people temporarily with a purpose outside their place of residence, activities carried out during their stay in the place, and facilities provided during the trip or at their destination [1,2,3].Tourism can increase a country's income, open employment opportunities for these citizens, and improve the development of the surrounding area. Indonesia is known as the largest archipelagic state which is physiographically composed of ± 18,000 islands where the land area of about 1.9 million km2 with a coastline length reaching 95,161 km, the second largest longest after Canada. According to the United Nations Convention on the Law of the Sea (UNCLOS) in 1982, the total area of Indonesia's sea was 5.9 million km2, consisting of 2.7 million km2 of Exclusive Economic Zone waters and 3.2 million km2 of territorial waters (Central of Statistic Bureau). In a book entitled Indonesian Biodiversity Presence published by the Indonesian Institute of Sciences in 2014, it was noted that the richness of biodiversity for flora in Indonesia reached 15.5% of the total amount of flora found in the world. For fauna in Indonesia, there are ± 10,000 species, both Vertebrates and Invertebrates which as a whole reaches 10% of the fauna species in the world. One of the unique fauna possessed by Indonesia is the Komodo dragon, which is the largest lizard in the world and is only found on Komodo Island, East Nusa Tenggara (Central of Statistic Bureau).The things above are some of the factors that make Indonesia as one of the best places as a tourist destination for both local and foreign tourists. According to the results of the Central Bureau of Statistics (BPS)'s savings (Central of Statistic Bureau) Indonesia has always experienced an increase in the arrival of foreign tourists each year. Evidently in 2017 tourism became the second

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highest foreign exchange earner under oil palm, and then the government tried to make tourism as the highest foreign exchange earner in 2019[2]. Therefore the government needs to pay attention to the supply of infrastructure and accommodation that will be used by tourists so that there is no imbalance with the number of tourists who come. To overcome these problem, it is necessary to balance the amount of infrastructure and accommodation with the number of foreign tourists coming. In addition to quantity, the quality of infrastructure must also be considered by the government so that it can provide comfort for tourists who come [4, 5]. The strategy to overcome these problems is to predict the number of foreign tourists in the future so that it can be estimated how much infrastructure and accommodation needs to be provided to tourists. Often the data on tourist arrivals shows a seasonal pattern. The method that is often used in forecasting seasonaldata is the Holt-Winters exponential smoothing method. Holt-Winters method is based on three smoothing equations, namely one for stationary elements, one for trends, and one for seasonal. This is similar to the Holt method, with one additional parameter to deal with seasonal [6,7].The forecasting method that is currently developing is the Artificial Neural Network (ANN) method. This method is a method that mimics biological neural network systems, so as to be able to learn previous data and recognize patterns of data that are always changing which can then produce more accurate forecasting [8-10]. Some studies reveal that the phenomenon of tourist arrivals often shows a non-linear pattern, so a forecasting method is needed such as ANN that can receive non-linear patterns well. The data on foreign tourist arrivals used in this study show a non-linear pattern [11]. Following the previous discussion above, this study attempts to apply the Artificial Neural Network (ANN) and Holt-Winters exponential smoothing approaches, for forecasting the number of foreign tourist's arrival in Indonesia. It aims to provide recommendations to related people in predicting foreign tourist arrivals to Indonesia. So that it can be taken into consideration in planning the provision of services to foreign tourists.

2. Materials and Forecasting Methods

This section discusses the materials used in the analysis, and forecasting methods which include: the Artificial Neural Network (ANN) method and Holt-Winters exponential smoothing method. The object in this study is the number of foreign tourist arrivals to Indonesia through all the entrance lines. The data used is secondary data on the number of arrivals of foreign tourists to Indonesia from January 2011 - December 2017 obtained from the website of the Central of Statistics Bureau.

Table1. Arrival of Foreign Tourists to Indonesia from January 2011 - December 2017

Times	2011	2012	2013	2014	2015	2016	2017
January	548821	652692	614328	753079	724698	814303	1107968
February	568057	592502	678415	702666	794302	888309	1023388
March	598068	658602	725316	765607	792804	915019	1059777
April	608093	626100	646117	726332	750999	901095	1171386
May	600191	650883	700708	752363	794294	915206	1148588
June	674402	695531	789594	851475	815307	857651	1144001
July	745451	701200	717784	777210	815351	1032741	1370591
August	621084	634194	771009	826821	853244	1031986	1393243
September	650071	683584	770878	791296	870351	1006653	1250231
October	656006	688341	719903	808767	826196	1040651	1161565
November	654948	693867	807422	764461	777976	1002333	1062030
December	724539	766966	860655	915334	913828	1113328	1147031

2.2. Forecasting Approach

Forecasting is a prediction of the values of a variable based on known values of these variables or related variables. Fortune-telling can also be based on judgment skills, which in turn are based on historical data and experience [12,5]. The important thing in determining the appropriate periodic method is to pay attention to the data pattern. Data patterns are divided into four types, namely: horizontal patterns, seasonal patterns, trend patterns, and cyclical patterns.

2.2.1. Stationary

If the generation process that underlies a periodic series is based on the middle value ($\boldsymbol{\mu}$) constant and variance ($\boldsymbol{\sigma^2}$) constant, the periodic series is stationary [13]. In time series data is usually not stationary. To see a data that is stationary, the following tests can be done: (i) when plotting data, the graph of the data will often cross the horizontal axis. (ii) In plotting ACF the autocorrelation values will drop to near zero after the second or third time lag.

2.2.2. Definition of ACF and PACF

The autocorrelation function (ACF) is used to describe the association between the values of a periodic series that are the same at different time periods. Slightly similar to correlation, but related to the periodic series for different time intervals. While the Partial Autocorrelation Function (PACF) is used to show how much the relationship between the value of the current variable and the previous value by assuming the effect of all other time lags is constant [13].

2.2.3. Linearity Test

In this study a linearity test will be conducted on the data to see whether the data is linear or nonlinear. The test method used in this study is the Ramsey's reset test. According to [5], the Ramsey's Reset Test step can be written as follows:

(1). Regressy_t to $1, x_1, x_2, \ldots, x_p$and determine the estimated value of the variable regression parameter$\hat{y}_t$, that is:

$$\hat{y}_t = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p \quad (1)$$

Then calculate the coefficient of determination from regression that is$R^2$with denoted asR^2_{old}.

(2). Regressy_t to $1, x_1, x_2, \ldots, x_p$by adding two additional predictors, namely$\hat{y}_t^2$ and $\hat{y}_t^3$, with the model:

$$y_t = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p + \alpha_1 \hat{y}_t^2 + \alpha_2 \hat{y}_t^3 \quad (2)$$

Then calculate the coefficient of determination from this model regression, that isR^2which is denoted byR^2_{new}.

(3). Calculate the F test value, using the formula:

$$F = \frac{(R^2_{new} - R^2_{old})/m}{(1 - R^2_{new})/(n-p-1-m)} \quad (3)$$

The test hypothesis applied in this linearity test is:

H_0 : f (X) is a linear function in X or the model is said to be linear

H_1 : f (X) is a non-linear function in X or the model is said to be non-linear.

When H_0rejected, means that the model is non-linear, the F test value that meets the rejection area is if the value$F > F_{(\alpha,m,n-p-1-m)}$ or *p-value*$< \alpha$, with$\alpha = 0.05$.

2.2.4. Linearity Test

The method of Artificial Neural Network was first introduced by McCulloch and Pitts in 1943. This method adopts a biological neural network system, so as to be able to study previous data and recognize patterns of ever-changing data which can then produce more accurate forecasting [8, 3]. The ANN method consists of several layers called neuron layers, namely: input layer, hidden layer, and output layer. There are three types of network architecture in Artificial Neural Network (ANN). First is the Single Layer Network. This architecture is a single layer that only consists of 1 input layer and 1 output layer with connected weights. The second architecture is the Multi Layer Network. This architecture has its own form, which is composed of 3 layers, namely the input layer, hidden layer, and output layer. The third network architecture is the Competitive Layer Network. In this architecture contains a group of neurons that compete with each other to become active [8- 10].

2.2.5. Back propagation

The Back propagation algorithm is included in supervised learning. This algorithm has a multi-layer network architecture that is composed of one input layer, at least one hidden layer, and one output layer. [9,14], the stages of the back propagation algorithm for networks with one hidden layer can be described as follows:

Step1. Initialize all weights with a small random number, training rate constant (α), and set tolerance error.

Step2. As long as the stop condition has not been met, then do steps 3 to 10.

Step3. For each pair of training data, do steps 4 to 9.

Stage I: advanced phase (*feed forward*)

Step4. Each input unit$x_i (i = 1,2, \ldots, n)$receives a signal and forwards it to all hidden layers.

Step5. Every unit is hiddenz_j $(j = 1,2, \ldots, p)$multiplied by its weight (v_{ij}) and added up and added to the bias (v_{oj}).

$z\_net_j = v_{oj} + \sum_{i=1}^{n} x_i v_{ij}$
(4)
The output signal is calculated using the activation function and send the results to all output units.

$z_j = f(z\_net_j)$
(5)
Step6. All output units y_k $(k = 1,2, \dots, m)$ multiplied by weight (w_{jk}) and added up and added to the bias (w_{ok}).

$y\_net_k = w_{ok} + \sum_{j=1}^{p} z_j w_{jk}$
(6)
And use the activation function to calculate the output signal,

$y_k = f(y\_net_k)$
(7)

Stage II: backward phase (back propagation)

Step7. Each output unit y_k $(k = 1,2, \dots, m)$ receive the target pattern (t_k) which matches the input pattern during training, then calculates the error (δ_k),
$\delta_k = (t_k - y_k) f'(y\_net_k)$
(8)
Calculate changes in weight (w_{jk}) with the pace of training α,

$\Delta w_{jk} = \alpha \delta_k z_j$
(9)
Calculate the change in bias (w_{ok}),
$\Delta w_{ok} = \alpha \delta_k$
(10)
Send error value (δ_k) to the unit at the bottom.

Step 8. In each hidden unit z_j $(j = 1,2, \dots, p)$ adding up the value δ which has been given weight comes from the top layer,

$\delta\_net_j = \sum_{k=1}^{m} \delta_k w_{jk}$
(11)
Then calculate the error information,
$\delta_j = \delta\_net_j \, f'(z\_net_j)$
(12)
Calculate the weight change rate with,
$\Delta v_{ij} = \alpha \delta_j x_i$
(13)
Calculate changes biased with,
$\Delta v_{oj} = \alpha \delta_j$
(14)

Stage III: weight change phase

Step9. Each output unit y_k $(k = 1,2, \dots, m)$ updating the weights and bias $(j = 1,2, \dots, p)$,

$w_{jk}(baru) = w_{jk}(lama) + \Delta w_{jk}$
(15)
Likewise, every unit is hidden z_j $(j = 1,2, \dots, p)$ fixing weights and bias $(i = 1,2, \dots, n)$,
$v_{ij}(baru) = v_{ij}(lama) + \Delta v_{ij}$
(16)

Step10. Test the stop condition. Stop when the MSE value < tolerance error.
In working on the ANN method, the activation function has the role of formulating the output of each neuron. There are several activation functions proposed [10, 14] in the ANN method, including:
1). Binary sigmoid function

This function is used for ANN who uses the Back propagation training method. Binary sigmoid functions have ranges from 0 to 1. The binary sigmoid activation function is formulated as follows:
$f(x) = \frac{1}{1+e^{-x}}$
(17)
with derivatives,
$f'(x) = f(x)[1 - f(x)]$
(18)

2). Sigmoid function bipolar

The bipolar sigmoid function is almost the same as the binary sigmoid function, the difference lies in the bipolar sigmoid function which has a range from -1 to 1. The bipolar sigmoid function is formulated as follows:
$f(x) = \frac{1-e^{-x}}{1+e^{-x}}$
(19)
With derivatives,
$f'(x) = \frac{1}{2}[1 + f(x)][1 - f(x)]$
(20)

3). Linear function

Linear function is used if the output generated by a network is any real number. This function also has an output value that is equal to the value of the input. Linear functions are formulated as:

$f(x) = x$
(21)

2.2.6. The Holt-Winters Multiplicative Approach

Multiplicative seasonal models are used to predict seasonal data variations from time series data that have increased or decreased (fluctuations). [15], the equations used in the multiplicative Holt-Winters model are as follows:

The equation for calculating multiplicative Holt-Winters smoothies:

$$S_t = \alpha\left(\frac{X_t}{I_{t-L}}\right) + (1-\alpha)(S_{t-1} + b_{t-1})$$
(22)

Equations for calculating trend smoothing:

$$b_t = \beta(S_t - S_{t-1}) + (1-\beta)b_{t-1}$$
(23)

The equation for calculating seasonal smoothing:

$$I_t = \gamma\left(\frac{X_t}{S_t}\right) + (1-\gamma)I_{t-L}$$
(24)

Forecasting equation model of Holt-Winters exponential additives:

$$F_{t+m} = (S_t + mb_t)I_{t-L+m}$$
(25)

The initial value of exponential smoothing is obtained from the average in the first season, denoted by:

$$S_L = \frac{1}{L}(X_1 + X_2 + X_3 + \cdots + X_k)$$
(26)

To initialize the initial value of the smoothing trend it is better to use complete data for two seasons or periods, denoted as follows:

$$b_L = \frac{1}{k}\left(\frac{X_{L+1}-X_1}{L} + \frac{X_{L+2}-X_2}{L} + \frac{X_{L+3}-X_3}{L} + \cdots + \frac{X_{L+k}-X_k}{L}\right) \quad (27)$$

The initial value of seasonal smoothing is a multiplicative model denoted by,

$$I_k = \frac{X_k}{S_L}$$
(28)

2.2.7. Accuracy of the Forecasting Method

The size of the forecasting used in the comparison method is the Mean Absolute Percentage Error (MAPE). [7,5], MAPE measurement can be formulated as follows:

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{X_i-\hat{X}_i}{X_i}\right| \times 100\%$$
(29)

3. Results and Discussion

3.1. Data Plot

The data presented in Table 1, hereafter devised plot the data and the results as given in Figure 1, as follows:

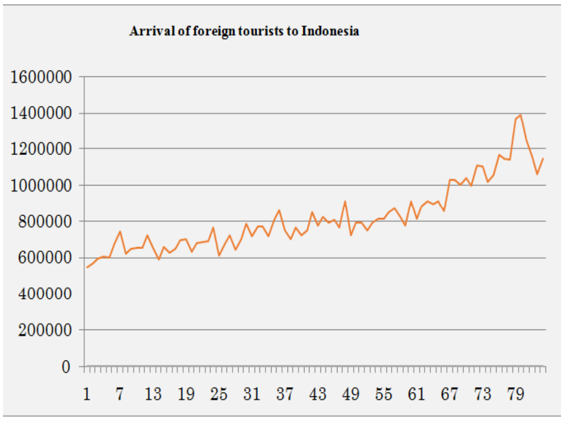

Figure1. Graph of Foreign Tourist Arrivals to Indonesia from January 2011 - December 2017.

From the plot data in Figure 1, it shows that the data has a seasonal pattern seen that the data has increased and decreased (fluctuations) which recur in each period and the data also has a trend pattern seen in the data which tends to increase from one period to the next, resulting in data that is not stationary in variance and in average [16,17].

3.2 Analysis Using the Artificial Neural Network Method

In this study the data is divided into 80% of the overall data for training data (training) or as much as 67 data and 20% of all data for testing data or as many as 17 data. Data needs to be transformed first in the interval of the activation function that is used so that data can do learning [5,18]. The transformation process is carried out by the following equation:

$$X_i' = \left[\frac{X_i - X_{min}}{X_{max} - X_{min}}\right](a-b) + b$$
(30)

To determine the number of input layers used can be determined based on a significant PACF plot. The ANN model tested in this study included models (12-5-1), (12-6-1), (12-7-1), and (12-8-1). Furthermore, the models are carried out by training processes and testing processes. The things needed for the initialization process are the number of iterations used as many as 2,000 iterations, the learning rate used is 0.1, and the error tolerance is 0.0001. After conducting the training process and testing each model, the MAPE comparison table is obtained from each model as follows:

Table2. Comparison of MAPE for each model

Models	Activation Function	MSE Training	MSE Testing	MAPE (out sample)
12-5-1	Log sig – log sig	0.019	0.396	56.90%
12-6-1		0.0117	0.0303	13.54%
12-7-1		0.00778	0.021927727	11.43%
12-8-1		0.0146	0.37256603	55.61%
12-5-1	Log sig - purelin	0.00296782	0.060661309	20.24%
12-6-1		0.00277	0.01736736	8.07%
12-7-1		0.00173	0.00993	6.41%
12-8-1		0.00249	0.151	30.21%
Kappa	Log sig – tan sig	0.00367	0.35	49.83%
12-6-1		0.00355	0.0111	8.57%
12-7-1		0.0027	0.0191	11.69%
12-8-1		0.00321	0.0257	11.96%
12-5-1	Tan sig – tan sig	0.0135	0.727	32.26%
12-6-1		0.0132	0.05	6.42%
12-7-1		0.00732	0.04	5.40%
12-8-1		0.00979	0.0421	5.73%
12-5-1	Tan sig - purelin	0.0106	0.205	15.19%
12-6-1		0.0130	0.0479	6.40%
12-7-1		0.00715	0.0405	5.72%
12-8-1		0.00903	0.237	15.67%
12-5-1	Tan sig – log sig	0.00351	0.186	37.12%
12-6-1		0.00463	0.0326	15.50%
12-7-1		0.00326	0.0309	15.45%
12-8-1		0.0034	0.0417	16.12%

Based on Table 2, the model (12-7-1) was obtained using the tan sig- tan sig activation function as the best model in forecasting foreign tourist arrivals to Indonesia with the smallest MAPE value of 5.400%.

3.3 Analysis Using the Holt-Winters Exponential Method

In the analysis using the Holt-Winter exponential method, starting with the initialization process in the exponential method, and obtained the initial value of exponential smoothing $S_L = 637477.5833$, element of tendency$b_L = 2741.1875$,and the initial value of smoothing seasonal elements (lk) multiplicative models.

3.3.1. Estimation and Determination of Value ofα, β, and γHolt-Winters Method

To determine the valueα, β, and γestimates are made through a process of trial and error until a value is foundα, β, and $\gamma$with a small error rate. The following table estimates the valueα, β, and $\gamma$with error measurement using the Mean Absolute Percentage Error (MAPE) and the results are given in Table 3.

Table3. Estimated Value of$\boldsymbol{\alpha}, \boldsymbol{\beta}$, and $\boldsymbol{\gamma}$

Alpha (α)	Beta (β)	Gamma (γ)	MAPE
0.1	0.1	0.1	6.633%
0.1	0.1	0.2	6.250%
0.1	0.1	0.3	5.999%
0.1	0.2	0.1	6.671%
0.1	0.3	0.1	6.670%
0.2	0.1	0.1	6.410%
0.3	0.1	0.1	6.445%
0.2	0.1	0.3	5.731%
0.2	0.1	0.9	5.483%
0.25	0.01	0.99	5.434%
0.25	0.0001	0.999	5.439%
0.27	0.0001	0.999	5.442%
0.23	0.0001	0.999	5.447%

So that it can be determined from Table 3, that the parameter valueα, β, and γcan produce small and optimal MAPE when$\alpha = 0.25$, $\beta = 0.01$, and $\gamma = 0.99$with MAPE value of 5.434%.

3.3.2Prediction of Foreign Tourist Arrivals with Artificial Neural Network and Holt-Winters Methods

The prediction results of foreign tourist arrivals to Indonesia using the artificial neural network method and the holt-winters method can be seen in table 4.

Table4. Prediction Value of Tourist Arrivals with Artificial Neural Network and Holt-Winters Method

Month	Prediction of Artificial Neural Network Method	Prediction of the Holt-Winters Method
	Arrival in 2018	Arrival in 2018
January	1187239	1201591
February	1194096	1127681
March	1179938	1173290
April	1182313	1253863
May	1194216	1209541
June	1190062	1177530
July	1200729	1376359
August	1198365	1363237
September	1187610	1226439
October	1190398	1165011
November	1183156	1091375
December	1190014	1209792

4. Conclusion

This paper has carried out research on the application of artificial neural network (ann) and holt-winters' exponential smoothing approaches, for forecasting the arrival of foreign tourists to Indonesia. Based on the supply chain strategy and results of data analysis, the following conclusions can be obtained: in forecasting the arrival of foreign tourists to Indonesia using the artificial neural network method the forecasting error rate (mape) is 5.400% and the holt-winters approach has a forecasting error of 5.434%. it appears that the artificial neural network method is relatively more accurate, compared to the holt-winters method, although the difference in mape values is only 0.043%. the forecasting results using these two methods are expected to be a material consideration for the relevant parties, in preparing the planning of providing services to foreign tourists.

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