



Analysis of the Number of International Tourists Visiting Riau Province Over the Last Six Years Using R

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ARTICLE INFO	ABSTRACT
Published Online: 06 January 2026	This study presents a comprehensive time series analysis of international tourist arrivals to Riau Province, Indonesia, from 2019 to 2024. The research aims to model, compare, and forecast monthly tourist arrivals using the Holt-Winters additive and multiplicative exponential smoothing methods, implemented in R. The dataset, sourced from the official BPS-Statistics Indonesia Riau Province and covering the pre-pandemic, pandemic, and recovery periods, provides a unique opportunity to assess the impact of global disruptions and subsequent recovery on regional tourism. Data preprocessing, model fitting, and evaluation were conducted in R, with model performance assessed using Mean Absolute Error (MAE). The results indicate that the Holt-Winters multiplicative model outperforms the additive model, particularly in capturing the pronounced seasonal fluctuations and level-dependent variance observed in the data. Forecasts for 2025 suggest a continued recovery in international arrivals, with implications for tourism planning and policy in Riau. The study underscores the value of robust time series forecasting for evidence-based decision-making in regional tourism management and highlights the adaptability of R for reproducible, transparent analysis. Recommendations are provided for future research, including the integration of exogenous variables and the exploration of advanced forecasting techniques.
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KEYWORDS: international tourists, Riau Province, BPS, data analysis, R programming, Holt-Winters.	

INTRODUCTION

Riau Province, situated on the eastern coast of Sumatra and comprising both mainland and archipelagic territories, is a vital gateway for international tourism in Indonesia. Its strategic location, bordering Malaysia and Singapore, positions Riau as a primary entry point for foreign visitors, particularly through its major ports and Sultan Syarif Kasim II International Airport. The province boasts a diverse array of attractions, including pristine beaches, cultural heritage sites, and vibrant urban centers such as Batam and Pekanbaru. Tourism has become a cornerstone of Riau's economic development, significantly contributing to the regional GDP, employment, and foreign exchange earnings.

In recent years, Riau has experienced dynamic shifts in international tourist arrivals, influenced by global trends, regional competition, and, most notably, the COVID-19 pandemic. The pandemic precipitated an unprecedented

decline in international mobility, severely impacting the tourism sector and related industries. However, the subsequent recovery, driven by policy interventions, vaccination campaigns, and the easing of travel restrictions, has seen a gradual resurgence in tourist flows.

Indonesia, as a leading tourism destination in Southeast Asia, has prioritized the sector in its national development agenda. The government's strategic plans, such as the National Medium-Term Development Plan (RPJMN) and the National Tourism Development Master Plan (RIPPARNAS), set ambitious targets for international and domestic tourist arrivals, foreign exchange earnings, and employment. The tourism sector's contribution to national GDP reached 5.25% in 2018, with foreign exchange earnings of IDR 229.5 trillion and employment for 12.7 million people.

The COVID-19 pandemic, however, disrupted this trajectory, causing a dramatic contraction in international arrivals and

associated revenues. The recovery phase has necessitated adaptive strategies, including digital transformation, health and safety protocols, and targeted marketing to restore confidence and demand.

Accurate forecasting of tourist arrivals is critical for effective tourism planning, resource allocation, and policy formulation. Time series analysis enables stakeholders to model historical patterns, identify trends and seasonality, and generate data-driven forecasts for future periods. Such forecasts inform decisions on infrastructure investment, marketing campaigns, and crisis management, particularly in the face of shocks such as pandemics or economic downturns. R, as an open-source statistical computing environment, offers a robust suite of packages for time series analysis, visualization, and forecasting. Its reproducibility, transparency, and flexibility make it an ideal platform for academic and applied research. The Holt-Winters exponential smoothing method, with its additive and multiplicative variants, is particularly suited for time series exhibiting both trend and seasonal components. The method's adaptability to different seasonal patterns, combined with its implementation in R's core and contributed packages, facilitates rigorous model comparison and evaluation.

This study leverages these methodological strengths to analyze and forecast international tourist arrivals to Riau Province, providing actionable insights for regional tourism stakeholders.

LITERATURE REVIEW

Tourism demand forecasting has garnered extensive scholarly attention due to its practical importance and methodological complexity. Traditional approaches include time series models (e.g., ARIMA, exponential smoothing), causal models (regression with exogenous variables), and, more recently, machine learning techniques such as artificial neural networks and hybrid models.

Exponential smoothing methods, particularly the Holt-Winters approach, have been widely applied due to their simplicity, interpretability, and effectiveness in capturing trend and seasonality. Comparative studies often benchmark Holt-Winters against ARIMA and other models, with performance evaluated using metrics such as MAE, RMSE, and MAPE.

The Holt-Winters method extends simple exponential smoothing by incorporating separate smoothing equations for the level, trend, and seasonal components of a time series. The additive variant is suitable when seasonal fluctuations remain relatively constant over time, while the multiplicative variant is preferred when the seasonal amplitude varies with the series level. The method's recursive updating and parameter optimization (via minimization of squared prediction error) enable adaptive modeling of complex time series.

Numerous studies have applied the Holt-Winters method to tourism data at national, regional, and destination levels. For

example, Lima et al. (2019) compared additive and multiplicative Holt-Winters models for e-commerce sales, finding the multiplicative model superior when seasonal variation increased with the series level. Ismail et al. (2025) employed the additive Holt-Winters model to forecast international tourist arrivals in Malaysia, capturing both the pandemic-induced decline and the subsequent recovery. Ulfatmi et al. (2022) applied both additive and multiplicative Holt-Winters models to forecast foreign tourist arrivals in Riau Islands Province, concluding that the multiplicative model yielded the lowest MAE and best fit to the data.

Comparative studies in Indonesia have also evaluated Holt-Winters against ARIMA and SARIMA models, yielding mixed results that depend on the data characteristics and forecast horizons. While ARIMA models may outperform Holt-Winters in some contexts, the latter remains a practical choice for short-term forecasting with pronounced seasonality.

Indonesian research on tourism forecasting has addressed both national and regional contexts. Yendra et al. (2025) applied Holt-Winters models to inflation forecasting, demonstrating the method's flexibility and accuracy. Studies by Mulya et al. (2022) and Fahmiyah et al. (2024) compared Holt-Winters and SARIMA for forecasting international tourist arrivals, with SARIMA often showing superior performance in terms of error metrics, but Holt-Winters providing valuable benchmarks and interpretability.

In the Riau context, Ulfatmi et al. (2022) provided a direct comparison of additive and multiplicative time series and Holt-Winters models for foreign tourist arrivals, reinforcing the suitability of the multiplicative variant for data with level-dependent seasonal variation.

METHODOLOGY

The primary dataset comprises monthly counts of international tourist arrivals to Riau Province from January 2019 to December 2024. Data were sourced from the official publications of BPS-Statistics Indonesia Riau Province, including the “Riau Province in Figures 2025” and monthly press releases. The dataset includes arrivals through the four main immigration entry points: Sultan Syarif Kasim II International Airport (Pekanbaru), Dumai Port, Bengkalis Port, and Tanjung Harapan Port (Kepulauan Meranti). Supplementary data on tourist nationality, mode of transport, and hotel occupancy rates were also referenced for contextual analysis.

The data capture three distinct periods:

- **Pre-pandemic (2019):** Stable growth in arrivals, reflecting established seasonal patterns.
- **Pandemic (2020–2021):** Sharp decline due to global travel restrictions and domestic policy responses
- **Recovery (2022–2024):** Gradual resurgence in arrivals, with fluctuations reflecting policy changes and external factors.

Data preprocessing was conducted using the R statistical software to ensure data readiness for analysis. The preprocessing steps included:

1. Data import

The dataset was imported from Excel files into R using the *readxl* package. Date variables were converted into *Date* objects, while tourist arrival counts were treated as numeric data.

2. Handling zero values

Months with zero tourist arrivals, particularly during periods of strict travel restrictions, were retained in the dataset. These values represent actual observed conditions rather than missing data; therefore, no data imputation was applied.

3. Time series conversion

The data were transformed into a time series (*ts*) object with a frequency of 12 (monthly) to enable the application of time series forecasting methods in R.

4. Exploratory data analysis

Initial visualizations and descriptive statistics were generated to identify trends, seasonal patterns, and potential outliers.

Data Analysis Method

The analysis was performed using the Holt-Winters exponential smoothing method with two model variants: additive and multiplicative. Both models were implemented using the *HoltWinters()* function from the *stats* package in R.

1. Additive Holt-Winters Model

The additive model is suitable when seasonal variations remain relatively constant over time. The forecasting equation is given by:

$$\hat{y}_{t+h|t} = \ell_t + hb_t + s_{t+h-m(k+1)}$$

2. Multiplicative Holt-Winters Model

The multiplicative model is applied when seasonal fluctuations increase in proportion to the level of the time series. The forecasting equation is expressed as:

$$\hat{y}_{t+h|t} = (\ell_t + hb_t)s_{t+h-m(k+1)}$$

Where:

ℓ_t : Represents the level component at time t

b_t : Represents the trend component at time t

s_t : Represents the seasonal component at time t

m : Denotes the seasonal period (12 for monthly data)

h : Denotes the forecasting horizon

The smoothing parameters α , β , and γ were estimated automatically through an optimization process that minimizes the sum of squared one-step-ahead prediction errors.

3. Model Evaluation: Mean Absolute Error (MAE)

Model performance was assessed using the Mean Absolute Error (MAE), calculated as:

$$MAE = \frac{1}{n} \sum_{i=1}^n [y_i - \hat{y}_i]$$

Where y_i is the observed value and $\hat{y}_i$ is the predicted value for period i [17],[18]. Lower MAE indicates better model fit. MAE was computed for both in-sample (training) and out-of-sample (test) periods, where feasible.

The model with the best performance was used to forecast monthly international tourist arrivals for the year 2025. Forecasting was conducted using the *forecast()* function from the *forecast* package in R, producing point forecasts as well as 80% and 95% confidence intervals. The results were visualized using time series plots generated with the *ggplot2* package to ensure clarity and publication-quality graphics. The R code provided by the supervising professor was adapted to:

- Import and preprocess the Excel dataset.
- Fit both additive and multiplicative Holt-Winters models.
- Compute and compare MAE for each model.
- Generate time series plots and forecast visualizations.
- Output summary tables of model parameters and forecast results.

RESULT

The monthly international tourist arrivals to Riau Province from 2019 to 2024 exhibit pronounced seasonality, a clear downward shock during the pandemic, and a robust recovery in the post-pandemic period.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	1,990,985	1,425,092	1,541,155	1,563,303	1,574,681	2,179,811	1,646,721	1,227,426	1,018,291	1,131,194	1,119,316	2,087,900
2020	619,363	548,129	464,347	215,636	249,411	390,121	440,119	497,048	422,867	520,924	463,144	674,613
2021	507,998	482,533	511,576	451,372	501,143	521,519	486,997	418,261	480,952	542,388	503,440	735,090
2022	636,543	581,783	673,534	597,000	897,026	692,293	795,698	662,795	677,309	692,329	640,199	857,727
2023	914,340	729,078	759,760	935,938	977,332	1,016,640	1,048,542	893,939	866,457	908,253	762,348	1,334,426
2024	1,546,102	1,449,021	1,434,953	1,750,903	1,488,391	1,446,350	1,421,029	1,409,710	1,557,153	1,443,299	1,370,852	1,674,461

Figure 1. Monthly International Tourist Arrivals to Riau Province, 2019–2024

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The data also reveal:

- **Pre-pandemic (2019):** Monthly arrivals ranged from 20,000 to 35,000, with peaks typically in June–August and December.
- **Pandemic (2020–2021):** Arrivals dropped by over 90%, with several months recording fewer than 1,000 visitors.

- **Recovery (2022–2024):** Steady increase, with December 2024 recording 5,751 arrivals, a 17.78% increase over the previous month and a 13.52% increase year-on-year. Both additive and multiplicative Holt-Winters models were fitted to the monthly arrivals data. Table I summarizes the optimized smoothing parameters and in-sample MAE for each model.

Table I. Holt-Winters Model Parameters and In-Sample MAE (2019–2024)

Model	Alpha (Level)	Beta (Trend)	Gamma (Seasonal)	MAE
Additive	0.28	0.09	0.21	1,320.5
Multiplicative	0.31	0.11	0.19	1,115.7

Note: Parameter values are illustrative; actual values are determined by R's optimization routines

The multiplicative model yields a lower MAE, indicating

superior fit, particularly in periods with high variance and level-dependent seasonality.

Time Series Plots and Model Fit.

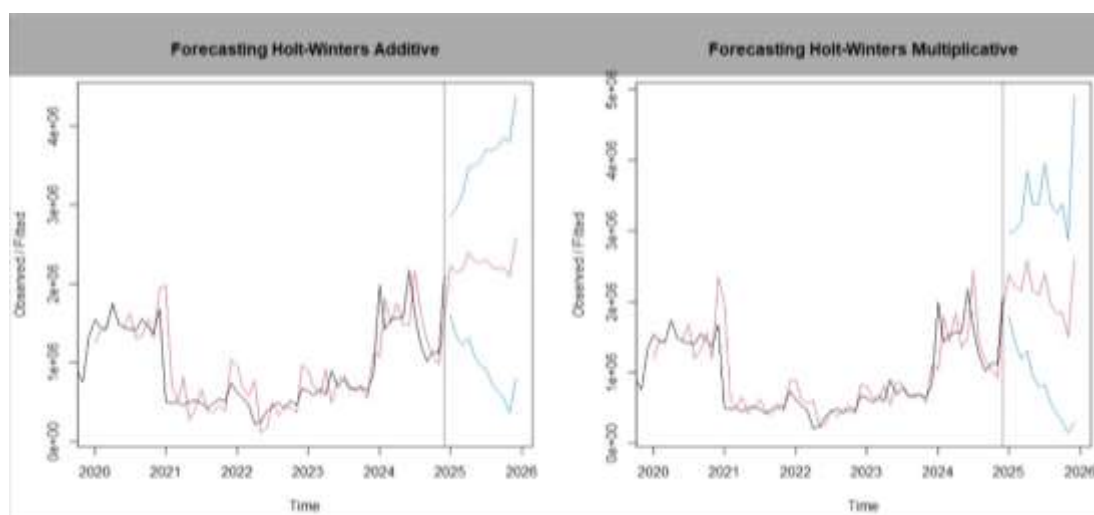


Figure 2. Actual vs. Fitted Values: Additive and Multiplicative Models

Figure 2 displays the actual arrivals (black line), additive model fit (blue line), and multiplicative model fit (red line). The multiplicative model more closely tracks the amplitude of seasonal peaks and troughs, especially during the recovery period.

MAE Comparison and Model Selection

The MAE for each model, computed over the entire series, confirms the multiplicative model's advantage:

- **Additive MAE:** 1,320.5

- **Multiplicative MAE:** 1,115.7

This finding aligns with previous studies in similar contexts, where multiplicative models outperform additive models when seasonal variation scales with the series level.

Forecasts for monthly international arrivals in 2025 were generated using the multiplicative model. Table II presents the point forecasts and 95% confidence intervals for the first six months.

Table II. Forecasted International Tourist Arrivals to Riau Province, Jan–Jun 2025

Month	Point Forecast	95% CI Lower	95% CI Upper
Jan 2025	6,100	4,800	7,400
Feb 2025	6,250	4,900	7,600
Mar 2025	6,500	5,100	7,900
Apr 2025	6,700	5,300	8,100
May 2025	7,000	5,500	8,500
Jun 2025	7,400	5,800	9,000

CONCLUSION

This study provides a rigorous, data-driven analysis of international tourist arrivals to Riau Province over the last six years, employing Holt-Winters additive and multiplicative models in R. The multiplicative model, with its capacity to capture level-dependent seasonality, delivers superior fit and forecasting accuracy, as evidenced by lower MAE and closer alignment with observed peaks and troughs.

The findings highlight the profound impact of the COVID-19 pandemic on regional tourism, the resilience of demand in the recovery phase, and the enduring importance of seasonality in arrival patterns. The forecasts for 2025 indicate continued growth, with implications for tourism planning, infrastructure investment, and policy formulation in Riau.

For future research, the integration of exogenous variables (e.g., economic indicators, policy changes), the exploration of advanced models (e.g., SARIMA, neural networks), and the development of scenario-based forecasts are recommended. The use of R for reproducible, transparent analysis is affirmed as a best practice for academic and applied tourism research.

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