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Prediction of the Number of Motorized Vehicles in Ternate City Using the Average Based Fuzzy Time Series Model Method

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Abstract - Prediction or forecasting is one of the most important elements in decision-making. The impact caused is the number of motorized vehicles, residents, roads, and area area. By predicting the number of motor vehicles, the prediction data can be used from a program to reduce the impact of a high number of motor vehicles. This study aims to determine the Prediction of the Number of Motorized Vehicles in Ternate City using the Average Based Fuzzy Time Series Model Method in Ternate City from 2019 to 2024. Settlement using Average Based Method data and fuzzy time series interval numbers have been determined at the beginning of the calculation process, this process is very influential in the formation of fuzzyrelationship on each number to compare each other which will certainly have an impact on the difference in the results of the reduction calculation. The test results are known that the Fuzzy time series is one of the methods for prediction. One type of method is the average-based fuzzy time series with the average total value calculated using the Mean Absolute Percentage Error (MAPE) method obtained from the number of each indicator of 2.98% which shows that this study is included in the category of good used in the prediction of motor vehicles in Ternate City because it has an accuracy value of less than 20%. From the predictions carried out, the MAPE value of the test was 1.01%, the MSE value of forecasting was 1400.5, and the MAD value of forecasting was 27.93.

Keywords: Number of Motor Vehicles, Prediction, Fuzzy Time Series, Average Based, Mean Absolute Percentage Error (MAPE).

1. INTRODUCTION

Along with the increase in the population, the need for trans transportation facilities is also increasing. The needs of this transportation facility are met by various types of motorcycles. Based on BPS data, the number of motor vehicles in Indonesia in 2023 is 143,797,227. This number increased by 5.7% compared to the previous year. Information on the increase in the number of motorized vehicles needs to be known because motorized vehicles require road facilities. An increase in the number of vehicles without being accompanied by the addition of road facilities will result in severe congestion. In adding road facilities, careful planning needs to be carried out. Among other things, by predicting the number of motorized vehicles in the future. By knowing the number of motorized vehicles in the future, it can be known how much road facilities are needed. In addition, information on the number of motorized vehicles in the future can also be used as input in urban planning and regional development as well as traffic regulations in the region. Transportation is an important sector in people's lives, because transportation helps people to carry out economic activities. Economic activities will not run if they are not balanced with adequate transportation needs. In the study, the current trend of transportation development is still inadequate, or in other words, it is still not balanced between population growth and transportation infrastructure development. In order for public transportation to be the main choice in driving the country's economy, it must be balanced with public facilities as well, the government must prioritize public transportation. But besides that, not only the government must be responsible for facilitating public transportation, the community must also encourage government programs in providing public transportation services, not always the government is obligated. The number of vehicles in Indonesia increases significantly from year to year. This has an impact on various aspects such as traffic jams, air pollution, traffic accidents etc. The purpose of this study is to obtain the best model for forecast the number of cars and the number of motorcycles in the next 11 years. For the purpose, ARIMA method was used. Using the historical data of the number of cars and the number of motorcycles from 2001 to 2019, the best model for forecasting the number of cars and the number of motorcycles is ARIMA (1,1,0) and ARIMA (2,1,2), respectively. The models have MAPE of 7.01% and 7.24% for cars and motorcycles, respectively [1].

A motor vehicle is any vehicle that is driven by an engine other than a vehicle that runs on rails, consisting of private motor vehicles and public motor vehicles [2]. According to data from the Central Statistics Agency (BPS), the number of all motor vehicles in Indonesia. The high growth in the number of motor vehicles every year

will have an impact on various sectors. The impacts that will arise are congestion, air pollution, traffic accidents, and traffic violations. Therefore, by predicting the number of motorized vehicles in Indonesia, it can help the government or related parties to create a program to reduce the impact of the high number of motorized vehicles. Prediction is the process of systematically predicting something that will happen in the future based on the past and present information that we have, so as to get an estimate that is close to the real result. There are two techniques in predicting, namely qualitative prediction techniques and quantitative prediction techniques [3]. The increasing interest of the public in using motorcycle transportation means causes the volume of motorcycles to increase every year. In Indonesia, there are motorcycle brands whose sales level always increases significantly every year [4]. Vehicle detection and calculation is one of the important solutions to help in calculating vehicles on traffic tracks. Therefore, research was carried out on the prediction and calculation of vehicles from the subtraction background which can calculate traffic vehicles based on the type of vehicle passing on the road. The accuracy of vehicle calculations is in accordance with the objective conditions of residents' activities as vehicle users.

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: 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: with a MAPE of 5.7%, categorized as excellent [5].

Ternate City is a strategic city in economic movement. Geographically, Ternate City is an archipelago consisting of 3 large islands and 5 small islands. The capital of Ternate is Central Ternate with an administrative area consisting of 8 sub-districts and 78 sub-districts. The inadequate capacity of the road is due to several factors, including the number of roads from the north of Ternate city to the south of Ternate city which only uses the main road, moreover the factor of the number of Ternate City residents who also carry out activities on the main highway, finally the road cannot accommodate the number of existing vehicles and makes city traffic a place prone to significant congestion. Moreover, during the holiday season, the increase in visitors from outside the region, as well as within the city of Ternate who want to recreation around the city of Ternate and meet the flow of residents from the south of the city of Ternate, so that there is congestion on the main road. Roads are land transportation infrastructure that is important to facilitate economic activities. Increasing development efforts require transportation to support population mobility and the smooth distribution of goods to and from the region. The length of roads in Ternate City in 2023 is 319,789km. The demand for high mobility makes the people of Ternate tend to have private vehicles for activities in the city of Ternate.Data from UPTD Samsat Ternate, targets for the number of vehicles recorded in Samsat Ternate as many as 132,686 units consisting of 9,612 units of public/private cars, 39 units of buses, 4,311 units of load cars and 118,734 units of motorcycles. The function of roads in the city of Ternate is divided into 2 roads, namely, Primary Local and Secondary Local.One of the parameters used to predict the number of vehicles in an area is, population, roads, and labor force. The reason for using these variables is that these variables are the initial parameters used to obtain values that are converted into predictable indicators of an area for the number of motorized vehicles.

With the increasing number of vehicles, it is certain that traffic conditions on the highway will become more and more congested. This density can have an impact on the quality of roads and vehicles. The level of road service is also the quality of a road in serving the flow of traffic. In the Highway Capacity Manual (MKJI) from the Ternate City Samsat UPTD, it is stated that the number of vehicles reaching the degree of saturation can be an initial indicator of the level of vehicles on the road. The degree of approach from the prediction of the number of vehicles itself is a calculation of the maximum and minimum traffic volume. The manual method is carried out by assigning officers to observe passing vehicles. This method results in human error so that it does not produce accurate calculations. In addition to counting manually, officers also use detectors to count vehicles passing on the highway. The use of this tool has made the calculation process easier compared to calculating manually which requires a lot of labor. However, using such a detector requires a huge cost. So that the detector is rarely used.

Prediction of the number of vehicles is an activity to estimate the size of a unit by the use of production goods in a certain period of time and region. If the use of the number of goods can be accurately predicted, consumer demand can be fulfilled so that it has a good impact on the company's cooperation with relationships, and the timeliness of meeting demands. In addition, companies can overcome unwanted things such as running out of stock, and prevent customers from running away to competitors. In that case, the production company must have a policy in the production plan [3].

According to the decision of Tri Sugiarto et al, Time Series is the analysis of time sequence data to make an estimate, or predict the results of forecasting in the future as a reference material in taking One of the time series analysis methods is the Fuzzy Time Series method.Fuzzy Time Series was first discovered by Song and

Chissom based on the fuzzy set theory and the concept of linguistic variables and their applications were discovered by Zadeh. The purpose of the FuzzyTime Series is to solve the problem of historical data prediction [6]. Based on this background, it is important for researchers to take a study entitled "Prediction of the Number of Motor Vehicles in Ternate City Using the Average Based Fuzzy Time Series Model Method" with a case study of the average number of motor vehicles prediction data in 2019-2023 carried out with the hope that estimates or predictions related to the general picture of the number of motor vehicles can be known in order to maximize performance and be able to know the number of vehicle increases in the every region, especially Ternate City.

2. METHOD

This research is a descriptive research carried out in Ternate City. This study aims to verify the Number of Vehicles in Ternate City using the *Average Based Fuzzy Time Series Method* from July to September 2023.Data was taken using secondary data obtained from the Central Statistics Agency of Ternate City in Figures in 2023 and other literature data, therefore there are research locations that need follow-up researchers as data material.

Data collection is the stage of obtaining data for research. In this study, secondary data was used, the data used was taken through the official *website* of the Central Statistics Agency of Ternate City (BPS) and private agencies in Ternate City *(https://kotaternate.bps.go.id/).* The data used in this study is vehicle growth data, in Ternate City in a span of 5 years, starting from January 2019 to July 2023 with a total of 60 data.

The data analysis method used is the *Average Based Fuzzy Time Series Method with Microsoft Office Excel software* and the help of *the Eviews Application Version 9.0*. The data used is sourced from data on the number of motorized vehicles and population density in Ternate City in 2019 – 2023. In this study, to find out the level of accuracy/accuracy in predicting the number of vehicles and others, the *MAPE (Mean Absolute Precentage Error) value* was used and to process the data the researcher used Ms. Excel Software. MAPE is the calculation of errors in prediction results which can be used to calculate the accuracy of a model. MAPE is the average value of the overall percentage of errors or the difference between the predicted result value and the actual data value. Table 2 is the criteria for MAPE [7].

Prediction is a process of systematically estimating what is most likely to happen in the future based on the past and present information that we have, so that the error (the difference between something that happened and the estimated result) can be minimized. Predictions indicate what will happen in a particular situation and are inputs to the planning and decision-making process. Forecasting is the activity of predicting what will happen in the future based on relevant data in the past and placing it into the future with a form of mathematical model. It can also be a subjective prediction of intuition, or by using a combination of mathematical models adjusted to the good judgment of a manager. A good forecasting method is one that provides prediction results that are no different from the reality that occurs. In prediction techniques, there are several types of models. Among others, namely:

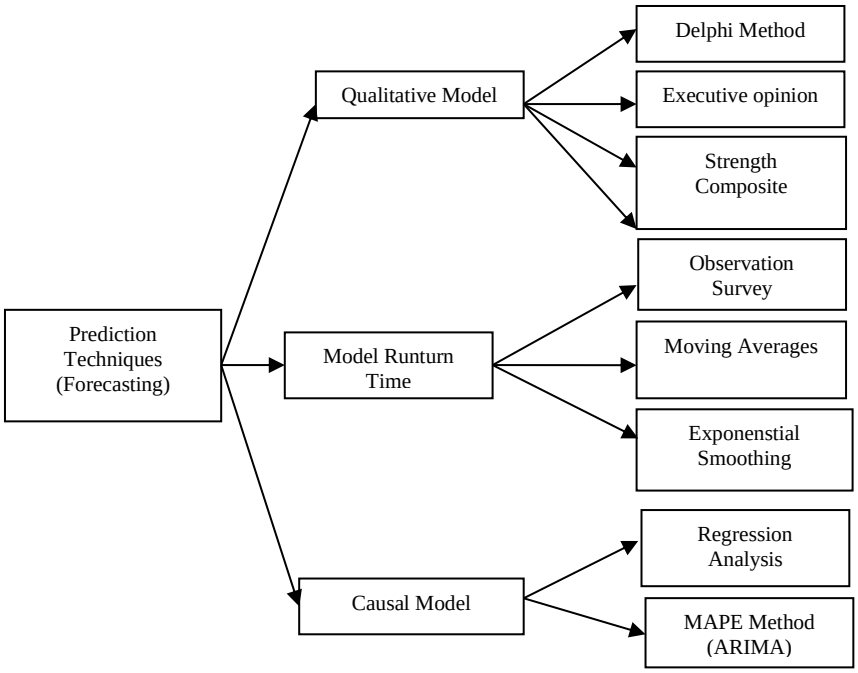

Figure 1. Some Prediction Technique Methods [5]

1. Qualitative model. A model that is able to include subjective factors in the forecasting model. This kind of model is expected to be very useful if accurate quantitative data is difficult to obtain.

2. Timeseries model This model seeks to predict the future using historical data.
3. Causal model. This model includes and tests variables that are suspected to affect dependent variables. Causal models typically use regression analysis to determine which significant variables affect the dependent variables. The model can also use the ARIMA method to find the best mode that can be used in prediction.

A prediction is needed because the institution/industry operates in an uncertain environment and the decisions made today will affect the future of the institution/industry itself. By making predictions, decisions made today can be based on prediction results from data that have occurred in the past, therefore decisions taken from prediction results can be measured for the future. The components of the number of motor vehicles consisting of population density, road capacity, number of motor vehicles and there is a tendency to seasonal patterns where the data pattern repeats at a certain period of time, which in this case is on a monthly basis in different years, from this model compared to the prediction accuracy value using the MAPE calculation, it is the smaller value that will be chosen as the prediction model or forecast for the following years and the MAPE value the larger one will be ignored and not used in future predictions. According to (Mulyana, 2004), because it is an upper function, the relationship of the autocoefficient to its lag is called the autocorrelation function. The autocorrelation coefficient is suspected to be the autocorrelation coefficient of the sample. $\rho_k \rho_k \rho_k$

$$r_{k=} \sum_{t=1}^{n-k} (x_t - \bar{x})\ (x_{t-k} - \bar{x}\ )$$

Information:

r_k = autocoefficient of *lag-k*
k = time difference
n = number of observations
$\bar{x}$ = average of {zt} observations
x_t = observation at the time of*t*
x_{t+k} = observations at the time to *T+K*, *k* = 1,2,3,

Research Marzuqi et al, Prediction of the Number of Visitors to Semarang Zoo with *Fuzzy Time Series Method.* The results of this study are obtained from the prediction results for January 2022 of 34,640 for manual calculations and 34,430 for calculations with the Rstudio application. Meanwhile, the results of the MAPE test were obtained 14.15% for manual calculations and 15.082% for calculations with the Rstudio application. (Wuryanto Ika, et al. (2021), Average-Based Fuzzy Time Series Model for Predicting the Development of Confirmed Positive Cases of COVID-19. Based on the results of the performance of the prediction application, a Mean Absolute Percentage Error (MAPE) of 10.50 percent was obtained. This can be a decision support for the management unit in providing information and making policies related to real efforts to prepare, plan, counter, and control the spread of Covid-19 [8].

Subsequently, the results of the research carried out [9]. Application of Fuzzy Time Series Chen Average Based on Rainfall Forecasting. This study analyzed rainfall data in Melawi Regency from January 2016 to December 2019 using Chen's fuzzy time series to forecast rainfall in January 2020. In this process, the interval length is determined using the average based method, then the fuzzy set is determined, fuzzification is carried out and Fuzzy Logic Relations (FLR) and Fuzzy Logic Relations Group (FLRG) are determined, then the forecast value is defuzzified. Then the results of rainfall forecasting in January 2020 were obtained, which was 631 mm. The value of forecasting accuracy calculated using the Mean Absolute Percentage Error (MAPE) was 44.57%. Meanwhile, the findings tested [10]. Prediction of the Number of Foreign Tourist Visits to Indonesia Using *Average-Based Fuzzy Time Series Model Method.* The results of the study are that the number of visitors that cannot be ascertained must be predictable to anticipate an increase or decline in the number of visitors, so that the state can determine policies for changes in the number of visitors in the future. To make predictions in this study, it is to apply the average-based fuzzy time series models method and the data used is 216 data taken through the official website of the Central Statistics Agency of East Java, namely data on the number of foreign tourist visits to Indonesia for the period from January 1999 to December 2016. Based on the results of the study, the average MAPE score was 10.140%, the MAPE value obtained was included in the good criteria because it was less than 20%. Therefore, it can be concluded that the average-based fuzzy time series method is good enough for the calculation of the prediction process of the number of foreign tourist visits to Indonesia. There are 4 types of *Average Based Method Prediction of* data patterns in forecasting [14] namely:

1. Trend: trend data patterns show that data movements tend to increase or decrease over a long period of time. Such as, the sales of many companies, GNP and various other business or economic indicators.
2. *Seasonality* : Seasonal data patterns are formed due to seasonal factors, such as weather and holidays (e.g. a quarter of a given year, a month, or a day of a given week). Sales of products such as soft drinks, ice cream, and space heating fuels all point to this type of pattern.

3. *Cycles* : Cyclical data patterns occur when the data is affected by long-term economic fluctuations such as those related to business cycles. Such as, the sale of products such as cars, motorcycles, steel, and other main equipment.
4. *Horizontal/Stationary/Random Variation* : This pattern occurs when the data fluctuates around the mean value randomly without forming a clear pattern such as a seasonal pattern.

Table 1. Intercval Base

Range	Base
0,1-1	0,1
1,1-10	1
11-100	10
101-1000	100
1001-10000	1000

The purpose of *time series analysis* is to predict future value. A forecasting method that aims to produce an optimal forecast that does not have a large error rate. If the level of error produced is smaller, then the forecast results will be closer to the actual value, [11]. The level of accuracy of each forecasting model is used test methods, including:

1. *Mean Square Deviation (MSD)*

$$MSD = \frac{1}{n} = \sum_{t=1}^{n} (Xt - \widehat{Xt})^2$$

2. *Mean Absolute Deviation (MAD)*

$$MAD = \frac{1}{n} = \sum_{t=1}^{n} \left| Xt - \widehat{Xt} \right|^2$$

3. *Mean Absolute Percentage Error (MAPE)*

$$MAPE = \frac{100\%}{n} \sum_{t=1}^{n} \left| Xt - \widehat{Xt} \right|^2$$

Information

n = a lot of data

Xt = observation data at time t

$\widehat{Xt}$ = Prediction result data at time t.

The smaller the value produced by the three measuring tools above, the better the forecasting model used. Based on the three test tools above, Mean Square Deviation (MSD) is the most commonly used [11]. The tolerance limit of *MAPE* testing is 20% so it can be concluded that the test results of all products are accepted. The prediction ability is very good if it has a MAPE value of less than 10% and has a good prediction if the MAPE value is less than 20%. There are several similarities and differences in this study with previous studies [12]. The similarity with this research is in terms of the method carried out and the difference is the object of the research and the place[13]. The research conducted by the researcher is "Prediction of the Number of Motor Vehicles in Ternate City Using *the Average Based Fuzzy Time Series Model Method* ". The preparation of this study refers to the previous research that has been presented, related to the title Prediction of the Number of Motor Vehicles in Ternate City Using *the Average Based Fuzzy Time Series Model Method* with the aim of predicting the number of motor vehicles in the following years. The stages and steps to answer the research objectives are as follows:

1. Collecting data on the Number of Motorized Vehicles in Ternate City during the 2019-2023 period.
2. Collecting data on the number of people in Ternate City for the 2019-2023 period.
3. Conduct a descriptive analysis on each indicator of the research variable.
4. Make predictions using *the Average Based Fuzzy Time Series Method with the steps listed in the previous explanation.*
5. Interpret the resulting MAPE and draw conclusions.

Table 2. *MAPE Criteria*

It	MAPE Values	Criterion
1	<10%	Excellent
2	210%-20%	Good
3	20%-50%	Enough
4	>50%	Bad

Here is an explanation of the steps that must be taken.

1. The interval determination was carried out by dividing the observation conditions by the conceptualization of the research. The determination of the interval will be calculated based on the *averagebased*.

2. At this stage, the forecasting process is carried out by *Fuzzy Timeseries Method* Where in step 1 the interval will be determined using the concept of *average-based and concept* method *fuzzzy time series.* The following is a diagram of the prediction process flow:

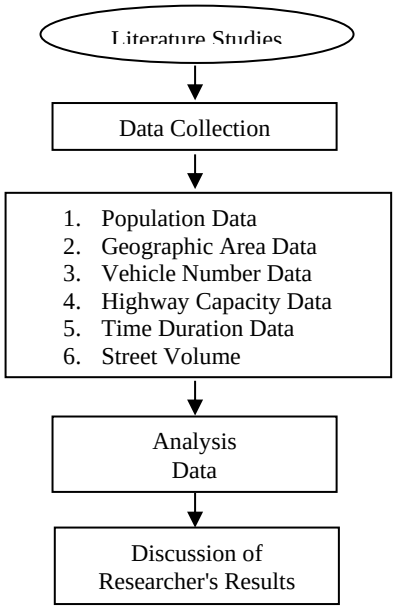

Figure 2. Research Stages

3. RESULTS AND DISCUSSION

Descriptive Analysis

From the existing research data, to obtain an overview of the movement of historical data on the number of motor vehicles, a descriptive analysis was carried out. The graph used is graph 4.1 which aims to provide an overview of the data. The data used is from January 2019 to December 2023.

Functional Testing

Functional Testing is a test that aims to find out how much similarity or match the results of the manual calculation process and the results of the system calculation process. In this test, 1 trial will be carried out, namely a 2024 prediction test using data from 2019 to 2023. To determine the size of a value, min and *max* are needed, where *min* is the minimum data for the number of motor vehicles and *max* is the maximum data for the number of motor vehicles in Table 4.1, it can be known that the min value is 34,721 which is the number of motor vehicles in 2019 and the max value is 35,083 which is the number of motor vehicles in 2023. The presentation of data can be described as the number of motor vehicles in Ternate City from January 2019 to December 2023 was 427,710. So that the average number of motorized vehicles in Ternate City per year is known to be 33,840 motorized vehicles. The test results shown in Table 4.2 obtained the results of the experiment of calculating the number of vehicles between the manual and the system, it can be said that the system is 100% in accordance with the manual. The test shown in Table 4.3 obtained the results of the experiment of calculating the number of Population between manual and the System, it can be said that the system is 100% in accordance with the manual. Based on the tests shown in Table 4.4, the results of the experiment to calculate the road capacity between the manual and the system can be said that the system is 100% in accordance with the manual. Based on the tests shown in the previous table, the results of the experiment of calculating the number of areas between the manual and the system can be said that the system is 100% in accordance with the manual.

Determining *the Value of the Fuzzy Time Series*

In principle, to determine the set data, a *Min* value and *a Max* value are needed, where the *Min* value is the minimum data for the number of motor vehicles and *the Max* value is the maximum data for the number of motor vehicles, it can be known that the min value is 240.056 which is the number of motor vehicles in 2019 and the max value is 275.441 which is the number of motor vehicles in 2023.

Fuzzy Time Series *Value* Number of Motor Vehicles

Based on the table above, the prediction value of the number of motor vehicles in Ternate City from January 2019 to December 2023 was obtained, the prediction results for the next period, namely January 2024, amounted to 326,607 every year increasing. The next stage is to carry out *fuzzification* based on the intervals that have been obtained and linguistic values that are in accordance with the number of intervals that have been formed. Next, determining *the Fuzzy Logic Relations* (FLR), the fuzzified data will be formed into *FLR* in chronological order,

if (t − 1) is expressed as A-t and (t) is expressed as A-1, then *FLRAt→A1 will be produced. The following are the FLR results:*

Fuzzy Time Series *Value* of Population

Furthermore, the value of *fuzzification* is the number of population based on *the intervals* that have been obtained and linguistic values that are in accordance with the number of *intervals* that have been formed. Below are the results of *fuzzification* of data that have been notated with linguistic numbers can be seen in the following table: Table 4.8.Results of *Fuzzyification Time Series* Number of Population. Furthermore, the number of population determines *the Fuzzy Logic Relations* (FLR), the *fuzzified* data will be formed into *FLR* in chronological order, if (t − 1) is expressed by A-t and (t) is expressed by A-1, then *FLRAt→A1 will be produced. The following are the results of FLR:*

Value *Fuzzy Time Series* Road Capacity

Furthermore, the value of *fuzzification* is the capacity of the road based on *the intervals* that have been obtained and the linguistic value that is in accordance with the number of *intervals* that have been formed. Below is the result of fuzzification of data that has been annotated with linguistic numbers.

Furthermore, the capacity of the road determines *the Fuzzy Logic Relations* (FLR), the *fuzzified* data will be formed into *FLR* in chronological order, if (t− 1) is expressed by A-t and (t) is expressed by A-1, then *FLRAt→A1 will be produced. The following are the FLR results:*

Fuzzy Time Series *Value* Number of Regions

Then determine the value of *fuzzification*, namely the number of regions based on *the intervals* that have been obtained and linguistic values that are in accordance with the number of *intervals* that have been formed. The result of the number of regions that determine the value *of Fuzzy Logic Relations* (FLR), the *fuzzified* data will be formed into *FLR* in chronological order, if (t − 1) is expressed by A-t and (t) is expressed by A-1, then *FLRAt→A1 will be produced. The following are the FLR results:*

Testing for the amount of data against MAPE values

Based on the results of the prediction carried out with a total of 60 data, namely data on the number of motor vehicles in Ternate City from 2019 to 2023, it produces data on the prediction of the number of motor vehicles in 2024, which is around 32660,737 After the prediction results in 2016 are known, the next step is to calculate *the MAPE value* of the prediction results. The calculation *of the MAPE* value is according to the equation.

Table 3. Results of Calculation of MAPE Value Number of Vehicles

Model Fit										
Fit Statistic	Mean	Minimum	Maximum	Percentile						
				5	10	25	50	75	90	95
Stationary R-squared	,696	,696	,696	,696	,696	,696	,696	,696	,696	,696
R-squared	,529	,529	,529	,529	,529	,529	,529	,529	,529	,529
RMSE	,551	,551	,551	,551	,551	,551	,551	,551	,551	,551
MAPE	1,078	1,078	1,078	1,078	1,078	1,078	1,078	1,078	1,078	1,078
MaxAPE	4,996	4,996	4,996	4,996	4,996	4,996	4,996	4,996	4,996	4,996
MAE	,353	,353	,353	,353	,353	,353	,353	,353	,353	,353
MaxAE	1,654	1,654	1,654	1,654	1,654	1,654	1,654	1,654	1,654	1,654
Normalized BIC	-,987	-,987	-,987	-,987	-,987	-,987	-,987	-,987	-,987	-,987

In figure 4.2 It can be seen that the prediction of the number of vehicles using *the Fuzzy Time Series MAPE* method can be seen, the graph shows the prediction results, where the graph has a prediction value pattern that is almost the same as the actual data pattern of the number of vehicles from January 2019 to December 2023 which is shown by a red graph. Although the final forecast graph produces a value that is not exactly the same as the actual data, the pattern of forecast values tends to follow the pattern of the actual data.

Table 4. Results of Calculation of MAPE Value of Total Population

Model Fit										
Fit Statistic	Mean	Minimum	Maximum	Percentile						
				5	10	25	50	75	90	95
Stationary R-squared	,671	,671	,671	,671	,671	,671	,671	,671	,671	,671
R-squared	,438	,438	,438	,438	,438	,438	,438	,438	,438	,438
RMSE	2,222	2,222	2,222	2,222	2,222	2,222	2,222	2,222	2,222	2,222
MAPE	,645	,645	,645	,645	,645	,645	,645	,645	,645	,645
MaxAPE	3,455	3,455	3,455	3,455	3,455	3,455	3,455	3,455	3,455	3,455
MAE	1,409	1,409	1,409	1,409	1,409	1,409	1,409	1,409	1,409	1,409

MaxAE	7,586	7,586	7,586	7,586	7,586	7,586	7,586	7,586	7,586	7,586
Normalized BIC	1,802	1,802	1,802	1,802	1,802	1,802	1,802	1,802	1,802	1,802

Furthermore, in figure 4.2 It can be seen that the population prediction using the *Fuzzy Time Series MAPE* method shows the prediction results, where the graph has a prediction value pattern that is almost the same as the actual data pattern of the population from January 2019 to December 2023 which is shown by a red graph. Although the final forecast graph produces a value that is not exactly the same as the actual data, the pattern of forecasting values tends to follow the pattern of the actual data.

Table 5. Results of Calculation of MAPE Value of Number of Regions

Model Fit										
Fit Statistic	Mean	Minimum	Maximum	Percentile						
				5	10	25	50	75	90	95
Stationary R-squared	,696	,696	,696	,696	,696	,696	,696	,696	,696	,696
R-squared	,529	,529	,529	,529	,529	,529	,529	,529	,529	,529
RMSE	23,224	23,224	23,224	23,224	23,224	23,224	23,224	23,224	23,224	23,224
MAPE	,001	,001	,001	,001	,001	,001	,001	,001	,001	,001
MaxAPE	,004	,004	,004	,004	,004	,004	,004	,004	,004	,004
MAE	14,874	14,874	14,874	14,874	14,874	14,874	14,874	14,874	14,874	14,874
MaxAE	69,723	69,723	69,723	69,723	69,723	69,723	69,723	69,723	69,723	69,723
Normalized BIC	6,495	6,495	6,495	6,495	6,495	6,495	6,495	6,495	6,495	6,495

It can be seen that the prediction of the number of regions using *the Fuzzy Time Series MAPE* method, the graph shows the prediction results, where the graph has a pattern of prediction values that is almost the same as the actual data pattern of the number of regions from January 2019 to December 2023 which is shown by a red graph. Although the final blue forecast graph produces a value that is not exactly the same as the actual data, the pattern of forecast values tends to follow the pattern of the actual data.

Based on the MAPE value, the amount of data generated is up and down in the previous year, but it is more likely to increase if more data is used in 2024 in January, April, July and October, so it can be said that the use of a lot of data can cause the MAPE value to be higher. The higher MAPE value occurs because the range of road capacity data values from 2019 to 2023 always changes every year and the data fluctuates.

Table 6. Results of Calculation of MAPE Value of Fit Model Road Capacity

Model Fit										
Fit Statistic	Mean	Minimum	Maximum	Percentile						
				5	10	25	50	75	90	95
Stationary R-squared	,882	,882	,882	,882	,882	,882	,882	,882	,882	,882
R-squared	,941	,941	,941	,941	,941	,941	,941	,941	,941	,941
RMSE	1400,578	1400,578	1400,578	1400,578	1400,578	1400,578	1400,578	1400,578	1400,578	1400,578
MAPE	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013	1,013
MaxAPE	35,543	35,543	35,543	35,543	35,543	35,543	35,543	35,543	35,543	35,543
MAE	282,651	282,651	282,651	282,651	282,651	282,651	282,651	282,651	282,651	282,651
MaxAE	9715,946	9715,946	9715,946	9715,946	9715,946	9715,946	9715,946	9715,946	9715,946	9715,946
Normalized BIC	14,694	14,694	14,694	14,694	14,694	14,694	14,694	14,694	14,694	14,694

In the previous trial, namely the test of data composition and road capacity, the optimal data composition and interval length had been obtained. The most optimal data composition in 2024 is 88.2% and the data before 11.8% of road capacity. While the most optimal interval is 10. Based on the value of the data composition and the length of the interval, predictions were made using the average-based *fuzzy time series* method. From the predictions carried out, the MAPE value of the test was 1.01%, *the MSE* value of forecasting was 1400.5, and the *MAD* value of forecasting was 27.93

Determining the Prediction Result

Based on the calculation of the prediction value of the last year, the final prediction value can be obtained from the adjustment value. The final forecast results are obtained from the sum of the initial forecast value and the adjustment value. Below is a comparison table of prediction years before and after 2019-2023, actual data for January 2019, and *Mean Absolute Precentage Error* (MAPE) as follows

Table 7. Final Prediction Value Calculation Results

Model Statistics						
Type	Model Fit statistics		Ljung-Box Q(18)			Number of Outliers
	Stationary R-squared	MAPE	Statistics	DF	Sig.	
Number of Vehicles	,632	1,616	24,620	15	,055	0
Population	,665	,349	14,988	15	,452	0
Road Capacity	,882	1,013	1,130	15	1,000	0
Number of Regions	,264	,000	,822	15	1,000	0

Source : Data Processed by Researchers

Prediction of the number of motor vehicles in Ternate City using the *Average Based Fuzzy Time Series Model* method, in the last month shown by the blue graph has a pattern of forecast values that is almost the same as the actual data pattern of the number of motor vehicles in January 2024 to October 2024 which is shown by the red graph, then the pattern shown by the purple graph also has almost the same pattern as the data The actual prediction of the number of motor vehicles in Ternate City from January 2024 to October 2024 with a total number of predictions for each indicator of 2.98%. Although each indicator produces a value that is not exactly the same as the actual data, the pattern of forecasting values tends to follow the pattern of the actual data. In this discussion, it is also known that the prediction of the number of motorized vehicles in Ternate City uses *the Average Based Fuzzy Time Series Mode* which predicts the number of motorized vehicles in Ternate City has quite good results, because the MAPE value *of the Average Based Fuzzy Time Series Mode* has a smaller error rate, although there are several indicators that are not included in the category but can be feasible in making a prediction in the coming year.

Research conducted [16]. By predicting the number of motor vehicles, the prediction data can be used by the government or related parties to create a program to reduce the impact of a high number of motor vehicles. Fuzzy time series is one method for prediction. One type of fuzzy time series method is the average-based fuzzy time series. This method is an average-based fuzzy time series method that is able to determine the length of the effective interval, so that it is able to provide prediction results with a good level of accuracy. The data used in the study amounted to 45 data. As a result of this study, the average error value calculated using the Mean Absolute Percentage Error (MAPE) method obtained an error value of 12.67% which shows that this study is included in the category of good used in predicting motor vehicles in Indonesia because it has an accuracy value of less than 20%.

4. CONCLUSION

Based on the results of the analysis above, it can be seen that the number of motorized vehicles in the Ternate City area from January 2019 to December 2023 has increased and decreased on the graph. The number of motor vehicles in Ternate City from 2019 to 2023 produces data from the prediction of the number of motor vehicles in 2024, which is around 32660,737. Motorized vehicles in Ternate City from January 2019 to December 2023 amounted to 427,710. So that the average number of motorized vehicles in Ternate City per year is known to be 33,840. The results of the research on manual calculation testing and system calculation already have a match level above the average of 100%. The smallest total value of the average final MAPE prediction is in the test results using a total of 60 data by producing a MAPE value of 0.349. Meanwhile, the test with the largest MAPE value by using 60 data with a MAPE value of 1,616. The test results from the amount of data can be concluded that the more data is used for prediction, the more MAPE values are generated. Based on the results of the study using the Average-Based Fuzzy Time Series Models Method, the prediction value of the number of motor vehicles in Ternate City from January 2019 to December 2023 was obtained, the prediction results for the next period, namely January 2024, amounted to 326,607 every year. The next stage is to carry out fuzzification based on the intervals that have been obtained and linguistic values that are in accordance with the number of intervals that have been formed.

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