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Modelling ASEAN Tourist Visits to Indonesia Using Nonparametric Regression with Penalized Spline Estimator

Dita Amelia[1*], Gabriella Agnes Budijono[1], Anisah Nabilah Ghasani[1], Dustin Nathanael Kurniawan Tagawa[1], Nabila Shafa Aflaha[1]

[1]*Statistics Study Program, Faculty of Science and Technology, Universitas Airlangga, Indonesia*

**Corresponding Author Email: dita.amelia@fst.unair.ac.id*

ABSTRACT

Tourism is one of the sectors that plays an important role in supporting Indonesia's national economic growth. Indonesia is one of the favorite countries for foreign tourists, especially tourists from ASEAN countries. This study aims to analyze the pattern of foreign tourist visits from ASEAN countries to Indonesia using a nonparametric regression approach with a penalized spline estimator. The data used is secondary data from the Indonesian Central Statistics Agency, regarding the number of tourist visits per month from January 2020 to December 2023. The results of the analysis showed that the best nonparametric regression model was obtained using a 2nd-order polynomial with 4 knots at positions 4, 19, 27, and 31. With an R-square value of 93,18% and an optimal lambda of 0,026. This research is expected to provide insights for the management of Indonesia's tourism sector, support economic growth, and promote sustainable development.

Keyword: *Mathematics; Statistics; Applied mathematics; Computational Mathematics*

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1. Introduction

Tourism plays a crucial role in Indonesia's economy. Tourism foreign exchange in 2023 will reach US$5,95 Billion, placing it as the third largest contributor to foreign exchange transactions in the country. Indonesia's diverse natural wealth and cultural heritage make Indonesia an attractive destination for foreign tourists (Elistia, 2020). Foreign tourist visits, especially from ASEAN countries, continue to increase from time to time. According to the Central Statistics Agency (BPS), the number of foreign tourist visits from ASEAN countries who visited Indonesia in 2021 was 528.200 people or equivalent to 54%. Meanwhile, in 2022, as many as 3,11 million people or equivalent to 52,89% of the total foreign tourist visits. The number of visits increased by 66,31% compared to the previous year. Meanwhile, in April 2023, foreign tourist visits to Indonesia reached 865,81 thousand people, most of whom were visitors from ASEAN countries, namely 332,01 thousand people. The number of visits increased sharply by 270,34% compared to visits in April 2022. Nonetheless, the impact of the COVID-19 pandemic has collapsed the tourism industry in 2020. Travel restrictions and border closures have led to a drastic decline in the number of foreign tourist visits to Indonesia. However, recovery efforts have been seen with a surge in visits in the following years (Wijaya and Mariani, 2021). In 2022, Indonesia's tourism ranking jumped sharply, placing it in 32nd place from 44th place. This makes Indonesia included in the 2021 Travel and Tourism Competitiveness Index (TTCI), ranking above Malaysia, Thailand, and Vietnam.

In previous studies, it has been shown that nonparametric regression analysis with an R 2 value of 81,88% and MSE of 12,46 has proven to be effective in explaining the estimated number of tourists in the archipelago, namely the number of visits by Indonesian citizens to various tourist destinations in the country using the spline truncated method (Nastiar, Lemido, Siswanto, & Kalondeng, 2024). In managing the tourism industry, an in-depth understanding of tourist visit patterns is essential, to help plan effective marketing strategies, as well as predict future trends and overcome challenges that may arise. It is also in line with the goal of Sustainable Development Goals (SDGs) number 8: Decent Work and Economic Growth, namely increasing inclusive and sustainable economic growth, productive and comprehensive job opportunities, and decent work for all, where the number of foreign tourist visits can be an indicator of economic growth and job creation. The nonparametric regression approach with a penalized spline estimator is one of the right ways to analyze complex data and not follow a specific pattern. Through a nonparametric regression approach with a penalized spline estimator, relevant patterns related to the number of tourist visits to Indonesia from ASEAN countries can be found. It is hoped that this analysis can help Indonesia's tourism sector become more stable and sustainable in the future, and continue to contribute to economic growth and community welfare.

2. Literature Review

2.1 Tourist

Tourism is one of the important sectors in encouraging a country's economic growth, namely by generating the country's foreign exchange and distributing foreign exchange. In addition, tourism can also showcase the country's diversity and cultural richness (Budi, 2016). Therefore, Indonesia as the largest archipelagic country that has diverse natural resources and cultures can be an opportunity to develop the tourism industry (Maulana & Putri, 2020). In its development, tourism activities have turned into a tourism industry that can provide economic benefits (Wijaya & Mustika, 2014). Tourists are categorized into two, namely domestic tourists and foreign tourists. Domestic tourists are domestic tourists where a citizen travels within the boundaries of his own country. Meanwhile, foreign tourists are foreign tourists where a foreign citizen travels to another country beyond the territorial boundaries of his own country (Amerta & Budhiasa, 2014).

2.2 ASEAN

ASEAN (Association of Southeast Asian Nations) is an international organization consisting of countries in the Southeast Asian region. It was founded by 5 countries, namely Indonesia, Malaysia, the Philippines, Singapore, and Thailand on August 8, 1967 in Bangkok. Currently, there are 10 members of ASEAN, namely Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam (Khairunisa, Sabaria, & Munzir, 2022). The ASEAN Tourism Forum (ATF) is a forum to promote tourism among ASEAN member countries and in the ASEAN region has great tourism potential in each country because of cultural diversity, natural beauty, and geographical proximity between member countries so as to facilitate the movement of tourists. As infrastructure continues to develop, the flow

of tourists between ASEAN countries will be important. Therefore, modeling foreign tourist visits from ASEAN countries in Indonesia is relevant to understand and predict visit patterns and provide insights to develop effective tourism strategies (Budi, 2016).

2.3 Parametric Regression

The general regression model has 2 approach models, namely the parametric regression model and the nonparametric regression model. If the form of the regression function is known, then parametric regression is used, which has 2 types of models, namely simple linear regression and multiple linear regression (Chamidah & Lestari, 2022). Simple Linear Regression (SLR) is a statistical method that attempts to model the relationship between two random variables where one random variable affects the other. SLR involves one independent variable (X) and one bound variable (Y) which has a linear relationship in the form of a straight line to its regression parameters (Mufidah, et al., 2023). The following are the assumptions of a simple linear regression model: the free variable (X) affects the bound variable (Y) linearly; the bound variable (Y) or also called the quantitative value response where the variable has a normal distribution; the free variable (X) has a quantitative value and has no distribution; the error value or measurement error of the regression model (ε) has a normal distribution. The values of both the X and Y variables are measured on a quantitative scale. This relationship pattern can be expressed as a simple linear regression model. The form of linear functions is as follows:

$$y = \beta_0 + \beta_1 x \tag{1}$$

So that it can be stated as follows:

$$y = \beta_0 + \beta_1 x + \varepsilon \tag{2}$$

Where Y is the bound variable; X is an independent variable; β_0 is a constant; β_1 is a simple linear regression coefficient; ε is an error. Error is not an error but rather a statistical term that presents the effects of factors outside of control.

2.4 Spline Regression

Spline regression is an approach towards data matching while still taking into account the smoothness of the curve. Splines are segmented polynomial pieces connected by knots that can explain the characteristics of the data (Putra IMB, Srinadi IGA, Sumarjaya IW, 2015). While the knot itself is a fusion point that explains the change in behavior of the spline function at different intervals.

2.5 Penalized Spline Method

Penalized spline regression is a form of spline regression where the model is derived by minimizing the Penalized Least Squares (PLS) function. This estimation function merges the least squares approach with the requirement for curve smoothness. The nonparametric regression model for longitudinal data can be represented as:

$$y_i = g(x_i) + \varepsilon_i \quad , i = 1,2, \dots, n \tag{3}$$

$g(x_i)$ is a regression function that assumes smooth (continuous and differentiable) and ε_i is an independent random error with a mean of 0 and variance σ^2. Function $g(x_i)$ stated:

$$g_\lambda(x) = \sum_{j=0}^{p+k} \beta_\lambda \varphi_j(x) \tag{4}$$

With is a vector parameter. The Least $\boldsymbol{\beta} = \left(\beta_0, \beta_1, \dots, \beta_{\rho+k}\right)^T$ Square Spline function is a polynomial piece combined with a knot point, and $\tau_1, \tau_2, \dots, \tau_k \lambda = \tau_1, \tau_2, \dots, \tau_k$. The optimal estimator for the regression function is obtained by obtaining the solution of PLS optimization, i.e. the solution that minimizes the PLS function $g(x_i)$(Chamidah & Lestari, 2022):

$$\sum_{i=1}^{n} \left(y_i - g(x_i)\right)^2 + \lambda \sum_{l=1}^{k} \beta_{p+l}^2, \lambda \geq 0 \tag{5}$$

To obtain a solution that minimizes the PLS function in equation (5), the following steps are performed:

1. Transform $\sum_{i=1}^{n}\left(y_i - g(x_i)\right)^2$ into the following matrix notation:

$$\sum_{i=1}^{n} \left(y_i - g(x_i)\right)^2 = \left(\boldsymbol{y} - \boldsymbol{g}(\boldsymbol{x})\right)^T \left(\boldsymbol{y} - \boldsymbol{g}(\boldsymbol{x})\right) = (\boldsymbol{y} - \boldsymbol{X\beta})^T (\boldsymbol{y} - \boldsymbol{X\beta}) \tag{6}$$

2. Changing the penalty function $\sum_{l=1}^{k}\beta_{p+l}^2$ into the following matrix notation:

$$\sum_{l=1}^{k}\beta_{p+l}^2 = \beta_{p+1}^2 + \beta_{p+2}^2 + \cdots + \beta_{p+k}^2 \quad (7)$$

After that it is assumed that $\boldsymbol{D}$ is a defined diagonal matrix:

$$\boldsymbol{D} = \begin{pmatrix} a_{11} & 0 & \cdots & 0 & \cdots & 0 \\ 0 & a_{22} & \cdots & 0 & \cdots & 0 \\ \vdots & \vdots & \ddots & \cdots & \vdots & \vdots \\ 0 & 0 & \cdots & a_{(p+1)(p+1)} & \cdots & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 0 & \cdots & a_{(p+k+1)(p+k+1)} \end{pmatrix} \quad (8)$$

With:$a_{11} = a_{22} = \cdots + a_{pp} = a_{(p+1)(p+1)} = 0; a_{(p+2)(p+2)} = \cdots = a_{(p+k+1)(p+k+1)} = 1$. From the penalty function $\sum_{l=1}^{k}\beta_{p+l}^2$ can be expressed as:

$$\sum_{l=1}^{k}\beta_{p+l}^2 = \boldsymbol{\beta}^T\boldsymbol{D}\boldsymbol{\beta} \quad (9)$$

So that the following PLS functions are obtained:

$$L = (\boldsymbol{y} - \boldsymbol{X\beta})^T(\boldsymbol{y} - \boldsymbol{X\beta}) + \boldsymbol{\lambda\beta^T D\beta} \quad (10)$$

3. To obtain the one that minimizes the value of L, then equation (10) is derived partially against $\widehat{\boldsymbol{\beta}}\boldsymbol{\beta}$, which results in the following equation $\widehat{\boldsymbol{\beta}}$:

$$\widehat{\boldsymbol{\beta}} = \left(\boldsymbol{X^T X} + \lambda\boldsymbol{D}\right)^{-1}\boldsymbol{X^T y} \quad (11)$$

So based on equation (12), the form of the estimator penalizes spline is obtained:

$$\widehat{\boldsymbol{g}}(\boldsymbol{x}) = \boldsymbol{X}\left(\boldsymbol{X^T X} + \lambda\boldsymbol{D}\right)^{-1}\boldsymbol{X^T y} \quad (12)$$

2.6 Selection of Smoothing or Refining Parameters

Smoother parameters (λ) is a balance controller of the smoothness of the function on the data. If (λ) The estimated regression function obtained will be smoother, but the ability to map the data is not very good. On the other hand, if (λ) is small, the estimated regression function obtained will be larger. Therefore, in choosing a value λ it is expected that the value is optimal so that the estimator of the regression function obtained is also optimal. One method to get λ optimal is the Generalized Cross Validation (GCV) method. GCV functions can be expressed as follows (Ruppert D, Wand M.P, Carroll R.J, 2003):

$$GCV = \frac{MSE}{\left(\frac{1 - tr(A_\lambda)}{n}\right)^2} \quad (13)$$

With $tr(A_\lambda) = tr[X(X^TX + \lambda D)^{-1}X^T]$ and $MSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2$. For selection the optimal order is taken based on the minimum GCV value.

2.7 Number of Knots (K)

The number of knots is the number of knots or the number of points where changes in the behavior of the function occur at different intervals. There are two methods of determining the location of knot points, namely (Chamidah & Lestari, 2022):

1. The knots that are uniformly located at intervals [a,b] of the time points:

$$\tau_j = a + \frac{(b-a)j}{k+1}; j = 0,1,2,\ldots,k,k+1 \quad (14)$$

with and the interior point of the knots is $\tau_0 = a$; $\tau_{k+1} = b(\tau_1, \tau_2, \ldots, \tau_k)$

2. The knots are a quantum sample:

$$\tau_j = X_{\left(\left[\frac{nj}{k+1}\right]\right)}; j = 1,2,\ldots,k \quad (15)$$

By expressing the ordered $X_{(j)}$ statistic to j and expressing the integer of. This method allows for more knots, with $[a]aj = \left[\frac{n}{5}\right][a]\left[\frac{n}{3}\right]$.

2.8 Model Goodness Measures

There are two measures that can be used to calculate accuracy, namely MSE and determination coefficient (R^2). MSE is used to measure the accuracy of the model's conjecture value expressed in the mean of the squares of the error. While R^2 used to describe how much variation can be explained in a model. A minimum MSE is a good MSE, while R^2 the good ones are R^2 which is getting closer to 1. The MSE formula and R^2 are as follows:

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2 \; ; \; R^2 = 1 - \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \tag{16}$$

3 MATERIAL AND METHOD

3.1 Data and Data Sources

Secondary data for this study was sourced from the website of the Central Statistics Agency (BPS). The number of international visitors to Indonesia each month from ASEAN nations serves as the data source. 48 pieces of data were used, and they came from the quantity of tourists that visited between January 2020 and December 2023.

3.2 Research Variables

According to Sugiyono (2018), a research variable is an attribute, trait, or value of individuals, things, or activities that have specific variations chosen by researchers for examination and subsequent conclusion-making. The following research variables were included in this study:

Table 1. Research Variables

Types of Variables	Variable
Response Variables	Monthly number of international visitors arriving in Indonesia from ASEAN nations
Predictor Variables	Time per month from January 2020 to December 2023

3.3 Data Analysis Steps

In this study, several steps were used to analyze the data, including:

1. Describe the predictor variable with the number of tourist visits from ASEAN countries to Indonesia carried out with the following steps:
   a. Conduct a literature study related to the number of tourist visits from ASEAN countries to Indonesia to decipher the relationship with the predictor variables used.
   b. Determine the descriptive statistical value of the response variables which include maximum value, minimum value, average, and variance.
   c. Blind scatter plot between the response variable (Y) and the predictor variable (X).
2. To model the number of tourist visits from ASEAN countries to Indonesia using nonparametric regression based on a penalized spline estimator, with the following program algorithm:
   a. Determining the polynomial order, the number of knots, and the lower and upper boundaries of the lambda.
   b. Determine the knot point based on the visualization of the scatter plot between the response variable (Y) and the predictor variable (X).
   c. Calculating the value $\hat{\beta}_j$.
   d. Calculating MSE, GCV, and R-Square.
   e. Repeat all steps until the minimum GCV value is obtained. The polynomial order, the number of knots, and the smoothing parameters corresponding to the minimum GCV value are the optimal.
3. Interpret the results of modelling the number of tourist visits from ASEAN countries to Indonesia per month.

4. RESULT AND DISCUSSION

4.1 Data dan Data Plots

The description of the characteristics of the data on the number of foreign tourist visits from ASEAN countries in 2020-2023 is as follows:

Table 2. Descriptive Statistics on the Number of Foreign Tourist Visits from ASEAN Countries in Indonesia in 2020-2023

Mean	Standard Deviation	Minimum	Median	Maximum
181.386	147.088	37.545	81.903	492.188

Based on Table 2. It is known that the average number of foreign tourist visits from ASEAN countries to Indonesia in the period January 2020 to December 2023 is 181.386 or it can be assumed that there are around 181.386 visitors every month with a standard deviation of 147.088 visitors. Meanwhile, the highest number of tourist visits was 492.188 visitors and the lowest was 37.545 visitors. The best estimation model for the number of foreign tourist visits from ASEAN countries to Indonesia in 2020-2023 using the penalized-spline (p-spline) method can be determined through several stages. This is done so that the model produced is the best model, so that later it can be used as a reference in interpretation. The following is a graph for data on the number of foreign tourist visits from ASEAN countries in Indonesia in 2020-2023:

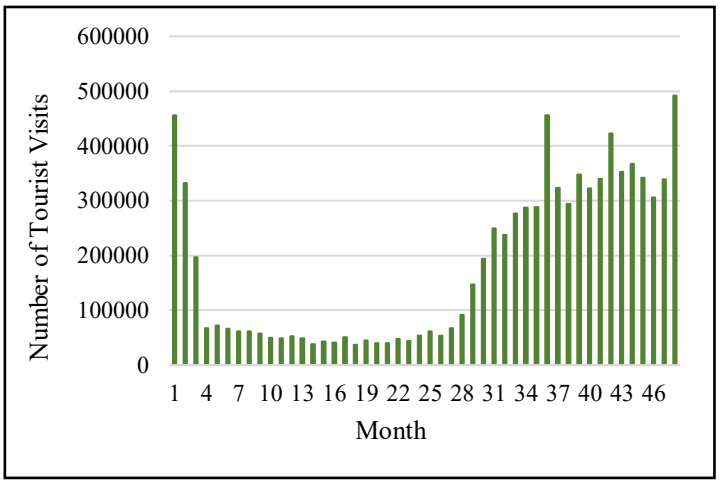

Figure 1. Number of Foreign Tourist Visits from ASEAN Countries in Indonesia by Time in 2020-2023

Based on Figure 1. During January 2020 to December 2023, there was a decrease and increase in the number of tourist visits. The lowest number of visits was found in the 18th observation, which was in June 2021. This was due to the surge in COVID-19 cases in ASEAN countries at that time. In Indonesia itself, on June 15-19, 2021, there was a surge in COVID-19 from 8.000 cases per day to more than 12.000 cases per day. The Central Statistics Agency (BPS) reports that, in June 2021, there were 10.04 percent fewer foreign visitors to Indonesia than there were in June 2020. The quantity of foreign visitors in June 2021 fell by 7.71 percent in comparison to the circumstances in May 2021. Meanwhile, the highest number of visits at the 48th observation was in December 2023. This is due to the easing of travel restrictions that were previously imposed to prevent the spread of COVID-19. In addition, the incessant promotion of tourism carried out by the government to stabilize the condition of tourism after COVID-19. Minister of Tourism and Creative Economy, Sandiaga in "The Weekly Brief With Sandi Uno" said that in December 2023 the number of foreign tourists has reached more than 20% compared to December 2022. The following is a scatterplot graph for data on the number of foreign tourist visits from ASEAN countries in Indonesia in 2020-2023 which shows a decrease and increase in the number of tourist visits during 2020 to 2023.

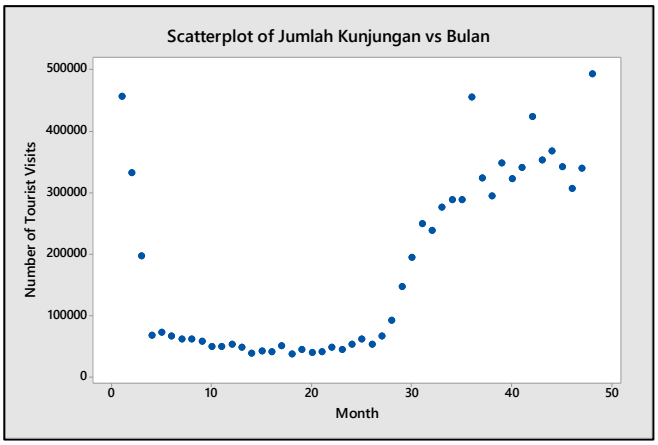

Figure 2. Scatterplot Number of Foreign Tourist Visits from ASEAN Countries in Indonesia by Time in 2020-2023

4.2 Nonparamteric Regression

Based on Figure 2, it can be seen that the data does not form a linear, quadratic or cubic pattern so that a nonparametric regression approach will be carried out. The nonparametric regression approach is used for data whose pattern is unknown. The penalized spline estimator uses the knot point at each point of the predictor variable value and determines the polynomial order of its regression equation. To find out the optimal lambda, the GCV criterion is used where if the GCV is the minimum, then the lambda is the optimal lambda. In addition, to find out the goodness of the model, MSE is also used.

Table 3. Possible Combination of Point Knots

Order of the Polyno-mial	Number of Knots	Knot Point	Lambda Lower Limit	Lambda Upper Limit	Increament Lambda	Model Fit Size			λ Optimal
						GCV	R^2	MSE	
1	1	27	0	0,01	0,001	8047576051	0,666103	7073335110	0,01
	2	25 39	0	0,05	0,001	5772150674	0,770648	4858634030	0,05
	3	10 27 31	0	0,05	0,001	3175886979	0,8784675	2557587269	0,021
	4	10 19 21 40	0	0,05	0,001	3801092653	0,8590569	2959637135	0,029
2	1	35	0	0,05	0,001	4032604835	0,840044	3410270253	0,05
	2	24 40	0	0,05	0,001	3882067528	0,8529263	3115636849	0,05
	3	27 31 44	0	0,05	0,001	3231527318	0,8830592	2477295069	0,05
	4	4 19 27 31	0	0,05	0,001	1972898555	0,9317949	1441851656	0,026

Based on Table 3. It was obtained that the minimum GCV value occurred when the model estimation was carried out in the polynomial order 2 with a total of 4 knots, namely 4; 19; 27; 31 and resulted in an MSE of 1.441.851.656 and an R-square value of 93,18%. Then for the optimal lambda value of 0,026 so as to produce the minimum GCV as shown in the image below:

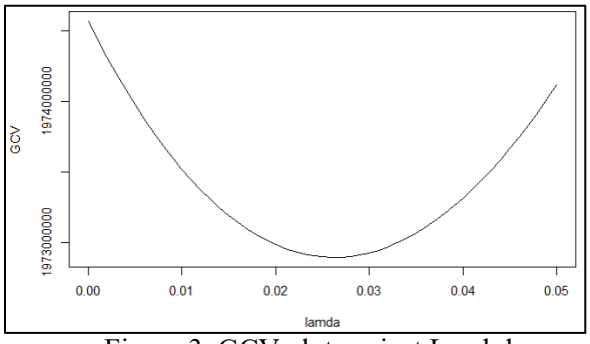

Figure 3. GCV plot against Lambda

Therefore, the best model estimation with the order of polynomials 2, the number of knots 4 is 4; 19; 27; 31 and the following estimates are obtained:

Table 4. Nonparametric Regression Parameters

Parameter	Value
$\hat{\beta}_0$	761994,5
$\hat{\beta}_1$	-320764,7
$\hat{\beta}_2$	38973,5
$\hat{\beta}_3$	-38707,73
$\hat{\beta}_4$	1160,771
$\hat{\beta}_5$	-876,2467
$\hat{\beta}_6$	-1546,832

Thus a model of nonparametric regression equations can be written:

$$\hat{y} = 761994{,}5 - 320764{,}7x + 38973{,}5x^2 - 38707{,}73(x-4)_+^2 + 1160{,}771(x-19)_+^2 - 876{,}2467(x-27)_+^2 - 1546{,}832(x-31)_+^2 \quad (17)$$

The result of the model estimation above are depicted through the following plot form:

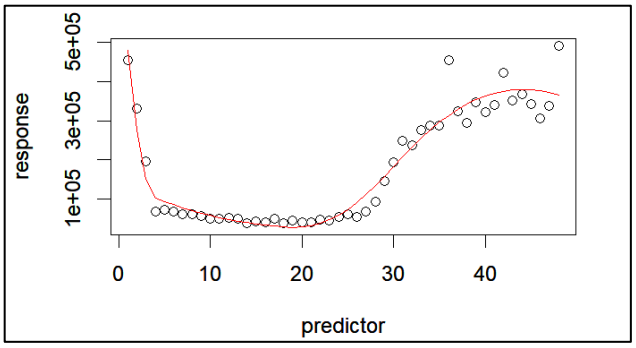

Figure 4. Plot of Nonparamteric Regression Model Estimation Results

4.3 Comparison of R-Square Values

Based on parametric and nonparametric regression calculations, the R-Square values are obtained as follows:

Table 5. Comparison of R-Square *Values*

R-Square Nonparametric	R-Square Parametric
93,18%	41,09%

From **Table 5.** It can be seen that the parametric R-square value from the data on the number of tourist visits is 41,09%, which is less than the nonparametric regression R-square, which is 93,18%. This shows that the data used is appropriate for analysis with nonparametric regression.

4.4 Interpretation of the Optimal Regression Model

Equation (17) can be written as follows:

$$\hat{y} = \begin{cases} 761994{,}5 - 320764{,}7x + 38973{,}5x^2, \text{for } x < 4 \\ 142670{,}82 - 11102{,}86x + 265{,}77x^2, \text{for } 4 \leq x < 19 \\ 561709{,}151 - 55212{,}158x + 1426{,}541x^2, \text{for } 19 \leq x < 27 \\ -77074{,}693 - 7894{,}8362x + 550{,}2943x^2, \text{for } 27 \leq x < 31 \\ -1563580{,}2453 + 88008{,}7478x - 996{,}5377x^2, \text{for } x \geq 31 \end{cases} \quad (18)$$

Based on equation (19), the model can be interpreted as follows:

1. When the monthly variable is less than 4, then every increase of one month will result in the number of visits decreasing by 320764,7 in the first order and increasing by 38973,5 in the second order. This is because starting in January 2020 when COVID-19 cases first appeared, WHO announced all countries to carry out strict lockdowns so that various tourism sectors experienced a decline.
2. When the monthly variable is from 4 to less than 19, then every increase of one month will result in the number of visits decreasing by 11102,86 in the first order and increasing by 38973,5 in the second order. In April 2020, there was a very drastic decrease compared to March 2020 with the number of foreign tourist visits from ASEAN countries to Indonesia totaling to 196.377 people, down to 67.133 people in April 2020. The main factor that affects this is the existence of COVID-19 so that there are several government policies, namely lockdowns and restrictions on access to tourist attractions.
3. When the monthly variable is from 19 to less than 27, then every increase of one month will result in the number of visits decreasing by 55212,158 in the first order and increasing by 1426,541 in the second order. According to the Indonesian Central Statistics Agency, the number of foreign tourist visits to Indonesia in July 2021 decreased by 10,77 percent from July 2020, but when compared to June 2021 it experienced an introduction of 1,25 percent. Based on the official website of the Ministry of Health, it was recorded as the highest number of deaths due to COVID-19 in July 2021 and until July 18, 2021 the number of deaths was recorded as many as 73.582 people, which caused the government to limit access to enter and leave the country for tourists, which caused the number of visits to also decrease.
4. When the monthly variable is from 27 to less than 31, each increase in one month will result in the number of visits decreasing by 7894,8362 in the first order and increasing by 550,2943 in the second order. In March 2022, the number of visits by foreign tourists from ASEAN countries to Indonesia rose from February 2022 to 53.174 people to 66.821 people in March 2022. Based on information from the Ministry of Tourism and Creative Economy (Kemenparekraf), it was stated that in March 2022 there had been an easing of travel restrictions related to the COVID-19 pandemic. Differences between interpretation and actual data can occur due to external factors such as easing of restrictions that may not be factored into the model.
5. When the monthly variable is greater than or equal to 31, each increase of one month will result in the number of visits increasing by 88008,7478 in the first order and decreasing by 996,5377 in the second order. In July 2022, the number of foreign tourist visits from ASEAN countries saw a significant rise. In June 2022, the number of tourist visits was recorded at 193.733 people and in July 2022 there were 249.305 people. According to the Indonesian Central Statistics Agency, the total number of foreign tourist visits from ASEAN countries was introduced 6.396,46 percent from July 2021, with the largest contributors of tourists being Malaysia and Singapore. This is because at that time it had entered a period of recovery in tourist interest from ASEAN countries to Indonesia after the COVID-19 pandemic.

5. CONCLUSION

Based on the results and discussion in this study, it can be concluded that the average number of foreign tourist visits from ASEAN countries to Indonesia in the period January 2020 to December 2023 was 181,386, with a standard deviation of 147,088. Throughout the period, there were fluctuations in tourist arrivals, with the lowest number recorded in the 18th observation, June 2021, at 37,545 visitors, and the highest in the 48th observation, December 2023, at 492,188 visitors. The onset of the COVID-19 pandemic led to a sharp decline in tourist arrivals during the early months (before month 4) due to strict restrictions. Subsequently, from the 4th month to the 18th month, the decline slowed down as some restrictions were relaxed, leading to an increase in visitation. From the 19th to the 26th month, there was a significant drop in visitation due to increased mortality and stricter travel controls. A slight increase in tourist arrivals occurred from the 27th month to the 30th month after further easing of travel restrictions. After the 31st month, there was a significant increase in

tourist arrivals as interest in travel recovered and policies were further relaxed. The analysis resulted in an optimal lambda of 0.026 and an R-squared value of 93.18%, indicating that the data was suitable for analysis by nonparametric regression compared to parametric regression (R-squared of 41.09%). The optimal lambda equation and model were derived with polynomial order 2 and 4 knots at observations 4, 19, 27, and 31.

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