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HYBRID DOUBLE EXPONENTIAL SMOOTHING METHOD FOR PREDICTING FOREIGN TOURIST ARRIVALS TO BALI

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Abstract. *Tourism is one of the main key factors and income sources for many countries. It has the tendency to be national economy support and is predicted to grow at 4% annually outpacing many other economic sectors of a country. With the huge tourist flow volume each year, Bali has become the most popular tourist destination in Indonesia. Since accurate tourist flow prediction is a key issue in tourism economic analysis and development planning, we are trying to predict the direct foreign tourist arrivals to Bali in this study. A relatively new method, namely Brown's Weighted Exponential Moving Average (B-WEMA), was incorporated with two scenarios, one to find the best model parameters from the historical data, and the other one to predict the foreign tourist arrivals to Bali in 2019. B-WEMA has successfully been implemented and we found that there is a slight increase in foreign tourist arrivals for 2019, with the two biggest increments in January and November 2019.*

Keywords: Bali, B-WEMA, Economy support, Foreign tourist, Prediction

1. **Introduction.** Tourism sector is one of the key factors and income sources for many countries, not to mention Indonesia. It has the tendency to be a national economy support for countries with many natural resources [1] and is predicted to grow at 4% annually which is outpacing many other economic sectors [2].

Indonesia is one of 20 countries with the fastest tourism sector growth [3]. Based on the Travel and Tourism Competitiveness Index (TTCI) – an index to measure the factors and policies that make a country a viable place to invest in Travel and Tourism sector [4] – its rank is always getting better. In 2011, Indonesia was ranked 74 then crawled up to rank 70 in 2013 [5]. Then it was ranked 50 in 2015 and increased eight positions to rank 42 in 2017 [6,7].

Bali is one of the most popular tourist destinations in Indonesia. It is one of the biggest contributors of tourist visit to Indonesia [8]. Based on Badan Pusat Statistik (BPS) report, there were 4,927,937 direct foreign tourist arrivals to Bali in 2016 which was increased to 5,697,739 in 2017 and increased again in 2018 to 6,070,473 [9]. The increasing tourist arrival to Bali each year could improve not only the economic sector in Bali province, but also for the general Indonesia's economic sector.

In this study, we are trying to predict the direct foreign tourist arrivals to Bali province, Indonesia. Accurate tourist flow prediction is a key issue in tourism economic analysis and development planning [10]. There have been many other researches focusing in tourist flow prediction such as the works of Kang and Gu [10], Ren et al. [11], Li et al. [12], and Hopken et al. [13]. They have tried different methods and algorithms to get a better tourist arrivals prediction result, such as Multiple Additive Regression Tree (MART), Bounded Online Gradient Descent (BOGD), PCA-ADE-BPNN hybrid model, and even

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search engine traffic model. In this study, we are trying to predict Bali's foreign tourist arrivals by using the Brown's Weighted Exponential Moving Average (B-WEMA) method.

B-WEMA is a relatively new hybrid Moving Average method, first introduced in 2016. It combines the weighting factors calculation as can be found in Weighted Moving Average (WMA) to Brown's Double Exponential Smoothing (B-DES) method. The proposed method has successfully applied to various cases [14,15]. The implementation of B-WEMA in this study is determined to give contribution for the decision maker in Tourism sector at Bali province, so that they can build a better development plan for Tourism sector by having a proper prediction result of foreign tourist arrivals to Bali province.

The organization of this paper is designed as follows. A more detailed description of B-WEMA will be given in Section 2. After that, we also give a brief explanation of Mean Square Error (MSE) and Mean Absolute Percentage Error (MAPE) as error measurement tools in Section 3. Bali's foreign tourist arrivals prediction will be discussed in Section 4 and some conclusion remarks will be given in Section 5. In the end, we found that B-WEMA method had successfully predicted the direct foreign tourist arrivals to Bali province, Indonesia.

2. **B-WEMA.** Brown's Weighted Exponential Moving Average (B-WEMA) is a hybrid moving average method that combines the weighting factors calculation in Weighted Moving Average (WMA) with the original procedures that can be found in Brown's Double Exponential Smoothing (B-DES). It was first introduced in 2016 by Hansun in his work entitled *A New Approach of Brown's Double Exponential Smoothing Method in Time Series Analysis* [16]. B-WEMA is actually also an improved version of Weighted Exponential Moving Average (WEMA) method which combines WMA with Exponential Moving Average (EMA) method [17].

As stated in [16], B-WEMA procedures can be written as the following.

1) Find a base value, B_t, using

$$B_t = \frac{\sum_{t=k-n+1}^{k} w_t A_t}{\sum_{t=k-n+1}^{k} w_t} \tag{1}$$

Here, n is the span data, k is the relative position of the period currently being considered, A_t is the real value at time t, and w_t is the weight of A_t.

2) Find the prediction value, F_{t+k}, by calculating the single-smoothed series of EMA method using

$$S'_t = \alpha A_t + (1-\alpha) S'_{t-1} \tag{2}$$

and the double-smoothed series using

$$S''_t = \alpha S'_t + (1-\alpha) S''_{t-1} \tag{3}$$

then the prediction value by

$$F_{t+k} = L_t + kT_t \tag{4}$$

where

$$L_t = 2S'_t - S''_{t-1} \tag{5}$$

$$T_t = \frac{\alpha}{1-\alpha}\left(S'_t - S''_{t-1}\right) \tag{6}$$

We start the model by defining

$$S'_{t-1} = S''_{t-1} = B_t \tag{7}$$

Here, α is the constant smoothing factor with a ranged value of 0 to 1, A_t is the real data at time t, L_t is the estimated level at time t, and T_t is the estimated trend at time t.

3) Back to Step 1) until all of the data point remained have been visited.

In the previous study, the value of α is determined as a single constant number; in this study we use a brute force approach to determine α value. By using this approach, we can

get a broader option of α values and we can choose the best α value for each B-WEMA experiment.

3. **MSE and MAPE.** Mean Square Error (MSE) and Mean Absolute Percentage Error (MAPE) are two of many forecast error measurements commonly used in time series analysis. MSE itself is a scale-dependent error, while MAPE is a scale-independent error [18]. MSE is obtained by averaging the square of error sum as depicted in Equation (8) [19], and MAPE can be obtained by averaging the absolute error sum between the forecasted and the actual data, divided by the actual data as shown in Equation (9) [20].

$$MSE = \frac{1}{n}\sum_{t=1}^{n}(A_t - F_t)^2 \tag{8}$$

$$MAPE = \left(\frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right|\right) \cdot 100\% \tag{9}$$

Here, n is the total data of time series, A_t is the real value of data, and F_t is the forecasted value of data.

4. **Prediction Results.** We try to predict the direct foreign tourist arrivals to Bali province in this study. The foreign tourist flows were taken from Bali Government Tourism Office. We used the data recorded monthly in 2017-2018 as can be seen in Table 1.

Table 1. Foreign tourist arrivals to Bali by month

Month	**2017**	**2018**	**Diff. Percentage**
January	460,824	358,065	−22.30
February	453,985	452,423	−0.34
March	425,499	492,678	15.79
April	477,464	516,777	8.23
May	489,376	528,512	8.00
June	504,141	544,550	8.02
July	592,046	624,366	5.46
August	601,884	573,766	−4.67
September	550,520	555,903	0.98
October	465,085	517,889	11.35
November	361,006	406,725	12.66
December	315,909	498,819	57.90
Total	5,697,739	6,070,473	6.54

There are two scenarios we used to predict the foreign tourist arrivals to Bali, 1) by using 2017 data to predict and evaluate the result in 2018 data and to find the best parameters, 2) by using 2017-2018 data and the found parameters to predict 2019 data. Table 2 shows the prediction results of foreign tourist arrivals to Bali province using scenario 1.

From Table 2, the best parameters that give the smallest error (based on MAPE) is 11 span data and 0.28 alpha value. Figure 1 shows the prediction results graph for the best parameters found.

Moreover, we used all the dataset we have and the found best parameters to predict future foreign tourist volume arrivals on scenario 2. Table 3 shows the prediction results for the future foreign tourist arrivals to Bali province in 2019, while Figure 2 depicts its graph.

Moreover, we also compare the prediction results from B-WEMA with other Moving Average (MA) methods. In this case, we choose the Weighted Moving Average method and the original Brown's Double Exponential Smoothing, which are the two building

TABLE 2. Parameters finding

Parameters	Best Alpha	MSE	MAPE
Span = 2	0.38	3734266213.0332	10.720195421983
Span = 3	0.37	3728065584.4404	10.748117920972
Span = 4	0.35	3700304590.1898	10.744131771336
Span = 5	0.33	3594104620.4262	10.531906519315
Span = 6	0.33	3513811025.4578	10.320864761701
Span = 7	0.32	3434593893.5523	9.9759382281167
Span = 8	0.31	3345692904.6228	9.5117398328141
Span = 9	0.30	3228282598.6574	9.0130096519311
Span = 10	0.29	3084353549.1409	8.8174172946491
Span = 11	0.28	2970265677.0199	8.7316937973519
Span = 12	0.27	2916538163.2348	8.7430759596155

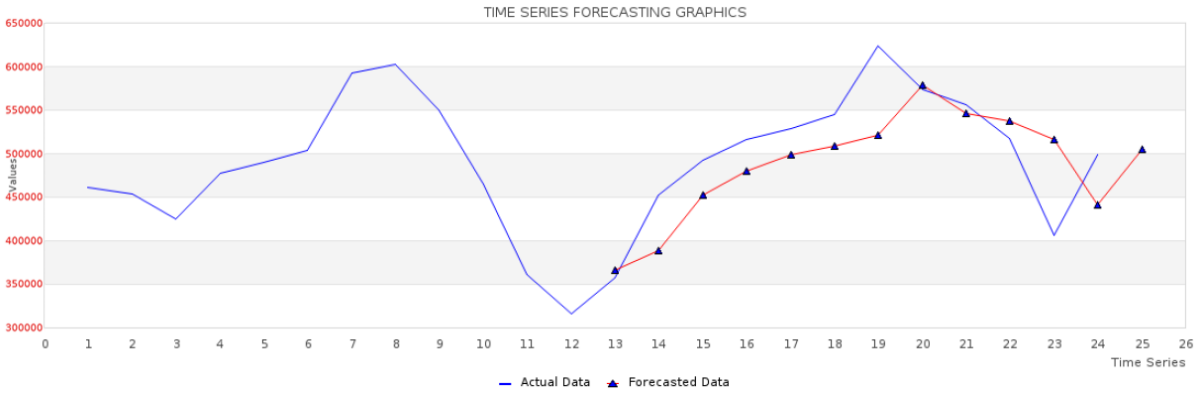

FIGURE 1. 2018 prediction results

TABLE 3. Prediction results for 2019

Month	2018	2019	Diff. Percentage
January	358,065	505,565	41.19
February	452,423	510,971	12.94
March	492,678	514,809	4.49
April	516,777	517,216	0.085
May	528,512	518,505	−1.89
June	544,550	518,743	−4.74
July	624,366	516,479	−17.28
August	573,766	513,697	−10.47
September	555,903	510,917	−8.09
October	517,889	508,959	−1.72
November	406,725	510,135	25.43
December	498,819	511,168	2.48
Total	6,070,473	6,157,164	1.43

methods for B-WEMA method. Table 4 shows the MSE and MAPE values found by using three different MA methods with 11 span data. As can be seen, B-WEMA has the smallest MSE and MAPE values and therefore, give a better prediction accuracy than WMA and B-DES methods.

5. **Conclusion.** Based on the experimental results, it can be concluded that Brown's Weighted Exponential Moving Average (B-WEMA) has been successfully implemented

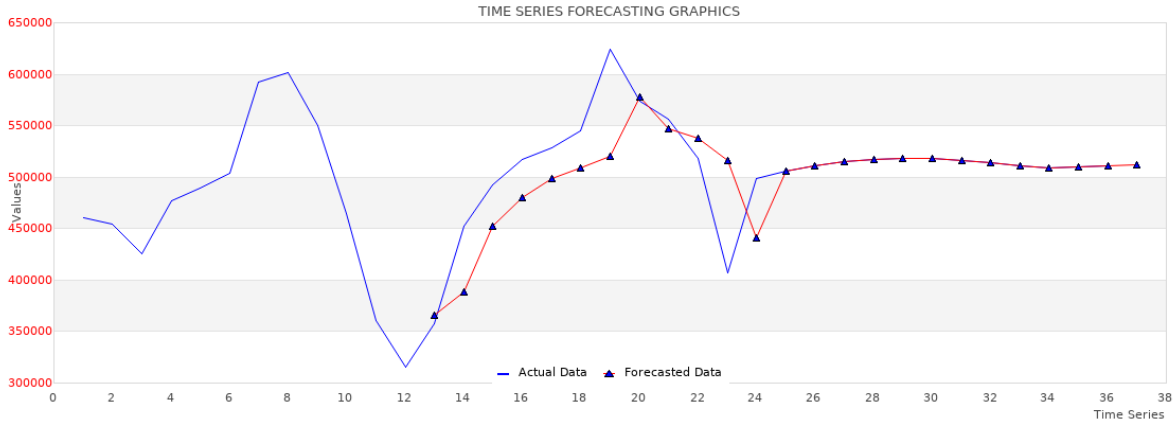

FIGURE 2. 2019 prediction results

TABLE 4. MSE and MAPE of WMA, B-DES, and B-WEMA for 2019

Error Measurements	MA Methods		
	WMA	B-DES	B-WEMA
MSE	3264173353.4916	3477418405.9561	1485132838.5456
MAPE	7.4297595387612	7.6619065057852	4.3658677308011

to predict the direct foreign tourist arrivals to Bali province, Indonesia. Using 2017 and 2018 data record, we had found the best parameters which were then being used to predict the future 2019 data. There is a slight increase of foreign tourist arrivals in 2019, where the two biggest ones are happening in January 2019 and November 2019.

In the near future, we can take a further exploration to predict the foreign tourist arrivals to Bali based on their nationality. We could also try to compare the prediction results using B-WEMA with other hybrid moving average methods, such as WEMA and H-WEMA.

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