# Application of The Least Square Method for The Prediction of The Number of Registration in Admission of New Students in Universities

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***Abstract*—— Seeing the huge potential that can be explored in new student admissions, the authors are interested in looking for stored patterns from the data to get predictions and information. That is to predict the number of registrants in the following year. To solve these problems, a method is used, namely the least square method. The existing data are five time series, consisting of five years of new student admissions data. To calculate the error rate, the mean absolute deviation (MAD), the mean square error (MSE), and the mean absolute percentage error (MAPE) are used. With the prediction results for 2020 obtained, there are 225 people for Informatics Engineering, 82 people for Information Systems, and 11.2 people for Information Management. And the results of the measurement of the suitability of forecasting with these methods are, for Informatics Engineering as much as 0.79%, Information Systems 0.8%, and Information Management as much as 3.4%.**

***Keywords*— Forecasting, Least Square Method**

## I. INTRODUCTION (*HEADING 1*)

Today's universities are required to have a competitive advantage by utilizing all available resources. In addition to facilities, infrastructure, and human resources, information systems are one of the resources used to increase competitive advantage. A system can be used to process data so that later it will produce decisions from the data. So that it can be used to support the operational activities of the university.

The Sumedang College of Informatics and Computer Management (STMIK) is one of the private universities in Sumedang Regency, West Java. STMIK Sumedang has three majors that students can choose from, namely Informatics Engineering (S1), Information Systems (S1), and Information Management (D3). Prospective students who enter STMIK Sumedang have various educational backgrounds. The number of applicants who enter each Department from year to year has increased or decreased. Based on the data obtained, the number of new students at STMIK Sumedang from 2015 to 2019 is as follows; in 2015 as many as 186 people, in 2016 as many as 212 people, in 2017 as many as 227 people, in 2018 as many as 280 people, in 2019 as many as 285.

Based on these data, STMIK Sumedang does not yet have a data pattern on the data it has. This data pattern can be used to gain knowledge and learning related to new student admissions. Information from research can help the process of forecasting the number of prospective students in the following year.

This study aims to apply and analyze the accuracy of the least square to predict the number of prospective students or applicants by utilizing new student data from previous years.

## II. LITERATURE REVIEW

### 2.1 Forecasting

In the Big Indonesian Dictionary (KBBI) the notion of forecasting is a process of estimating or guessing a result or need that will come in the future, using past data as input and taking into account the data to be appear in the future with a method or algorithm. There are several definitions of forecasting according to several experts, including: Forecasting is defined as the use of statistical techniques in the form of a future picture based on the processing of historical figures. Forecasting is a technique that uses historical data to forecast future projects. Forecasting is a forecast or forecast that has not yet happened. In social science, everything is uncertain, it is difficult to estimate accurately, therefore forecasting is used which aims to forecast or forecast which aims to minimize uncertainty to the company.

Forecasting is a prediction, projection, or estimation of an uncertain future level of events. Accuracy in predicting future events and activity levels will not be achieved, therefore when companies cannot see future events for sure it takes a lot of time and energy so that they can have the power to draw conclusions about future events [1].

### 2.2 Least Square Method

Method least square method is a method in the form of periodic series data which in making predictions requires past data to be calculated and produce predictive information

in the future. The Least Square Method or Least Square Method is used to get the linear regression coefficient estimator. In general, the formula for time series is shown by equation 3:

Y = a + bX ..... (3)

Description:

Y = periodic data (time series) = estimated trend

X = Time variable (day, week, month or year)

a = trend in base year

b = average growth trend in each year.

Y is the variable that the trend is looking for and X is the time variable (years). Meanwhile, to find the value of constant (a) and parameter (b) is shown in the following equation:

a = Y / N ..... ..... (4)

b =(ΣYX)/Σ ..... ..... (5)

The steps in this least square are as follows:

a. Determine the data amount Y.

b. Determine the parameter X.

Because it uses the least square , the value of X must be 0.

c. Determine the value and XY

After the parameter X is determined, the next step is to determine the value , by squaring the parameter X that has been determined earlier. After knowing the value of , then look for the value of XY, by multiplying the relevant data ( Y ) with the X parameter data.

d. Create trend equations.

Equation trend, you must first determine the value of "a" and the value of "b" with the formula:

a = Y / N

b =(ΣYX)/Σ ..... ..... (6)

e. Determine the value of the Y function.

The formula to get the Y forecasting results is obtained from equation 3. From the calculation results, the formula is the result of Least Square [2]

The Least Square method is also a method used to determine the trend which includes time series with two cases of even and odd data. The following is an explanation if the amount of data is even or odd.equation is trend searched using the Least Square, which uses equation no 3.

To find the values of a and b from the trend equation, two normal equations can be used as follows:

Y = na + b.∑X

XY = a.∑X + b.∑ ..... ... (7)

If the midpoint of the data is the base year, then X = 0 and equation 7 above can be omitted and becomes:

$a = \frac{\sum y}{n}$ ..... (8)

$b = \frac{\sum xy}{\sum x^2}$..... (9)

## 2.3 Measurement of Accuracy Error

In making predictions, whether or not the forecast results of a model will determine whether the model is used or not. The size of the forecasting error can be calculated through the size of the forecasting error [4].

Forecasting accuracy is an important thing for forecasting, namely how to measure the suitability of existing data with forecasting data. According to Pakaja (2012), there are several calculations commonly used to calculate the total forecasting error. Three of the most well-known calculations are theMean absolute deviation (MAD), theMean Squared Error (MSE), and theMean absolute percentage error (MAPE) [5].

### 2.3.1 Mean absolute deviation (MAD)

The method for evaluating forecasting methods is to use the sum of absolute errors. The mean absolute deviation (MAD) measures the accuracy of the forecast by averaging the estimated error (the absolute value of each error). MAD is useful when measuring forecast error in the same units as the original series. MAD is the first measure of the overall forecasting error for a model.

The formula for calculating MAD is as follows [5]

$$MAD = \frac{\sum_{t=1}^{n} |Y_t - F_t|}{n} \quad \text{..... (10)}$$

Description :
$Y_t$ = Actual data in period t
$F_t$ = Forecasting value in period t
n = Total data

### 2.3.2 Mean Squared Error (MSE)

MSE uses the denominator of n regardless of the degrees of freedom of the model. MSE is used to measure the accuracy of the estimated value of the model expressed in the average square of the error and can also be used to compare the predictions of predictions between different forecasting methods, but MSE provides better accuracy than MAD, so it is widely used in weight optimization [4]. .

Mean Squared Error (MSE) is another method for evaluating forecasting methods. Each error or remainder is squared. This approach manages large forecasting errors because the errors are squared. That method produces moderate errors which are probably better for small errors, but sometimes make a big difference. MSE is the second way to measure the overall forecasting error. MSE is the average of the difference in squares between the predicted and observed values. The disadvantage of using MSE is that it tends to feature large deviations due to squared.

The formula for calculating MSE is as follows [5].

$$MSE = \frac{\sum(Y_1 - Y_t)^2}{n} \quad \text{..... (11)}$$

Description:

$Y_1$=Original data of new students in period t

$Y_t$= Forecast of new students in period t

$n$ = Number of data periods.

### 2.3.3 Mean Absolute Percentage Error (MAPE)

The average absolute percentage error or MAPE provides an indication of how much the forecast error is compared to the true value. MAPE is used to measure the accuracy of the estimated value of the model which is expressed in the form of an average absolute percentage of error and is more widely used for comparisons on data that have different time interval scales [4].

Mean Absolute Percentage Error (MAPE) is a percentage calculated from the absolute value of the error in each period and divided by the actual amount of data for that period, then the average error is sought. Forecasting ability is very good if it has a MAPE value of less than 10% and has a good forecast if the MAPE value is less than 20% [2].

The MAPE value can be calculated using the following equation:

$$MAPE = \frac{\sum \frac{|Y1 - Yt|}{Y_1}}{n} \text{ X } 100\% \quad \text{..... (12)}$$

Description:
Y1 = data in period t
Yt = forecast for period t
n = total number of periods
|| = absolute value.

## III. METHOD

### 3.1 Data on the Number of Registrants for STMIK Sumedang for Each Major

Table 3.1 Number of Registrants for STMIK Sumedang by Major

| No. | Major | Year | | | | |
|---|---|---|---|---|---|---|
| | | 2015 | 2016 | 2017 | 2018 | 2019 |
| 1. | Informatic Engineering | 128 | 145 | 154 | 199 | 200 |
| 2. | Information Systems | 43 | 49 | 65 | 67 | 72 |
| 3. | Informatics Management | 15 | 18 | 8 | 14 | 13 |
| Total | | 186 | 212 | 227 | 280 | 285 |

### 3.2 Forecasting With The Least Square

Y data sources can be seen in table 1 according to each department. Meanwhile, because there are 5 years of data, the X values are -2, -1, 0, 1, 2. To determineforecastingfor the three majors, the three majors must be calculated one by one. The three majors include Informatics Engineering, Information Systems, Information Management.

The steps taken to obtain the results of the calculation of this method are:

a. Determine the number of new student data for each Department per year.

   In this step, a table is created that displays data on the number of new students from each Department per year in time series data. The data entered is the number of registrants in the Department of Informatics Engineering, Information Systems, and Information Management from 2015 to 2019. The data can be seen in table 1.

b. Determining data Y

   In this study, the value of Y is the number of students per year based on the Department. This is because what will be predicted is per Department. To is the number of applicants for each Department from 2015 to 2019.

c. Determining the value

   To determine the value of X, by looking at the amount of data used as a dataset, namely;

   1) The data is odd, then the value of X is ...,-2,-1,0,1,2,.. where the value of X if added up the result is 0.
   2) The data is even, then 0 is omitted, so the value of X is ...,-2,-1,1,2,.. where the value of X if added up the result is 0.

   Because dataset used in this study is five years old, and odd then, the value of x sequentially from 2015 to 2019 is -2, -1, 0, 1, 2. As for  is the value of x squared, namely 4, 1, 0, 1, 4 sequentially from 2015 to 2019. Then for the value of XY is the value of X multiplied by the value of Y. The value of Y in each Department varies according to the amount of data calculated.

d. Finding the trend in the base year (a)

   To determine the value of a, a calculation based on equation 8. is used, namely the number of registrants for each Department in 2015-2019 ($\sum Y$)divided by the number of consecutive years (n).

e. Determine the average growth trend every year (b)
f. Forecasting the number of new students in period X.

   After a and b are known, the prediction using equation 3 can be known, by entering the value of X from the year you want to predict. In this study, the year to be predicted is 2020, so the value of X is 3.

### 3.3 Measurement of Prediction Error

Whether or not the forecast results of a model will determine whether the model is used or not. The size of the forecasting error can be calculated through the size of the forecasting error.

The calculation uses three of the most well-known error calculations, namely theMean absolute deviation (MAD), theMean Squared Error (MSE), and theMean absolute percentage error (MAPE).

#### 3.3.1. Mean Absolute Deviation (MAD)

The mean absolute deviation (MAD) measures the accuracy of the forecast by averaging the error of the estimate (the absolute value of each error). MAD is very useful when one wants to measure forecast error in the same units as the original series.

Based on equation 10, MAD can be found using the following calculations, which have been adapted to the case in the study. It is calculated in each department, namely, Informatics Engineering, Information Systems, and Information Management.

$$\text{MAD} = \frac{1}{\text{Number of data periods}} \text{. The amount of difference between original data and forecast data} \quad \text{……..(13)}$$

#### 3.3.2. Mean Square Error (MSE)

The smaller the number of MSE, the better the forecasting value. The formula for calculating MSE is as follows:

$$\text{MSE} = \frac{\text{The amount of difference between original data \& forecast data}^2}{\text{Total data period}}$$

.(14)

### 3.3.3. Mean Absolute Percentage Error (MAPE)

The accuracy of MAPE is expressed as a percentage, the smaller the percentage value, the better the forecasting accuracy. MAPE values below 10% are considered very good, while below 20% are included in the good category, because the error (error) of forecasting is very small. The following equation is used to calculate the MAPE value, according to the case study:

$$MAPE = \frac{\frac{the\ amount\ of\ difference\ between\ the\ original\ data\ and\ the\ forecasted\ data}{number\ of\ original\ data}}{number\ of\ data\ periods} . 100\%$$

....(15)

## 3.4 Calculation of the Suitability Level of Forecasting

Methods Using the MAD and Methods MSE as a method to calculate the level of forecasting match is considered not easy, because MSD and MAD are absolute measures that are highly dependent on the scale of the time series data. The interpretation of MSD values is not intuitive, because this measure involves squaring a series of values.

Then used an alternative measure using the MAPE method. The result of the MAPE value is in the form of a percentage, where the smaller the MAPE value, the higher the level of accuracy produced.

The level of the forecasting suitability indicator is shown in the table below:

Table 3.2 MAPE Value for Forecast Fit

| Number of MAPE | Match Accuracy |
|---|---|
| MAPE ≤ 10% | High |
| 10% < MAPE ≤ 20% | Good |
| 20% < MAPE ≤ 50% | Reasonable |
| MAPE > 50% | Low |

# IV. Result and Discussion

## 4.1. Forecasting Informatics Engineering

The following are the results of calculations to predict the number of registrants in 2020 at the Department of Informatics Engineering.

Table 4.1 Values of Y, X, XY, and X2, Informatics Engineering Registrants Predicted

| Year | Number of Registered (Y) | X | X.Y | $X^2$ |
|---|---|---|---|---|
| 2015 | 128 | -2 | -256 | 4 |
| 2016 | 145 | -1 | -145 | 1 |
| 2017 | 154 | 0 | 0 | 0 |
| 2018 | 199 | 1 | 199 | 1 |
| 2019 | 200 | 2 | 400 | 4 |
| $\Sigma$ | 826 | 0 | 198 | 10 |

$$a = \frac{\sum Y}{n} = \frac{826}{5} = 165{,}2$$

$$b = \frac{\sum XY}{\sum X^2} = \frac{198}{10} = 19{,}8$$

Then:

$$Y = a + bX = 165{,}2 + 19{,}8(3) = 224{,}6$$

Predicted results of the number of registrants (y) taking the Department of Informatics Engineering for 2020 are 225 people.

## 4.2 Forecasting Information System

The following are the results of calculations to predict the number of registrants in 2020 in the Information Systems Department.

Table 4.2 Values of Y, X, XY, and X2, Information System Registrants

| Year | Number of Registered (Y) | X | X.Y | $X^2$ |
|---|---|---|---|---|
| 2015 | 43 | -2 | -86 | 4 |
| 2016 | 49 | -1 | -49 | 1 |
| 2017 | 65 | 0 | 0 | 0 |
| 2018 | 67 | 1 | 67 | 1 |
| 2019 | 72 | 2 | 144 | 4 |
| $\Sigma$ | 296 | 0 | 76 | 10 |

$$a = \frac{\sum Y}{n} = \frac{296}{5} = 59{,}2$$
$$b = \frac{\sum XY}{\sum X^2} = \frac{76}{10} = 7{,}6$$

Then:

$$Y = a + bX = 59{,}2 + 7{,}6(3) = 82$$

Prediction results of the number of registrants(y) taking Information Systems Department for 2020 are 82 people .

### 4.3 Forecasting Informatics Management

The following are the results of calculations to predict the number of registrants in 2020 in the Department of Information Management.

Table 4.3 Values of Y, X, XY, and X2, Informatics Management Registrants

| Year | Number of Registered (Y) | X | X.Y | $X^2$ |
|---|---|---|---|---|
| **2015** | 15 | -2 | -30 | 4 |
| **2016** | 18 | -1 | -18 | 1 |
| **2017** | 8 | 0 | 0 | 0 |
| **2018** | 14 | 1 | 14 | 1 |
| **2019** | 13 | 2 | 26 | 4 |
| $\Sigma$ | **68** | **0** | **-8** | **10** |

$$a = \frac{\sum Y}{n} = \frac{68}{5} = 13{,}6$$

$$b = \frac{\sum XY}{\sum X^2} = \frac{-8}{10} = -0{,}8$$

Then:

$$Y = a + bX = 13{,}6 + (-0{,}8)(3) = 11{,}2$$

Prediction results of the number of applicants (y) taking the Department of Information Management for in 2020 is 11.2 People.

### 4.4 Forecast of New Students In Period t

The value is calculated from each Department, based on the year period t that will be predicted. Based on the results of previous predictions or forecasting calculations, then:

1) Informatics Engineering Forecast

   In 2015 = 165.2 + 19.8(-2) = 125.6

   In 2016 = 165.2 + 19.8(-1) = 145.4

   In 2017 = 165.2 + 19.8( 0) = 165.2

   In 2018 = 165.2 + 19.8(1) = 185

   In 2019 = 165.2 + 19.8(2) = 204

2) Information System Forecast

   In 2015 = 59.2 + 7.6(-2) = 44

   In 2016 = 59.2 + 7.6(-1) = 51.6

   In 2017 = 59.2 + 7.6(0) = 59.2

   In 2018 = 59.2 + 7.6(1) = 66.8

   In 2019 = 59.2 + 7.6(2) = 74.4

3) Informatics Management Forecast

   In 2015 = 13.6 + (-0.8)(-2) = 15.2

   In 2016 = 13.6 + (-0.8)(-1) = 14.4

   In 2017 = 13, 6 + (-0.8)(0) = 13.6

   In 2018 = 13.6 + (-0.8)(1) = 12.8

   In 2019 = 13.6 + (-0.8)(2 ) = 12

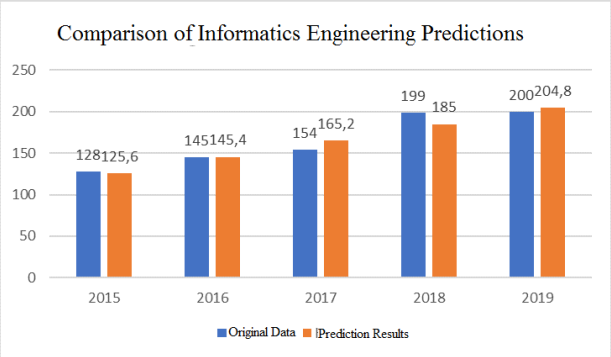


Figure 4.1 Comparison of Original Data and Predictions of Informatics Engineering

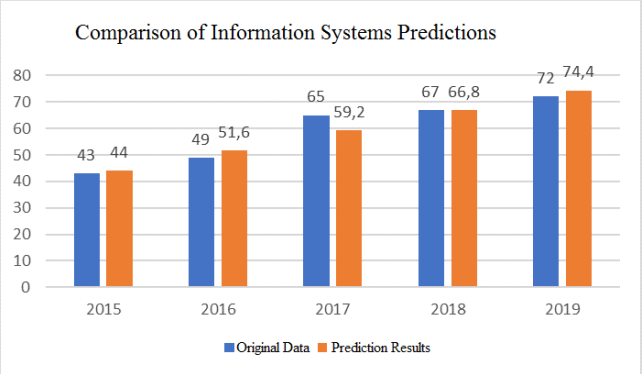


Figure 4.2 Comparison of Original and Predicted Data of Information Systems

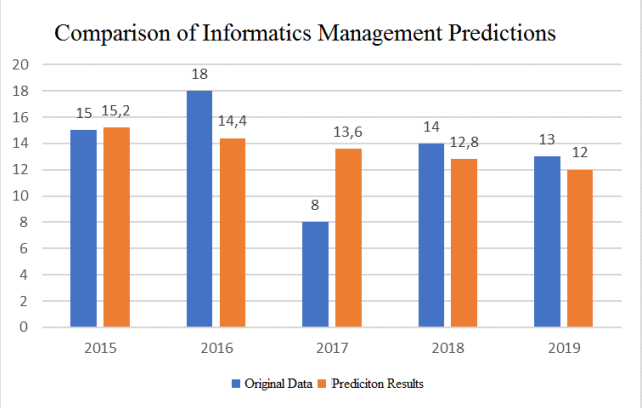


Figure 4.3 Comparison of Original Data and Predictions of Information Management

## 4.5 Analysis Forecasting

To calculate the level of prediction error (error) used mean absolute deviation (MAD), mean square error (MSE), and mean absolute percentage error (MAPE).

### 4.5.1 Informatics Engineering

The following are the results of the calculation of errorsinthe Department of Informatics using MAD, MSE, and MAPE.

Table 4.4 Analysis Errors Engineering Forecasting of Informatics

| Year | Original Data ($Y_1$) | Prediction Results ($Y_t$) | ($\lvert Y_1 - Y_t \rvert$) |
|---|---|---|---|
| **2015** | 128 | 125,6 | 2,4 |
| **2016** | 145 | 145,4 | 0,4 |
| **2017** | 154 | 165,2 | 11,2 |
| **2018** | 199 | 185 | 14 |
| **2019** | 200 | 204,8 | 3,4 |
| $\Sigma$ | **826** | | **32,8** |

$$\boldsymbol{MAD} = \frac{1}{n}\sum|Y_1 - Y_t| = \frac{1}{5}.32{,}8 = 6{,}56.$$

$$\boldsymbol{MSE} = \frac{\sum(Y_1 - Y_t)^2}{n} = \frac{(32{,}8)^2}{5} = 215.$$

$$\boldsymbol{MAPE} = \frac{\frac{\sum|Y_1 - Y_t|}{y_1}}{n} \text{ x } 100\% = \frac{\sum\frac{32{,}8}{826}}{5} \text{ x } 100\% = \frac{0{,}039}{5} \text{ x } 100\% = 0{,}79\%.$$

### 4.5.2 Information System

The following are the results of the calculation of errorsinthe Information Systems Department using MAD, MSE, and MAPE.

Table 4.5 Analysis of Errors Forecasting Information Systems

| Year | Original Data ($Y_1$) | Prediction Results ($Y_t$) | ($\lvert Y_1 - Y_t \rvert$) |
|---|---|---|---|
| **2015** | 43 | 44 | 1 |
| **2016** | 49 | 51,6 | 2,6 |
| **2017** | 65 | 59,2 | 5,8 |

| | | | |
|---|---|---|---|
| **2018** | 67 | 66,8 | 0,2 |
| **2019** | 72 | 74,4 | 2,4 |
| ***Σ*** | **296** | | **12** |

$$\boldsymbol{MAD} = \frac{1}{n}\sum|Y_1 - Y_t| = \frac{1}{5}.12 = 2{,}4.$$

$$\boldsymbol{MSE} = \frac{\sum(Y_1 - Y_t)^2}{n} = \frac{(12)^2}{5} = 28{,}8.$$

$$\boldsymbol{MAPE} = \frac{\frac{\sum|Y_1 - Y_t|}{y_1}}{n} \text{ x } 100\% = \frac{\sum\frac{12}{296}}{5} \text{ x } 100\% = \frac{0{,}04}{5} \text{ x } 100\% = 0{,}8\ \%.$$

### 4.5.3 Informatics Management

The following is the result of the calculation of errorsinthe Department of Informatics Engineering using MAD, MSE, and MAPE.

Table 4.6 Analysis Errors Management Forecasting of Informatics

| **Year** | **Original Data ($Y_1$)** | **Prediction Results ($Y_t$)** | **($\lvert Y_1 - Y_t \rvert$)** |
|---|---|---|---|
| **2015** | 15 | 15,2 | 0,2 |
| **2016** | 18 | 14,4 | 3,6 |
| **2017** | 8 | 13,6 | 5,6 |
| **2018** | 14 | 12,8 | 1,2 |
| **2019** | 13 | 12 | 1 |
| *Σ* | **68** | | **11,6** |

$$\boldsymbol{MAD} = \frac{1}{n}\sum|Y_1 - Y_t| = \frac{1}{5}.11{,}6 = 2{,}32.$$

$$\boldsymbol{MSE} = \frac{\sum(Y_1 - Y_t)^2}{n} = \frac{(11{,}6)^2}{5} = 26{,}9.$$

$$\boldsymbol{MAPE} = \frac{\frac{\sum|Y_1 - Y_t|}{y_1}}{n} \text{ x } 100\% = \frac{\sum\frac{11{,}6}{68}}{5} \text{ x } 100\% = \frac{0{,}17}{5} \text{ x } 100\% = 3{,}4\ \%.$$

### 4.6 Level of Suitability of the Least Square

Based on the results of theerrorrate forecasting new students at STMIK Sumedang using MAD, MSE, and MAPE in the table below, the match rate is calculated based on the MAPE value.

Table 4.7 Forecasting Error of New Student Admissions for Each Major

| **Major** | **Level of *Error*** | | |
|---|---|---|---|
| | **MAD** | **MSE** | **MAPE** |
| Infromatics Engineering | 6,56 | 215 | 0,79 % |
| Information System | 2,4 | 28,8 | 0,8 % |
| Informatics Management | 2,32 | 26,9 | 3,4 % |

So that the level of forecasting suitability for the Department of Informatics Engineering, Information Systems, and Information Management with the least square method (smallest square), based on the indicator of the size of the MAPE value in table 2. is as follows:

Table 4.8 Accuracy of Forecasting Suitability Based on MAPE Value

| **Major** | **MAPE** | **Match Accuracy** |
|---|---|---|
| Infromatics Engineering | 0,79 % | High |
| Information System | 0,8 % | High |
| Informatics Management | 3,4 % | High |

## V. CONCLUSION

The number of new students who apply to each major can be predicted using the time series method (least square). The use of this method in the case of the number of STMIK Sumedang students as registrants is considered suitable. The difference between the prediction results and the actual data is no more than six people in each department.

From the available data, it is known that the prediction results for the number of new students in 2020 are, the number of registrants in the Informatics Engineering department is 225 people, Information Systems 82 people,

and Information Management 11 people. New student data is very suitable for prediction using the least square. Forecasting suitability from the percentage of MAPE values, which is below 10%, namely MAPE results for Informatics Engineering as much as 0.79%, Information Systems 0.8%, and Information Management as much as 3.4% which means the level of suitability is very high.

Prediction or forecasting results are the results of calculations from previously available data. So when the number of forecasting results and the actual data are different and inaccurate, it is caused by factors outside the existing data.

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