Journal of Social Research

P-ISSN: 2827-9832
E-ISSN: 2828-335x
http://ijsr.internationaljournallabs.com/index.php/ijsr

NON-LINEAR TREND ANALYSIS TO FORECAST THE NUMBER OF NEW TWO-WHEELED AND FOUR-WHEELED VEHICLES IN MANOKWARI REGENCY

Patresia Sinaga[1], Esther Ria Matulessy[2], Nurhaida[3]
Universitas Papua, Indonesia
patresiasinaga20@gmail.com[1], e.matulessy@unipa.ac.id[2], n.nurhaida@unipa.ac.id[3]

ABSTRACT

Forecasting is a systematic effort that employs scientific methods (knowledge and technology) to predict future events. Trends depict patterns of time series data over long or significant time intervals, indicating a tendency to either rise or fall. Trend lines are not always linear; they can have a curved (non-linear) shape. Non-linear trends refer to trend models that involve quadratic, cubic, and so on equations. Based on the non-linear trend-shaped data plot and research objectives, non-linear trend analysis is used to forecast the number of motor vehicles in Manokwari Regency. The best model for forecasting the number of new two-wheeled vehicles is the cubic trend model, which is: $Y_i = 1935{,}815 + (1708{,}596)X_i - (193{,}815){X_i}^2 + (6{,}715){X_i}^3 + \varepsilon_i$ with a MAPE of 7.8%, categorized as excellent. The best model for forecasting the number of new four-wheeled vehicles is also the cubic trend model, which is: $Y_i = -60{,}189 + (257{,}708)X_i - (22{,}198){X_i}^2 + (0{,}540){X_i}^3 + \varepsilon_i$ with a MAPE of 5.7%, categorized as excellent."

Keywords: *non-linear trend analysis, new two-wheeled and four-wheeled vehicles, forecasting*

INTRODUCTION

West Papua is a province in Indonesia located on the western tip of Papua Island, of which the capital city is Manokwari (Peraturan Pemerintah No 2, 2007). Manokwari has an area of area 3.168,28 km^2 with a population of 173.020 people in 2018, 188,932 people in 2019, 192,663 people in 2020, and 194,905 people in 2021([BPS] Badan Pusat Statistika, 2022b). Based on these data, the population increases every year. With the growth around the world and the rapid advancement in human life, daily needs are increasing. This includes the need for clothing, food, shelter, electronic goods (gadget), and motor vehicles (Winardi, 1991).

According to the (Undang-Undang Republik Indonesia no, 2009), about traffic and road freight, Vehicles operated by machines are called motor vehicles, except vehicles that operate on rails. Private vehicles and public vehicles are included in the category of motor vehicles. According to Wiryanata (2020), Motor vehicles have become an important necessity in personal transportation facilities in this modern era. Motor vehicles are no longer considered a luxury item as in the past.

The number of vehicles sourced from UPT (Technical Implementation Unit) *Samsat* (One-Stop Manunggal Unit) Manokwari Regency in 2020 was 6,324 vehicles and in 2021 there were 6,902 vehicles so that from this data there was an increase in the number of vehicles in Manokwari Regency. The high number of motor vehicles will have an impact on air pollution, traffic accidents, and congestion in some places during rush hour (Wiryanata, 2020). According to ([BPS] Badan Pusat Statistika, 2022a), the number of accidents that occurred in 2017 was 162 accidents, in 2018 there were 165 accidents, and in 2019 as many as 185 accidents occurred, so from the data, it can be seen an increase in the number of accidents that occurred in Manokwari Regency (Madu, 2016).

Forecasting is a systematic effort that uses scientific methods (science and technology) to predict events that will occur in the future (Santoso, 2019). Trend describes the pattern of movement of time series data over long or significant intervals, indicating a direction that tends

to go up or down. The Trend line is not always straight (Linear) but can have a curved shape (non-linear). Trend non-linear refers to trend models involving quadratic, cubic, and other equations. The advantages of the analysis method trend non-linear is its ability to cope with long-term data and produce forecasts close to the original value. However, the drawback of this method lies in its unsuitability for short-term data. (number of data less than 10) (Dajan, 1986). Predicting the number of motor vehicles can provide benefits to relevant parties in the face of the consequences of a significant increase in the number of motor vehicles (Wiryanata, 2020).

Previous research conducted by (Pangestu, 2018), with the title "Prediction of the Number of Motor Vehicles in Indonesia Using the Method Average-Based Fuzzy Time Series Models." The fuzzy time series method is used to perform forecasting. The results of the study showed that the MAPE value obtained was 12.67% which was categorized as good for forecasting the number of motorized vehicles in Indonesia because it had an accuracy rate of less than 20%. Another study conducted by Wiryanata (2020), entitled "Analysis of Motor Vehicle Development in Bali Using Holt's Smoothing Model", the data used shows a pattern trend linear. Therefore, Holt's Smoothing Model was used to analyze the development of motor vehicles in Bali. The results showed that this model has the smallest MAPE value of 3.79% with a forecasting accuracy rate of 96.21%. This shows that this method is effectively used to forecast the development of motor vehicles in Bali with an elevated level of accuracy. Further research related to forecasting the number of vehicles is (Syamhalim, 2021), with the title Use of Genetic Algorithms to Predict the Number of Vehicles in South Tangerang City" This study aims to explore the correlation between the increase in the number of residents in South Tangerang City and the increase in the number of motorized vehicles owned by residents. The impact of the increase in population and the ever-increasing number of vehicles is congestion, air pollution, and traffic accidents. So, a solution is needed to overcome this problem, by predicting the number of vehicles in South Tangerang City. In this study, the use of MAPE was used as a measure of forecasting accuracy. The results showed that the MAPE value was 0.5%, which means the prediction results were categorized as very good because it was less than 10%. This shows that the forecasting model used in this study can provide accurate vehicle number prediction results and is used as a reference in overcoming the impact caused by vehicle growth in South Tangerang City.

Based on data obtained from UPT Samsat Manokwari, the number of vehicles in Manokwari Regency in this study will be used analysis methods trend non-linear Because the data used is long-term data and based on historical data plots, it is known that the data is trend non-linear So the author feels the need to conduct research with the title **"Analysis Trend Non-Linear to Forecast the Number of New Two-Wheeled and Four-Wheeled Vehicles in Manokwari Regency''** to apply analysis methods trend non-linear thus obtaining the best model by considering the smallest MSE, MAPE, MAD, and RMSE values and obtaining forecasting results for the number of vehicles in Manokwari Regency.

METHOD

This research was conducted in approximately 13 months from the preparation of the research proposal at the Mathematics Laboratory, located at the Faculty of Mathematics and Natural Sciences (FMIPA) University of Papua (UNIPA) in Manokwari. The data used is in the form of secondary data, namely the number of new vehicles in Manokwari in the annual period. This data consists of 14 years, starting from 2009 to 2022, obtained from UPT Samsat Manokwari. Research is carried out because it wants to obtain Forecasting models using analysis trend non-linear For new two-wheeled and four-wheeled vehicles, obtain the best forecasting model for the number of new two-wheeled and four-wheeled vehicles by using analysis trend non-linear, dan Obtain forecasting results on the number of new two-wheeled

and four-wheeled vehicles from the best models using analysis trend non-linear in 2023, 2024 and 2025. Software Microsoft Office Excel 2010 and Minitab 16 Used to facilitate the calculations that will be done in this study. Furthermore, the results of forecasting are interpreted descriptively, namely in the form of graphs and tables. This study uses the following stages of the procedure:

1. Plot time series data to see data patterns.
2. Determine the non-linear trend model using data on the number of two-wheeled and four-wheeled vehicles from 2009 to 2022, namely:
   a. Determination of exponential trend using the equation:
      $\ln Y_i = \ln \beta_0 + X_i \ln \beta_1 + \varepsilon_i \ , i = 1,2,3, \cdots n.$
   b. Quadratic *trend* determination using the equation:
      $Y_i = \beta_0 + \beta_1 X_i + \beta_2 {X_i}^2 + \varepsilon_i \quad , i = 1,2,3, \cdots n$
   c. Determination of cubic trend using the equation:
      $Y_i = \beta_0 + \beta_1 X_i + \beta_2 {X_i}^2 + \beta_3 {X_i}^3 + \varepsilon_i \quad , i = 1,2,3, \cdots n$
3. Determination of the *best non-linear trend* model by considering the smallest forecasting accuracy values. MSE determination using the equation:
   $$\text{MSE} = \frac{\sum_{t=1}^{n}(Y_t - F_t)^2}{n} \ ,$$
   determination of MAPE using the equation:
   $$\text{MAPE} = \frac{\sum_{t=1}^{n}\left|\frac{Y_t - F_t}{Y_t}\right|}{n} \times 100\%$$
   determination of MAD using the equation:
   $$\text{MAD} = \frac{\sum|Y_t - F_t|}{n}$$
   determination of RMSE using the equation:
   $$RMSE = \sqrt{\frac{\sum_{t=1}^{n}(Y_t - F_t)^2}{n}}$$
   The procedure for determining the best model is also carried out by (Yanti, 2016), (Solekah, 2022), (Putra, 2021), (Ferryan, 2022)and (Yonhy, 2013)
4. Forecasting of the best models for the number of two-wheelers and four-wheelers in 2023, 2024, and 2025
5. Conclusions are obtained.

RESULTS AND DISCUSSION

Time Series Plot

Time series plot aims to find out the data pattern of the number of new two-wheeled (R2) and four-wheeled (R4) vehicles. The number of two-wheeled and four-wheeled vehicles sourced from UPT Samsat Manokwari Regency for 2009 to 2022 can be seen in Table 1

Table 1. Number of new vehicles in Manokwari Regency from 2009 to 2022

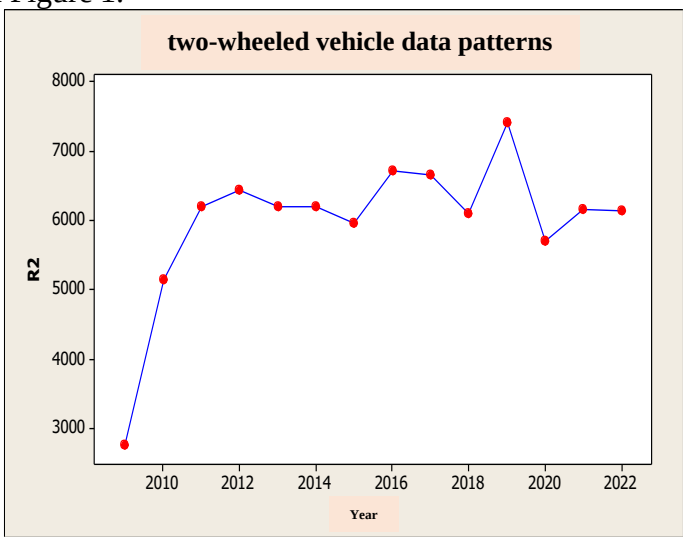
No	Year	R2	R4
1	2009	2756	179
2	2010	5153	385
3	2011	6202	502
4	2012	6436	689
5	2013	6201	684
6	2014	6210	815
7	2015	5961	794
8	2016	6717	880
9	2017	6666	924
10	2018	6102	879
11	2019	7415	827

No	Year	R2	R4
12	2020	5700	624
13	2021	6163	739
14	2022	6132	718

Source: UPT/ Samsat Manokwari Office

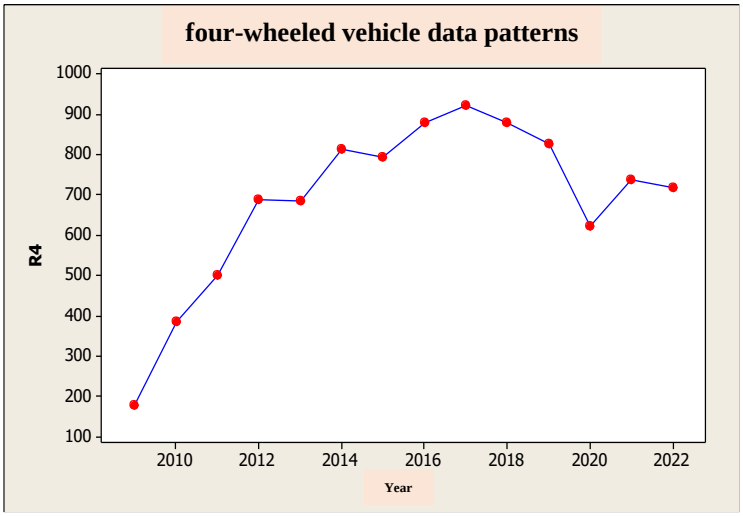
Based on Table 1 above, the highest number of new two-wheeled vehicles (R2) occurred in 2019, which was 7415 vehicles, and the lowest number of vehicles in 2009, which was 2756 vehicles, with an average number of vehicles each year of 5986.71, 5987 ≈ vehicles. The highest number of new four-wheeled vehicles (R4) occurred in 2017 at 924 vehicles and the lowest number of vehicles in 2009 at 179 vehicles with an average number of vehicles each year of 688.5 689 ≈ vehicles. The number of new two-wheeled and four-wheeled vehicles can be presented in the form of time series plots as follows:

a. Data Pattern of Number of New Two-Wheeled Vehicles (R2)
   The pattern of data on the number of new two-wheeled vehicles (R2) in Manokwari from 2009 to 2022 using Minitab Software, that the pattern formed is a non-linear trend data pattern shown in Figure 1.



Picture 1. Data Pattern of New Two-Wheeled Vehicles

b. Data Pattern of Number of New Four-Wheeled Vehicles (R4)
   The pattern of data on the number of new four-wheeled vehicles (R4) in Manokwari Regency from 2009 to 2021 using Minitab Software, shows that the pattern formed is a non-linear trend data pattern shown in Figure 2.



Picture 2. Data Pattern of New Four-Wheeled Vehicles

Trend Non-Linear Model

The non-linear trend models to be determined are exponential trend models, quadratic trend models, and cubic trend models.

Non-Linear Trend Model for Two-Wheelers

a. Determining model trend exponential

The exponential trend model can be determined by calculating the entries of the matrix and as follows:

$$\boldsymbol{X} = \begin{bmatrix} n & \sum_{i=1}^{n} x_i \\ \sum_{i=1}^{n} x_i & \sum_{i=1}^{n} {x_i}^2 \end{bmatrix};$$

$$= \begin{bmatrix} 14 & 105 \\ 105 & 1015 \end{bmatrix}.$$

$$\underline{\boldsymbol{y}} = \begin{bmatrix} \sum_{i=1}^{n} \ln y_i \\ \sum_{i=1}^{n} x_i \sum_{i=1}^{n} \ln y_i \end{bmatrix};$$

$$\underline{\boldsymbol{y}} = \begin{bmatrix} 121{,}471 \\ 917{,}457 \end{bmatrix}.$$

From equation (2.14) the column matrix can be calculated as follows: $\underline{b}$

$$\underline{\boldsymbol{b}} = \boldsymbol{X^{-1}}\,\underline{\boldsymbol{y}}$$

$$\begin{bmatrix} \ln b_0 \\ \ln b_1 \end{bmatrix} = \begin{bmatrix} 0{,}318 & -0{,}032 \\ -0{,}032 & 0{,}004 \end{bmatrix};\begin{bmatrix} 121{,}471 \\ 917{,}457 \end{bmatrix}$$

$$\begin{bmatrix} \ln b_0 \\ \ln b_1 \end{bmatrix} = \begin{bmatrix} 8{,}464 \\ 0{,}028 \end{bmatrix};$$

$$\begin{bmatrix} b_0 \\ b_1 \end{bmatrix} = \begin{bmatrix} 4744{,}411 \\ 1{,}029 \end{bmatrix}.$$

So the equation for the exponential trend model can be written as follows:

$$\mathrm{Y_i} = \beta_0 . {\beta_1}^{\mathrm{X_i}} + \varepsilon_i;$$

$$Y_i = 4744{,}411(1{,}029)^{X_i} + \varepsilon_i.$$

b. Determining the quadratic trend model

The quadratic trend model can be determined by calculating the entries of the matrix and as follows:

$$\boldsymbol{X} = \begin{bmatrix} n & \sum_{i=1}^{n} x_i & \sum_{i=1}^{n} {x_i}^2 \\ \sum_{i=1}^{n} x_i & \sum_{i=1}^{n} x_i^2 & \sum_{i=1}^{n} {x_i}^3 \\ \sum_{i=1}^{n} x_i^2 & \sum_{i=1}^{n} {x_i}^3 & \sum_{i=1}^{n} {x_i}^4 \end{bmatrix}$$

$$= \begin{bmatrix} 14 & 105 & 1015 \\ 105 & 1015 & 11025 \\ 1015 & 11025 & 127687 \end{bmatrix}$$

$$\underline{\boldsymbol{b}} = \begin{bmatrix} b_0 \\ b_1 \\ b_2 \end{bmatrix}$$

$$\underline{\boldsymbol{y}} = \begin{bmatrix} \sum_{i=1}^{n} y_i \\ \sum_{i=1}^{n} x_i y_i \\ \sum_{i=1}^{n} {x_i}^2 y_i \end{bmatrix} = \begin{bmatrix} 83814 \\ 658086 \\ 6394304 \end{bmatrix}$$

$$\underline{\boldsymbol{b}} = \boldsymbol{X^{-1}}\,\underline{\boldsymbol{y}}$$

$$\begin{bmatrix} b_0 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} 0{,}868 & -0{,}239 & 0{,}013 \\ -0{,}239 & 0{,}081 & -0{,}005 \\ 0{,}013 & -0{,}005 & 0{,}0003 \end{bmatrix} \begin{bmatrix} 65819 \\ 423719 \\ 3330085 \end{bmatrix}$$

$$\begin{bmatrix} b_0 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} 3305{,}665 \\ 770{,}517 \\ -42{,}729 \end{bmatrix}$$

So the equation for the model The quadratic trend can be written as follows:

$$Y_i = \beta_0 + \beta_1 X_i + \beta_2 {X_i}^2 + \varepsilon_i$$

$$Y_i = (3305{,}665) + (770{,}517)X_i - (42{,}729){X_i}^2 + \varepsilon_i$$

c. Determining the cubic trend model

The cubic trend model can be determined by calculating the entries of the matrix and as follows:

$$\boldsymbol{X} = \begin{bmatrix} 14 & 105 & 1015 & 11025 \\ 105 & 1015 & 11025 & 127687 \\ 1015 & 11025 & 127687 & 1539825 \\ 11025 & 127687 & 1539825 & 19092295 \end{bmatrix}$$

$$\underline{\boldsymbol{b}} = \begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

$$\underline{\boldsymbol{y}} = \begin{bmatrix} 83814 \\ 658086 \\ 6394304 \\ 69270348 \end{bmatrix}$$

$$\underline{b} = \boldsymbol{X^{-1}}\underline{\boldsymbol{y}}$$

$$\begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \end{bmatrix} = \begin{bmatrix} 2{,}056 & -1{,}053 & 0{,}144 & -0{,}005 \\ -1{,}053 & 0{,}639 & -0{,}094 & 0{,}003 \\ 0{,}144 & -0{,}094 & 0{,}014 & -0{,}0006 \\ -0{,}005 & 0{,}003 & -0{,}0006 & 0{,}00002 \end{bmatrix} \begin{bmatrix} 83814 \\ 658086 \\ 6394304 \\ 69270348 \end{bmatrix}$$

$$\begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \end{bmatrix} = \begin{bmatrix} 1935{,}815 \\ 1708{,}596 \\ -193{,}815 \\ 6{,}715 \end{bmatrix}$$

So the equation for the cubic *trend* model can be written as follows:

$$Y_i = \beta_0 + \beta_1 X_i + \beta_2 {X_i}^2 + \beta_3 {X_i}^3 + \varepsilon_i$$

$$Y_i = 1935{,}815 + (1708{,}596)X_i - (193{,}815){X_i}^2 + (6{,}715){X_i}^3 + \varepsilon_i$$

Non-Linear Trend Model for Four-Wheeled Vehicles

a. Determining the trend exponential model

The matrix approach is used to determine exponential trend models for new four-wheeled vehicle data. The determination of the exponential trend model is done by determining the entries of each matrix matrix and which are as follows:

$$\boldsymbol{X} = \begin{bmatrix} n & \sum_{i=1}^{n} x_i \\ \sum_{i=1}^{n} x_i & \sum_{i=1}^{n} {x_i}^2 \end{bmatrix} = \begin{bmatrix} 14 & 105 \\ 105 & 1015 \end{bmatrix}$$

$$\underline{\boldsymbol{y}} = \begin{bmatrix} \sum_{i=1}^{n} \ln y_i \\ \sum_{i=1}^{n} x_i \sum_{i=1}^{n} \ln y_i \end{bmatrix}$$

$$\underline{\boldsymbol{y}} = \begin{bmatrix} 90{,}525 \\ 694{,}043 \end{bmatrix}$$

$$\underline{\boldsymbol{b}} = \boldsymbol{X^{-1}}\,\underline{\boldsymbol{y}}$$

$$\begin{bmatrix} \ln b_0 \\ \ln b_1 \end{bmatrix} = \begin{bmatrix} 0{,}318 & -0{,}032 \\ -0{,}032 & 0{,}004 \end{bmatrix} \begin{bmatrix} 90{,}525 \\ 694{,}043 \end{bmatrix}$$

$$\begin{bmatrix} \ln b_0 \\ \ln b_1 \end{bmatrix} = \begin{bmatrix} 5{,}968 \\ 0{,}066 \end{bmatrix}$$

$$\begin{bmatrix} b_0 \\ b_1 \end{bmatrix} = \begin{bmatrix} 390{,}851 \\ 1{,}069 \end{bmatrix}$$

So the equation for the *exponential trend model*

$$Y_i = \beta_0 . {\beta_1}^{X_i} + \varepsilon_i$$

$$Y_i = 390{,}851(1{,}069)^{X_i} + \varepsilon_i$$

b. Determining the quadratic trend model

The determination of the quadratic trend model is done by determining the entries of each matrix matrix and are as follows:

$$\boldsymbol{X} = \begin{bmatrix} n & \sum_{i=1}^{n} x_i & \sum_{i=1}^{n} {x_i}^2 \\ \sum_{i=1}^{n} x_i & \sum_{i=1}^{n} x_i^2 & \sum_{i=1}^{n} {x_i}^3 \\ \sum_{i=1}^{n} x_i^2 & \sum_{i=1}^{n} {x_i}^3 & \sum_{i=1}^{n} {x_i}^4 \end{bmatrix} = \begin{bmatrix} 14 & 105 & 1015 \\ 105 & 1015 & 11025 \\ 1015 & 11025 & 127687 \end{bmatrix}$$

$$\underline{\boldsymbol{b}} = \begin{bmatrix} b_0 \\ b_1 \\ b_2 \end{bmatrix}$$

$$\underline{\boldsymbol{y}} = \begin{bmatrix} \sum_{i=1}^{n} y_i \\ \sum_{i=1}^{n} x_i y_i \\ \sum_{i=1}^{n} {x_i}^2 y_i \end{bmatrix} = \begin{bmatrix} 9639 \\ 79469 \\ 777213 \end{bmatrix}$$

$$\underline{\boldsymbol{b}} = \boldsymbol{X^{-1}}\,\underline{\boldsymbol{y}}$$

$$\begin{bmatrix} b_0 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} 0{,}868 & -0{,}239 & 0{,}013 \\ -0{,}239 & 0{,}081 & -0{,}005 \\ 0{,}013 & -0{,}005 & 0{,}0003 \end{bmatrix} \begin{bmatrix} 9639 \\ 79469 \\ 777213 \end{bmatrix}$$

$$\begin{bmatrix} b_0 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} 49{,}962 \\ 182{,}277 \\ -10{,}049 \end{bmatrix}$$

So the equation for the model *Trend* quadratic as follows:

$$Y_i = (49{,}962) + (182{,}277)X_i - (10{,}049){X_i}^2 + \varepsilon_i$$

c. Define the cubic trend model

The matrix approach is used to determine the cubic *trend* model for new four-wheeled vehicle data. by specifying the entries of each matrix and column matrix as follows:

$$X = \begin{bmatrix} 14 & 105 & 1015 & 11025 \\ 105 & 1015 & 11025 & 127687 \\ 1015 & 11025 & 127687 & 1539825 \\ 11025 & 127687 & 1539825 & 19092295 \end{bmatrix}$$

$$\underline{b} = \begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

$$\underline{y} = \begin{bmatrix} 9639 \\ 79469 \\ 777213 \\ 8370731 \end{bmatrix}$$

$$\underline{b} = X^{-1}\underline{y}$$

$$\begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \end{bmatrix} = \begin{bmatrix} 2{,}056 & -1{,}053 & 0{,}144 & -0{,}005 \\ -1{,}053 & 0{,}639 & -0{,}094 & 0{,}003 \\ 0{,}144 & -0{,}094 & 0{,}014 & -0{,}0006 \\ -0{,}005 & 0{,}003 & -0{,}0006 & 0{,}00002 \end{bmatrix} \begin{bmatrix} 9639 \\ 79469 \\ 777213 \\ 8370731 \end{bmatrix}$$

$$\begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \end{bmatrix} = \begin{bmatrix} -60{,}189 \\ 257{,}708 \\ -22{,}198 \\ 0{,}540 \end{bmatrix}$$

So the equation for the model *Trend* cubic as follows:

$Y_i = \beta_0 + \beta_1 X_i + \beta_2 {X_i}^2 + \beta_3 {X_i}^3 + \varepsilon_i$

$Y_i = -60{,}189 + (257{,}708) X_i - (22{,}198) {X_i}^2 + (0{,}540) {X_i}^3 + \varepsilon_i$

Best Model Determination

The determination of the best models for new two-wheeled and four-wheeled vehicles is carried out taking into account the value MSE, MAP, MAD, then RMSE the smallest of the doubling of each model *trend non-linear*.

Table 2. Selection of the Best Model Based on MAD, MSE, MAPE and RMSE Values

	Two Wheels			**Four Wheels**		
	Exponential	Quadratic	Cubic	*Exponential*	Quadratic	Cubic
MAP	15,472%	10,10%	7,889%	29%	7,246%	5,7%
MAD	781,025	509,849	430,474	165,384	41,648	39,256
MSE	845371,626	394482,264	281735,292	33668,704	3456,678	2727,672
RMSE	919,441	628,078	530,787	183,490	58,794	52,227

Based on Table 2 above, the best model for forecasting the number of new two-wheeled vehicles by considering the smallest forecasting accuracy value is the Cubic *trend* model with a MAPE value of 7.889%, MAD of 430.474, MSE of 281735.292 and RMSE of 530.787. The best model for forecasting the number of new four-wheeled vehicles by considering the smallest forecasting accuracy value is the cubic *trend* model with a MAPE value of 5.7%, MAD of 39,256, MSE of 2727,672 and RMSE of 52,277.

Forecasting the Number of New Two-Wheeled and Four-Wheeled Vehicles in Manokwari Regency

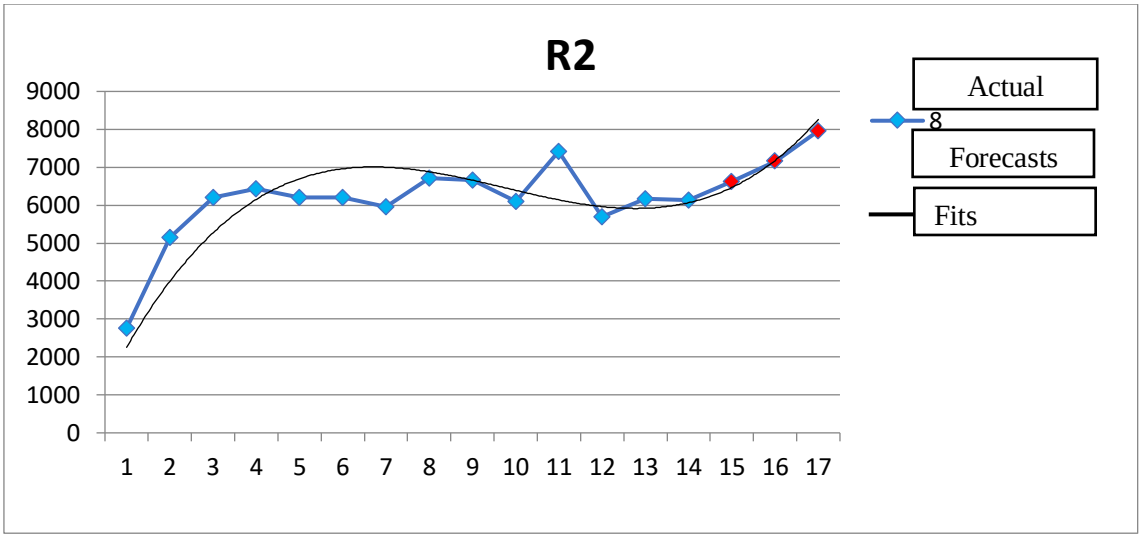
Forecasting is carried out to determine the number of new vehicles in Manokwari Regency in 2023, 2024 and 2025

a. Forecasting the number of new two-wheeled vehicles in Manokwari Regency

Table 3. Forecasting Results for New Two-Wheeled Vehicles

Year	Forecasting results
2023	6619 vehicles
2024	7161 vehicles
2025	7960 vehicles

Based on Table 3 The number of new vehicles for two-wheelers will decrease for 2023, 2024 and 2025. Picture. The following 3 shows the forecasting of the number of new two-wheeled vehicles in Manokwari Regency.



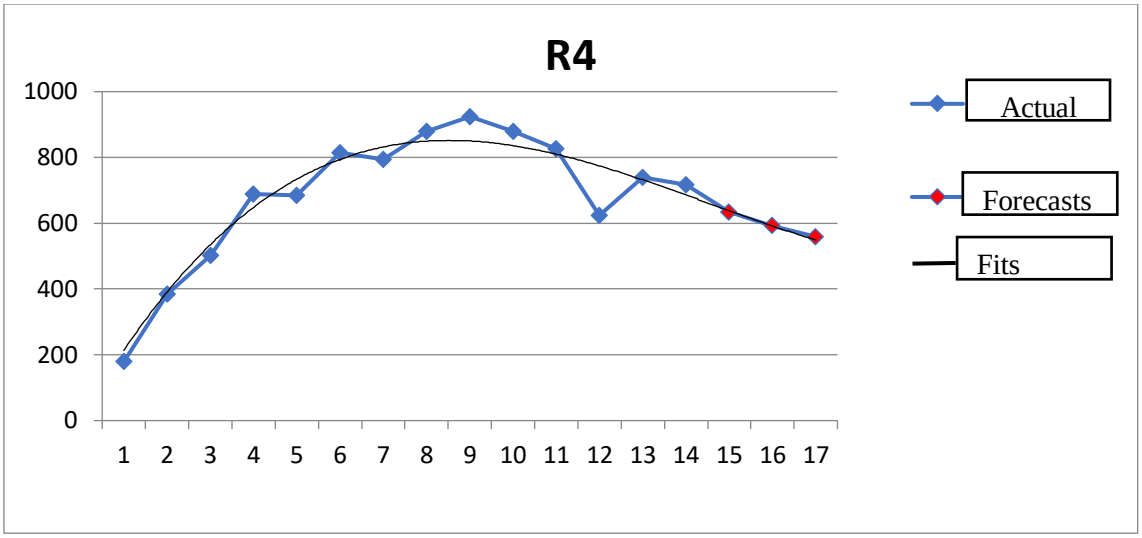
Picture 3. Forecasting charts for new two-wheelers

b. Forecasting the number of new four-wheeled vehicles in Manokwari Regency

Table 4. Forecasting Results for Four-Wheeled Vehicles

Year	Forecasting results
2023	633 vehicles
2024	592 vehicles
2025	558 vehicles

Based on Table 4 The number of new vehicles for two-wheelers will decrease for 2023, 2024 and 2025. Figure 4. shows the results of forecasting the number of new vehicles for the next three years.



Picture 4. Forecasting charts for four-wheelers

CONCLUSION

Based on the results and discussion, the forecasting models for new two-wheeled vehicles involve non-linear trend analyses, including exponential, quadratic, and cubic trends. The exponential trend model is represented by $Y_i = 4744{,}411(1{,}029)^{X_i} + \varepsilon_i$. The quadratic trend model is expressed as $Y_i = (3305{,}665) + (7703{,}517)X_i - (42{,}729){X_i}^2 + \varepsilon_i$, while the cubic trend model is given by $Y_i = 1935{,}815 + (1708{,}596)X_i - (193{,}815){X_i}^2 + (6{,}715){X_i}^3 + \varepsilon_i$.

Similarly, the forecasting models for new four-wheeled vehicles using non-linear trend analysis include exponential, quadratic, and cubic trends. The exponential trend model $Y_i = 390{,}851(1{,}069)^{X_i} + \varepsilon_i$. The quadratic trend model is $Y_i = (49{,}962) + (182{,}277)X_i - (10{,}049){X_i}^2 + \varepsilon_i$, and the cubic trend model is $Y_i = -60{,}189 + (257{,}708)X_i - (22{,}198){X_i}^2 + (0{,}540){X_i}^3 + \varepsilon_i$.

The best forecasting models for new two-wheeled and four-wheeled vehicles are determined based on Mean Absolute Percentage Error (MAPE) values. The quadratic trend model is identified as the best for forecasting new two-wheeled vehicles, yielding a MAPE value of 10.11%, categorized as good. For new four-wheeled vehicles, the quadratic trend model is considered very well, with a MAPE value of 7.18% The forecasted values for new wheeled vehicles using the best models indicate 6619 vehicles in 2023, 7161 vehicles in 2024, and 7960 vehicles in 2025. Specifically for new four-wheeled vehicles, the forecasted results are 633 vehicles in 2023, 592 vehicles in 2024, and 558 vehicles in 2025.

REFERENCES

[BPS] Badan Pusat Statistika, P. (2022a). *Kabupaten Manokwari dalam Angka 2022*. https://manokwarikab.bps.go.id/publication/2022/02/25/3853bce77629ca52ec2d6b44/kabupaten-manokwari-dalam-angka-2022.html

[BPS] Badan Pusat Statistika, P. (2022b). *Provinsi Papua Barat dalam Angka 2022*. https://papuabarat.bps.go.id/publication/2022/02/25/55355ed63b32c5ab9dad5f0b/provinsi-papua-barat-dalam-angka-2022.html

Ferryan, D. A. (2022). *Peramalan Harga Minyak Mentah Di Indonesia*. *19*, 13–18.

Madu, A. (2016). Comparison Of Trend Projection Methods And Backpropagation Projections Methods Trend In Predicting The Number Of Victims Died In Traffic Accident In Timor Tengah Regency, Nusa Tenggara. *Jurnal Mercumatika : Jurnal Penelitian Matematika Dan Pendidikan Matematika*, *1*(1). https://doi.org/10.26486/mercumatika.v1i1.188

Pangestu, F. (2018). Prediksi Jumlah Kendaraan Bermotor Di Indonesia Menggunakan Metode Average-Based Fuzzy Time Series Models memperoleh gelar Sarjana Komputer Disusun oleh : *Jurnal Pengembangan Teknologi Informasi Dan Ilmu Komputer*, *2*(9), 964.

Peraturan Pemerintah No 2, T. (2007). *Tentang Perubahan Nama Provinsi Irian Barat Menjadi Provinsi Papua Barat*.

Putra, A. E. (2021). *Prediksi Produksi Daging Sapi Nasional dengan Metode Regresi Linier dan Regresi Polinomial Pendahuluan Regresi Linier Regresi Polinomial*. *20*, 209–215.

Santoso, I. H. (2019). *Statistik II*. penerbit pres UWKS.

Solekah, N. (2022). *Analisis Peramalan Penjualan Minuman Sari Nanas Segarrr pada PT Putra Jaya Nanas di Kabupaten Blitar , Provinsi Jawa Timur*. *11*(1), 317–325.

Syamhalim, A. (2021). Prediksi Jumlah Kendaraan Di Kota Tangerang Selatan Dengan Metode Algoritma Genetika. *Bit (Fakultas Teknologi Informasi Universitas Budi Luhur)*, *18*(1), 35–40. https://doi.org/10.36080/bit.v18i1.1302

Undang-Undang Republik Indonesia no, 22 Tahun. (2009). *Undang-Undang Tentang Lalu Lintas Dan Angkutan Jalan*.

Winardi. (1991). *Marketing dan Perilaku Konsumen*. Penerbit Erlangga.

Wiryanata, K. S. A. (2020). Analisis Perkembangan Kendaraan Bermotor Di Bali Menggunakan Holt's Smoothing Model. *Jurnal Ilmiah Pendidikan Matematika*, *7 (2)*, 130–142.

Yanti, N. P. (2016). *Analisis Peramalan Penjualan Produk Kecap Pada Perusahaan Kecap Manalagi Denpasar Bali Ni Putu Lisna Padma Yanti 1 , I.A Mahatma Tuningrat 2 , A.A.P. Agung Suryawan Wiranatha 2 1*. *4*(1), 72–81.

Yonhy, Y. (2013). *Metode Trend Non Linear Untuk Forecasting Jumlah Keberangkatan Tenaga Kerja Indonesia Di Kantor Imigrasi Kelas II Kabupaten Nunukan Non Linear Trend Method For Forecasting The Departure Number Of Indonesian Labors At The Class II Immigration Office On Nun*. *4*, 47–54.