Journal of Applied Mathematics and Modelling
https://ejournal.cibnusantara.org/jamm
E-ISSN: 3090-5524

Application of Exponential Smoothing Method in Forecasting the Number of Visitors to Kinantan Zoo Bukittinggi, Indonesia

Alya Nasyifa Putri and Muhammad Adzan*

Electrical Engineering Department, Padang State Polytechnics, Padang, West Sumatera Province, Indonesia

*Corresponding email: muhammadzan@gmail.com

Article history:
Received : February 20th, 2025
Accepted : March, 31th, 2025
Published : April 15th, 2025

DOI :
https://doi.org/10.64570/jamm.v1i1.6

Abstract: Kinantan Zoo Bukittinggi is one of the main tourist attractions in West Sumatra, experiencing fluctuations in visitor numbers due to various factors such as holidays, weather, and regional policies. Accurate visitor forecasting is essential for effective management, resource optimization, and strategic planning. This study aims to apply the Exponential Smoothing method to predict the number of visitors to Kinantan Zoo Bukittinggi. The forecasting model was evaluated using the Mean Absolute Percentage Error (MAPE) to assess its accuracy. Secondary data from the Bukittinggi City Tourism, Youth, and Sports Office covering the years 2012 to 2023 were analyzed. Microsoft Excel, with the Data Analysis and Solver tools, was used to process the data and optimize the smoothing parameter α. The initial forecasting results yielded a MAPE value of 21%, indicating a reasonable level of accuracy. Further optimization using Solver reduced the MAPE value to 17%, demonstrating improved prediction reliability. The forecasted number of visitors for 2024 is approximately 937,665. The findings suggest that the Exponential Smoothing method is effective in predicting visitor trends at Kinantan Zoo. These results can assist in planning and decision-making, particularly in enhancing operational efficiency and marketing strategies. Future research may explore alternative forecasting models to further refine prediction accuracy.

Keywords: Exponential Smoothing, forecasting, Kinantan Zoo, MAPE

1. Introduction

Kinantan Zoo Bukittinggi is one of the main tourist destinations in West Sumatra that attracts many visitors every year. The fluctuation of the number of visitors is influenced by various factors, such as the holiday season, weather conditions, and regional tourism policies. Therefore, forecasting the number of visitors is an important aspect in zoo management to improve service quality, optimize resources, and develop better development strategies.

Forecasting is a quantitive technique or method for estimating what will happen in the future and off course requires past data as a reference (Alrahman et al., 2017). Forecasting is uncertain. Forecasting uncertainty is caused by several factors, namely competition, consumer behavior, business cycles, sales efforts,

product life cycles, random variations and others. To get accurate predictions, these data sources need to be supported by the right forecasting method (Oktavia et al., 2023).

One of the methods widely used in time series data forecasting is the Exponential Smoothing method. Exponential Smoothing is a time series forecasting technique that applies exponential weighting to past data to produce more accurate predictions (Handoko, 1984). This method is able to capture trend and seasonal patterns in historical data and provide accurate estimates of the number of visitors in the future. By implementing this method, the management of Kinantan Zoo can obtain better information in making decisions related to operational management and marketing strategies.

To assess the accuracy of the Exponential Smoothing method, this study employs the Mean Absolute Percentage Error (MAPE) as the evaluation metric. MAPE measures the forecasting error by calculating the average percentage deviation between actual and predicted values, allowing for an objective assessment of the method's effectiveness.

The purpose of this study is to apply the Exponential Smoothing method in forecasting the number of visitors to Kinantan Zoo Bukittinggi. The results of this study are expected to help in planning and managing the zoo more effectively, thus providing benefits for managers and improving the tourism experience for visitors.

2. Methods

This study used secondary data sourced from the Bukittinggi City Tourism, Youth, and Sports Office, 2024. The data used is data on the number of visitors to the Kinantan Bukittinggi Zoo from 2012 to 2023. The steps taken in this study are:

1. Collecting data.
2. Processing data using Exponential Smoothing.
3. Calculate the MAPE value.
4. Use Solver to find the best alpha value so that the MAPE value can be minimized.
5. Analyze the MAPE value.

Calculations are carried out using Microsoft Excel with the Data Analysis and Solver tools.

Exponential Smoothing Method

Exponential Smoothing method is one of the time series forecasting methods that is widely used because of its ability to capture historical data trend patterns effectively. This method works by giving more weight to the latest data, so that it can provide predictions that are more responsive to trend changes than other simple forecasting methods.

This method is used when the data has a horizontal pattern. This method uses one smoothing parameter, namely α, which has a value in the range of 0-1. The forecasting process can be done using Equation (1) (Ostertagová & Ostertag, 2011).

$$Ft = F_{t-1} + \alpha\ (D_{t-1} - F_{t-1}), \quad (1)$$

Note:

Ft : approximate value at t

F_{t-1}: approximate value at t-1

α : exponential smoothing constant

D_{t-1}: the value at t-1

In qualitative research, in order to ensure trustworthiness, the authors should carefully consider four aspects; transferability, credibility, dependability, and confirmability. Transferability is how the author(s) can explicate to which alternative contexts the findings might be applied. The second criterion, credibility, refers to accurate data presentations by the authors. In other words, the author(s) are able to accurately and richly describe the phenomenon in the research questions. The dependability of a qualitative study lies in a clear explanation of research procedures and instruments used so that other researchers will be able to collect data in similar conditions. That is to say, if these similar conditions are applied, similar data are obtained. Lastly, confirmability is how the author(s) can match the findings and interpretations with the data; all claims must be supported by data. To conclude, these criteria require the authors to write the articles in such a way that the readers can easily follow it, from the backgrounds of the research to the conclusion.

On the other hand, quantitative research has several criteria of trustworthiness, namely generalizability, internal validity, reliability, and objectivity. When research findings can be implemented across other wider contexts, it is called generalizability. Research is called to have internal validity if it is able to measure what the research seeks to measure. If findings can be replicated exactly in similar contexts and procedures, then the research is reliable or reproducible. In a quantitative or objective study, objectivity is about unbiased data.

Mean Absolute Percentage Error (MAPE)

MAPE is the percentage error to the actual value in a certain time period (Montgomery, et.al, 2015). The smaller the MAPE value, the more accurate the forecasting method is (Oktavia, et.al, 2023). The MAPE value can be calculated by

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{Y-Y'}{Y}\right|\ x\ 100\%\ , \quad (2)$$

Note:

n : amount of data

Y : sales value

Y' : predicted sales value

The interpretation of MAPE values can be seen in the table below.

Table 1. Interpretation of MAPE Values

MAPE Value	Interpretation
≤ 10	Forecasting results are very accurate
10 - 20	Forecasting results is good
20 - 50	Forecasting results are reasonable (good enough)
> 50	Forecasting results are not accurate

3. Results and Discussion

The table and figure below show the number of visitors to Kinantan Bukittinggi Zoo from 2012 to 2023.

Table 2. The Number of Visitors

No	Year	Number of Visitors
1	2013	486.995
2	2014	467.242
3	2015	623.711
4	2016	685.791
5	2017	632.724
6	2018	777.367
7	2019	729.705
8	2020	463.775
9	2021	615.018
10	2022	789.076
11	2023	986.527

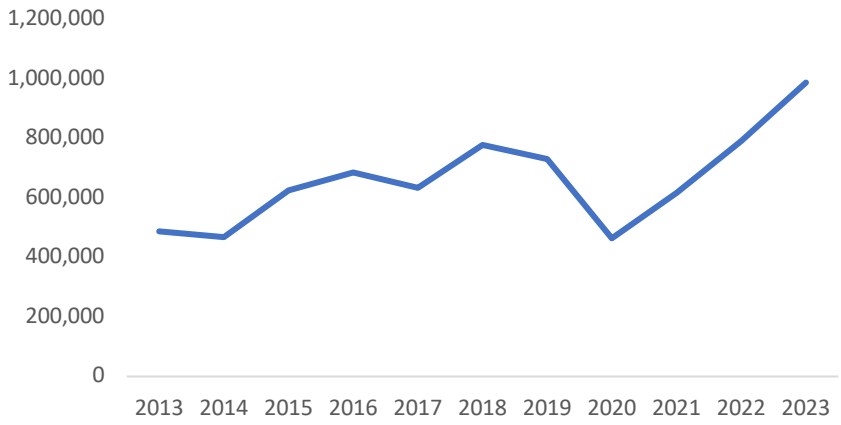

Figure 1. Visitors Data Graph

From the table 2 and graph 1 above, it is clear that there was a fluctuation in the number of zoo visitors and a significant decrease in the number of visitors occurred in 2020. Next, by using the Data Analysis tool in Microsoft Excel, we will look for predictions of the number of visitors in 2024. The calculation results with Ms. Excel can be seen in the table below.

Table 3. Exponential Smoothing with $\alpha = 0{,}2$

No	Year	Number of Visitors	Prediction	Abs Error	APE
1	2013	486.995	#N/A	#N/A	#N/A
2	2014	467.242	486.995	19753	0,042276
3	2015	623.711	483044,4	140666,6	0,225532
4	2016	685.791	511177,72	174613,28	0,254616
5	2017	632.724	546100,38	86623,624	0,136906
6	2018	777.367	563425,1	213941,899	0,275214
7	2019	729.705	606213,48	123491,519	0,169235
8	2020	463.775	630911,78	167136,785	0,360383
9	2021	615.018	597484,43	17533,5724	0,028509
10	2022	789.076	600991,14	188084,858	0,238361
11	2023	986.527	638608,11	347918,886	0,35267
12	2024		708191,89		

Table 3 show that the number of visitors in 2024 is 708191.89 with a MAPE value of 21%. From the results of this MAPE, the prediction results are still quite good. Next, the best α value will be sought in order to obtain a minimum MAPE value. This best α search uses the Solver tool in Ms. Excel. With Solver, the results obtained are as in the table below.

Table 4. Exponential Smoothing with Solver

No	Year	Number of Visitors	Prediction	Error	APE
1	2013	486.995	#N/A	#N/A	#N/A
2	2014	467.242	486.995	19753	0,042276
3	2015	623.711	515738,225	107972,8	0,173113
4	2016	685.791	580975,043	104816	0,15284
5	2017	632.724	649924,355	17200,35	0,027185
6	2018	777.367	690757,204	86609,8	0,111414
7	2019	729.705	762473,033	32768,03	0,044906
8	2020	463.775	806978,294	343203,3	0,740021
9	2021	615.018	770788,868	155770,9	0,253279
10	2022	789.076	782668,691	6407,309	0,00812
11	2023	986.527	839163,324	147363,7	0,149376
12	2024		937665,258		

From the table 4 above, we get a MAPE value of 17%. This means that the prediction results using the Exponential Smoothing method are quite accurate. So, by using $\alpha = 0.269971931$, we can get a prediction of the number of visitors in 2024 of 937.665 visitors.

Conclusion

This study applied the Exponential Smoothing method to forecast the number of visitors to Kinantan Zoo Bukittinggi. The analysis used historical visitor data from 2012 to 2023, with accuracy assessed using the Mean Absolute Percentage Error (MAPE). Initially, the MAPE value was found to be 21%, indicating a reasonably good forecasting performance. However, by optimizing the smoothing parameter (α\alpha$\alpha$) using Solver, the MAPE value improved to 17%, making the predictions more accurate. The results suggest that the Exponential Smoothing method effectively captures visitor trends and fluctuations, providing valuable insights for zoo management. The predicted number of visitors for 2024 is approximately 937,665. This forecast can assist in resource allocation, operational planning, and marketing strategies to enhance the visitor experience. Future research could explore other forecasting methods or incorporate additional influencing factors to further improve prediction accuracy.

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