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Research Article

Forecasting Model for Tourist Numbers: A Case Study of Tamansari Banyuwangi Tourism Village

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Abstract.
Developing a successful tourism village requires effective management, which includes forecasting tourist numbers. This study forecasts the number of visitors to Tamansari Banyuwangi Tourism Village, one of four tourist villages with independent status who had received national and international recognition. The Covid-19 pandemic from early 2020 to the end of 2022 had a considerable effect on tourist traffic around Tamansari Village's popular destinations, including Kawah Ijen, Sendang Seruni, and Taman Gandung Terakota, as well as the management of Tamansari Tourism Village; specifically, BUMDesa Ijen Lestari. Time series forecasting was performed using the decomposition method and Holt-Winter exponential smoothing based on tourist data from 2016 to September 2023. Based on the smaller RMSE and MAPE values, the Holt-Winter forecasting model is better, with $\alpha = 0.05$; $\beta = 0.12$; and $\gamma = 0.35$ as the utilized smoothing parameters. Additionally, the Holt-Winter method suggests an increasing trend for the following year's forecasting results, with seasonal data being present in the July and December periods. Overall, it delivers more accurate information. The study's findings can serve as a foundation for BUMDesa Ijen Lestari to create policies for the expansion of Tamansari Tourism Village and its surrounding destinations.

Keywords: decomposition, Holt-Winter, Tamansari Banyuwangi tourism village, time series forecasting

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1. Introduction

Tamansari Village is situated in the western region of Banyuwangi City's Licin sub-district, about 24 km away from the city centre. The village gained recognition as a smart village-based tourism destination since early 2016. Most notably, Tamansari Tourism Village was honoured with the Community Based Tourism (CTB) category award at the 2023 ASEAN Tourism Standard event. Tamansari Village has established itself as a prime destination for both domestic and international tourists, owing to its abundant offerings and accomplishments. Additionally, other villages and cities frequently study or use it as a pilot tourism village [1].

Tamansari village has potential in several areas, including natural tourism, MSMEs, and traditions. Regarding tourism, Tamansari Village is famous for Ijen Crater Nature Tourism, which serves as a symbol of Indonesian tourism recognized worldwide as a world Geopark [2]. In addition, Sendang Seruni offers a water pool tour sourced from mountain springs and managed by the surrounding community. Pine Forest Tourism is being developed as the next tourist destination, featuring a flower village and a Miner's village. Along with the Grand Harvest Resort and Villas, Taman Gandung Terakota, and Jiwa Jawa Resort in the Tamansari tourism village for lodging options, there are also numerous homestays available, all managed by BUMDesa Ijen Lestari.

Managing existing destinations in Tamansari tourism village requires a clear understanding of tourist visit patterns for local governments, tourism managers, and businesses surrounding tourist attractions. A crucial aspect of planning and managing sustainable tourist destinations in Tamansari is forecasting the number of tourists visiting the village.

Forecasting tourist numbers is a formidable task due to the intricate nature of its influencing factors. These factors involve seasonality, special events (including the Covid-19 pandemic), economic trends, marketing promotions, political stability, and changes in consumer preferences [3]. Additionally, accurate forecasting methods for the number of tourists in Tamansari require a careful analytical approach due to seasonal and stochastic variations in traveler data. This research aims to develop an effective and precise forecasting method using the Decomposition and Holt-Winters exponential smoothing methods.

An effective tourism forecasting model relies on historical data related to tourist visitation (pre-Covid 19, during-Covid 19, and post-Covid 19), weather and climate conditions, and other pertinent external factors to predict future visitation patterns. The study results can assist stakeholders in better planning, optimizing resources, enhancing the tourist experience, and bolstering revenue from the tourism sector in the region.

There are several techniques available for time series forecasting, such as the decomposition method and Holt-Winter's Exponential Smoothing (also known as Triple Exponential Smoothing), which are effective approaches for predicting time series data. Decomposition methods have been primarily employed for load, price, and distributed generation forecasting in power systems, as reported by Mbuli et al. [4].

Nava et al. [5] present a multistep-ahead forecasting approach that integrates empirical mode decomposition (EMD) with support vector regression (SVR) for financial time series. For additional information, refer to references [6-8].

Holt-Winter exponential smoothing is a widely used method with high accuracy in forecasting time series data. Some research in time series forecasting includes [9] who conducted a study on Covid-19 forecast using Holt-Winters exponential smoothing. They found that the most effective forecasting model for trend and seasonality smoothing parameters $\alpha = 0.1$ and $\beta = \gamma = 0.5$, respectively, gave the smallest MAPE value of 6.14. Heydari et al. [10] use Holt-Winters time series models to predict climate parameters (case study: Robat Garah-Bil station, Iran). For further information on the application of Holt-Winter exponential smoothing, refer to sources [11-15].

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This research aims to identify the key determinants of tourism volume in Tamansari. The insights gained could inform natural tourism management policies at both the regional and national levels, with a particular focus on strengthening Tamansari Tourism village as a sustainable nature-based destination while prioritizing community-based tourism. Moreover, the Tamansari tourism village community must continue to innovate creatively in the digital realm to support the establishment of Ijen Geopark by UNESCO.

2. Materials and Methods

This study is part of applied research and case study that focuses on practical application and the development of knowledge derived from basic research, including digital and human literacy studies, as well as quantitative descriptive research conducted with a statistical approach. The research steps are as follows (Figure 1):

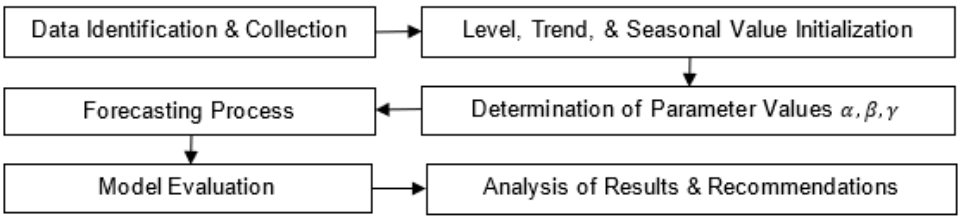

Figure 1: Research steps.

2.1. Data identification and collection

The study employed secondary data collected by BUMDesa Ijen Lestari, focusing on tourist numbers in Tamansari Tourism Village before, during, and after the Covid-19 pandemic. The analyzed data ranges from 2016 to August 2023 following an identification and integration process.

2.2. Level, trend, and seasonal value initialization

The initial step in utilizing time series forecasting techniques such as decomposition and Holt-Winter exponential smoothing methods or other methods where level, trend, and seasonality are present is to initialize the level, trend, and seasonal values. The objective of initialization is to provide an initial approximation for these components prior to forecasting.

2.3. Determination of parameter values α, β, γ

Determining the values of α, β, and γ parameters in the Holt-Winter exponential smoothing method is a crucial stage in time series forecasting. These parameters have a significant impact on the forecasting model's level (α), trend (β), and seasonal components (γ).

2.4. Forecasting process

2.4.1. Decomposition

The periodic series decomposition method decomposes periodic series data into multiple patterns, including trend and seasonal, and identifies each component individually. This is done to improve forecasting accuracy and better understand data behavior.

Additive and multiplicative decomposition models can be employed to predict both trend and seasonal patterns. Mathematically, the additive decomposition model can be expressed [8]:

$$X_t = T_t + S_t + I_t \tag{1}$$

and for multiplicative is below:

$$X_t = T_t \times S_t \times I_t \tag{2}$$

With T_t is trend component in period t and S_t is seasonal component in period t

2.4.2. Holt-Winters exponential smoothing

According [16], If the data contains both trend and seasonal components, the Holt-Winters Exponential Smoothing method can be used, which requires three smoothing parameters, namely α (for the level of the process), β (for trend smoothing), and γ (for the seasonal component). The MAPE (Mean Absolute Percentage Error) and RMSE (Root Mean Square Error) will be minimized through the selection of optimal values for α, β, and γ. The formula for Holt-Winter Exponential Smoothing is as follows (Table 1):

TABLE 1: Formula Holt-Winter exponential smoothing.

Value Initialization	Formula
Level (L_t)	$L_t = \alpha \frac{Y_t}{S_t - M} + (1-\alpha)(L_{t-1} + T_{t-1})$
Trend (T_t)	$T_t = \beta \left(L_t - L_{t-1}\right) + (1-\beta) T_{t-1}$
Seasonal (S_t)	$S_t = \gamma \frac{Y_t}{L_t} + (1-\gamma) S_{t-M}$
Forecast 'within' data set (F_{t+k})	$F_{t+1} = (L_t + T_t) S_{t-M+1}$ $F_{t+k} = (L_t + k \bullet T_t) S_{t-M+k}$

With α, β, and γ represent the smoothing parameters for level, trend, and seasonality, respectively, with values ranging from 0 to 1 [17].

2.5. Determining MSE, RMSE, MAPE values

When analyzing the model, it is necessary to pay attention to the following indicators: Mean Absolute Deviation (MAD), Mean Squared Error (MSE), Root Mean Squared Error

(RMSE), Mean Absolute Percentage Error (MAPE) [18]. The following is the formula used (Table 2):

Table 2: MAD, MSE, RMSE, and MAPE formula.

Indicators	Formula
MAD	$MAD = \frac{\sum_{t=1}^{n} X_t - F_t}{n}$
MSE	$MSE = \frac{\sum_{t=1}^{n} X_t - F_t^2}{n}$
RMSE	$RMSE = \sqrt{\frac{\sum_{t=1}^{n} X_t - F_t^2}{n}}$
MAPE	$MAPE = \frac{\sum_{t=1}^{n} \frac{X_t - F_t}{X_t}}{n} \times 100\%$

2.6. Analysis of Results and Recommendations

The obtained results will be analyzed comparatively, taking into account the components in the previous point, in order to obtain the best model for forecasting the number of tourists in Tamansari Tourism Village. The model and forecasted outcomes in the following years can serve as a reference for suggesting policies and enhancing tourism sites in the surroundings of Tamansari Banyuwangi Tourism Village.

3. Results and Discussion

The information utilized in this analysis was provided by Mr. Yatman, the chairman of BUMDesa Ijen Lestari. The information concerns the tourist quantity distribution between January 2016 and August 2023, including the Covid-19 pandemic period when there was a significant decrease. Notably, from April to June 2020, Tamansari Tourism Village had no visitors. A chart showcasing the number of tourists at Tamansari Tourism Village from January 2016 to August 2023 follows.

According to Figure 2, the tourist data displays both a trend pattern and seasonal variation. The trend appears to decline as the Covid-19 pandemic approaches but shows signs of positive growth post-pandemic. Additionally, there is clear evidence of a seasonal trend, with a marked increase in tourist numbers during July and December.

3.1. Forecasting using decomposition

The initial stage for smoothing time series through decomposition involves identifying the centred moving average (MA), the seasonal relative, and the seasonal index values.

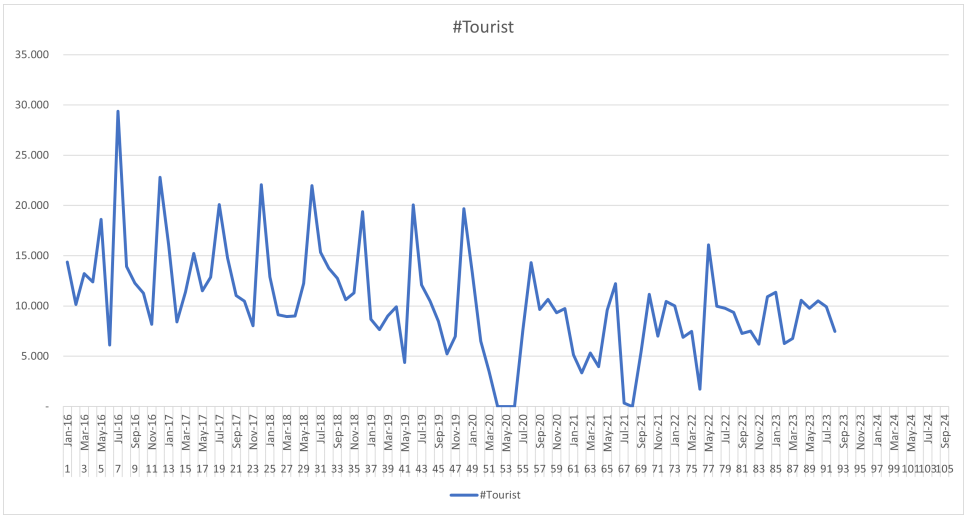

Figure 2: Graph of the number of tourist visits to Tamansari Tourism Village.

The seasonal index value determines the deseasonalized value, and the trend value derives from the linear trend equation, which is formed from the time-series data.

The outcomes of time series modeling using the decomposition method are presented below:

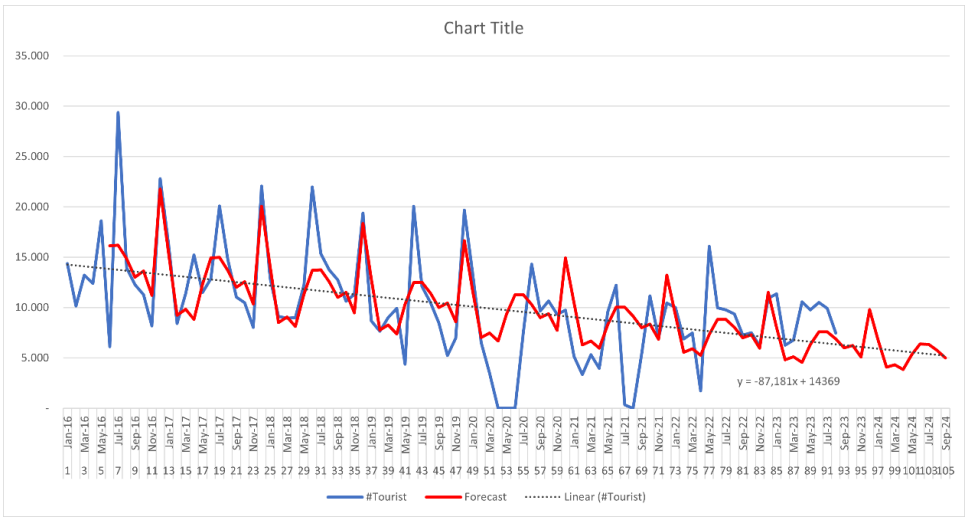

Figure 3: Graph of the forecast results of the decomposition method and the linear trend.

Based on Figure 3, the multiplicative decomposition forecast line exhibits precise outcomes in close proximity to actual values. Nevertheless, the data exhibits a substantial decline during the timeframe of April through June 2020 due to the Covid-19 pandemic, thereby affecting the overall pattern. As a result of this, the findings of the linear regression equation have been impacted.

Based on equation (1), the forecasting model obtained using the decomposition method is presented in the Table 3.

Table 3: Seasonal index and trend component for forecasting of time series data use decomposition.

Time	S_t	Time	S_t	Time	S_t	Time	S_t	T_t
Jun	1,1658	Sept	0,9586	Des	1,6329	Mar	0,7535	$T_t = y = -87,181x + 14369$ With x=6 to 105 (from June 2016 to September 2024)
Jul	1,1779	Oct	1,0094	Jan	1,1533	Apr	0,6798	
Aug	1,0846	Nov	0,8373	Feb	0,7018	May	0,9576	

The forecasted number of tourists for the upcoming year in Tamansari Tourism Village is as follows:

Table 4: Forecast results of tourist numbers for the next month (decomposition).

Time	Forecast	Time	Forecast	Time	Forecast	Time	Forecast
Oct-23	6232	Jan-24	6819	Apr-24	3841	Jul-24	6348
Nov-23	5096	Feb-24	4088	May-24	5328	Aug-24	5750
Dec-23	9797	Mar-24	4324	Jun-24	6384	Sep-24	4999

Table 4 indicates that the decomposition method forecasts an average of 5751 tourists visiting Tamansari tourism village per month in the upcoming year. Additionally, the forecast suggests a decrease in tourism with December having the highest volume.

3.2. Forecasting using Holt-Winter

The first step of Holt-Winter forecasting requires calculation of the end-of-year level, which is derived from the average value recorded in 2016. The subsequent process employs the equation provided in Table 1 to ascertain (L_t), trend (T_t), and seasonal (S_t) values for the upcoming computation. During this stage α, β, and γ values are randomly assigned and will be optimized later for identifying the minimum combination.

The outcomes of analyzing time series through the use of the Holt-Winters approach are presented below.:

The results in Figure 4 exhibit high similarity to those acquired through the use of the decomposition method. The absence of data during the Covid-19 pandemic has noticeably impacted the process of smoothing. By carefully examining the trend and seasonal patterns that were disclosed in the forecasting data spanning from April 2022 to August 2024, it is evident that there will be a gradual increase that will continue into the following year.

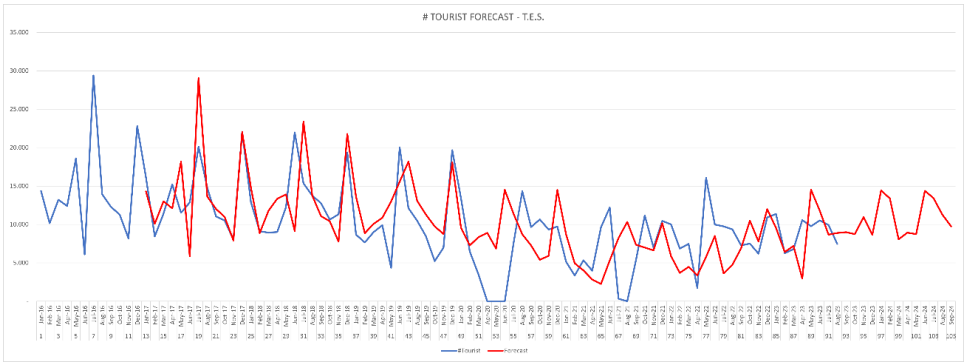

Figure 4: Graph of the forecast results of the Holt-Winter exponential smoothing.

The smoothing parameters (α, β, and γ) were selected to minimize RMSE via the Generalized Reduced Gradient Non-Linear method. This resulted in a combination $\alpha = 0.05$; $\beta = 0.12$; and $\gamma = 0.35$. According to the equation in Table 1, the forecast model that implements Holt-Winter is achieved with $F_{t+k} = (10744 + 170k)S_{t-M+k}$, as demontrated below (Table 5).

TABLE 5: Level (L_t), Trend (T_t), Seasonal (S_t), and k.

Level (L_t)	**Trend** (T_t)	**Seasonal** (S_t)	k
10.744	170	Aug-22=0,8236	
		Sep-22=0,7889	Sep-23=1
		Oct-22=0,9732	Oct-23=2
		Nov-22=0,7574	Nov-23=3
		Dec-22=1,2426	Dec-23=4
		Jan-23=1,1373	Jan-24=5
		Feb-23=0,6752	Feb-24=6
		Mar-23=0,7372	Mar-24=7
		Apr-23=0,7123	Apr-24=8
		May-23=1,1557	May-24=9
		Jun-23=1,0640	Jun-24=10
		Jul-23=0,8841	Jul-24=11
		Aug-23=0,7525	Aug-24=12

The forecasted number of tourists for the upcoming year in Tamansari Tourist Village is as follows (Table 6).

Table 6 predicts that Tamansari tourism village will receive an average of 10,832 visitors per month in the upcoming year. The forecast also indicates an increase in

Table 6: Forecast results of tourist numbers for the next month (Holt-Winter).

Time	Forecast	Time	Forecast	Time	Forecast	Time	Forecast
Oct-23	8.744	Jan-24	14.410	Apr-24	8.926	Jul-24	13.426
Nov-23	10.954	Feb-24	13.382	May-24	8.745	Aug-24	11.306
Dec-23	8.654	Mar-24	8.060	Jun-24	14.386	Sep-24	9.752

tourist volume, with the highest peak expected from December 2022 to February 2023 and June to August 2024.

3.3. Model evaluation

The modeling outcomes using both techniques will be evaluated by comparing multiple metrics, exhibited in Table 2, resulting in the subsequent findings.

Table 7: Evaluation model of both methods.

Forcast Method	MAD	MSE	RMSE	MAPE
Decompotition	2661	25842481	5084	62%
Holt-Winter	3278	22318285	4724	49.5%

Table 7 indicates that the Decomposition method has a smaller MAD value than Holt-Winter. However, Holt-Winter outperforms the Decomposition method in the other three indicators, specifically MSE, RMSE, and MAPE.

The forecasting model cannot be considered effective with an approximate MAPE value of 50%. Due to the Covid-19 pandemic, tourist destinations were closed, including the Tamansari tourist village, resulting in zero tourist attendance from April to June 2020 and August 2023. This caused a disorganized smoothing process, ultimately leading to intriguing data in the following year.

The Decomposition method has limitations in its ability to effectively explain seasonal patterns and trends. This is demonstrated in the obtained forecasting results, which indicate a decreasing trend for the upcoming year. Additionally, the results are impacted by the lack of pandemic data and a negative (downward) trend in the linear regression equation based on existing data patterns.

Compared to the Holt-Winter method, the forecasting results indicate a positive trend (upward) post-pandemic. Additionally, the findings suggest that the data distribution reflects both seasonal and trend patterns. Specifically, the Holt-Winter technique offers

greater accuracy in predicting time series data for tourist numbers in Tamansari Tourism Village than the Decomposition technique.

4. Conclusion and Suggestions

Forecasting time series data using the decomposition method typically indicates a decline, as the absence of data during the Covid-19 pandemic has had a substantial influence on forming the subsequent year's forecasting model. Unlike the Holt-Winter method, the analysis of time series data indicates a decline during the Covid-19 pandemic; however, subsequently, the model exhibits a tendency to increase while continuing to display trend and seasonal patterns.

Overall, it can be deduced that the Holt-Winter approach yields a superior forecast model compared to the Decomposition approach, as evidenced by the smaller RMSE and MAPE values.

Suggestions for future research could focus on using post-pandemic Covid-19 time series data until December 2023, excluding pandemic data. The data can be analysed using the Holt-Winter method, as well as other methods such as Artificial Neural Network.

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