The web-based estimation of motorcycles sales using linear regression method

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Abstract. The purpose of this research is to use the linear regression method to predict motorcycle sales results, the variable used is the period as an independent variable (X) and sales as the dependent variable (Y). The data used in the calculation of linear regression is the last four years data, from January 2014 to December 2019. The implementation of the motorcycle sales forecasting system is to predict sales in the coming months. To find out the level of accuracy of the prediction error calculation is needed so that it is known how many error levels are obtained. Calculation of forecasting errors using Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE). The results of this study are web based motorcycle sales prediction systems using linear regression method. From this system, motorcycle sales forecasting is obtained the following month. In January 2015 with forecasting results of 12.63. To find out how accurate the forecasting level is, the error calculation result using Mean Absolute Deviation (MAD) is 3.40 and Mean Absolute Percentage Error (MAPE) is 44.33%. The results show that the error rate is small and the forecasting results are close to accurate.

1. Introduction

The development of motorcycles in Indonesia has increased from year to year, making many companies compete in offering their products. Each company provides the best advantage of the products offered to consumers, so that the company can win a competitive market with other companies. Many ways are taken by the company to encourage the public's attraction towards the motorbikes offered. One way that is often used is through the variety of promotional media used. Promotion media evaluation system must always be run at the end of each year to find out the role of promotional media towards marketing targets [1].

Likewise, Agung Motor dealers who are the object of this research want motorcycle sales to reach high sales targets to sell motorcycle units. Besides having to think about sales targets that must be achieved every year, the manager must determine the number of motorcycle products that will be in stock each year. Determination of the number of stock of motorcycle products must be in accordance with the sales target to be achieved to avoid unsold products. Products that are not sold at the end of this year will become a new problem in stock inventory management, resulting in product build up. In overcoming this problem an information system is needed that is able to forecast product sales which can be used to prepare strategies for increasing motorcycle sales.

Forecasting is the process of estimating products that will be sold in the future in certain circumstances and made based on data that has occurred within a certain time period [2]. In forecasting
there must be a difference between forecasting results with sales reality, therefore forecasting results can be said to be good if the level of distrust shows a small value [3]. In forecasting, sales data with monthly periods in 2014-2019 are needed to produce the number of forecasting every month going forward. The forecasting process will be more effective if more and more sales data are used and the error result shows a small number [4]. There are many forecasting methods that can be used in this case, including the fuzzy time series method, linear regression, moving average, and other forecasting methods [5]. The method used for forecasting motorcycle sales at Agung Motor dealers is linear regression. Linear regression is a measuring tool used to determine whether there is a relationship between variables[6]. Linear regression is more accurate in knowing the rate of change of a variable against other variables. The variables used are period as independent variable (X) and sale as dependent variable (Y) [7].

The results of this study are in the form of information systems forecasts for motorcycle sales in the coming months based on 2014-2019 sales data. To find out the results of forecasting that are obtained will be calculated using Mean Absolute Deviation (MAD), Mean Absolute Percentage Error (MAPE) [8]. So that the level of distrust will be known from the results of forecasting.

2. Methods
This research focuses on forecasting motorcycle sales using linear regression methods. To do this forecasting there are two variables used, namely the period as an independent variable (X) and sales as the dependent variable (Y) [9]. The data that will be used are sales data for the past four years that come from Agung Motor dealers. The system can predict motorcycle sales for the following year through calculations using linear regression. In a forecasting there will definitely be a difference with the actual data. so to measure the level of accuracy in the forecasting system is done by using some calculation errors in forecasting accuracy, namely the Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE) [10]. The user is the admin, admin as the main operator in using the system and can add or change data according to the provisions. Research also requires steps to make it easier to conduct research, and know which needs to be done first. Figure 1 below is a further explanation of the research procedure.
The picture above explains that the first thing to do in a research procedure is to conduct a literature study to find information contained in online and printed books. Next is the formulation of the problem, namely the stage of identifying the problem, in this thesis the problem to be identified is how to design and implement a linear regression method to determine the forecasting of web-based motorcycle sales. Then to complete the data in this study, it requires the data collection stage where the data obtained from the Agung Motor dealer sales data in Maumere, the data obtained are four-year sales data, namely in January 2014 - December 2019. To complete this study the variables used are the independent variable (X) is the period and for the dependent variable (Y) is the sale\[11]. Next is the stage of making a Honda motorcycle sales system, the programming language used in this system is PHP, and for the database used to store data is MySQL. In this system for forecasting the linear regression method is used.

Linear regression is a method that functions to test the extent of the causal relationship between the independent variable (X) and the dependent variable (Y), where the independent variable is the period and the dependent variable is sales \[12].

\[
Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p + \varepsilon
\]

\[
Y = X\beta + \varepsilon
\]

where:
- \(Y\) = dependent variable (predicted value)
- \(X\) = the matrix of independent variable (\(n \times (p +1)\))
- \(\beta\) = vector of regression model parameters ((\(p +1\) \(\times\) 1))
- \(\varepsilon\) = vector of error (\(n \times 1\))

The results obtained from this study in the form of a forecasting system for Honda motorcycle sales using linear regression method. The user of this system is the admin as the main user. Admin entered the data for the last four years, from January 2014 to December 2019, then the data was processed into the system and produced a linear regression equation to calculate sales forecasting. After the results of the forecasting come out to determine the level of accuracy of the forecasting results, it is necessary to know the level of error using the Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE) \[13\].

The MAD calculation equation is as follows \[14\]:

\[
\text{MAD} = \frac{\sum |X_t - F_t|}{n}
\]

when:
- \(X_t\) = sales
- \(F_t\) = result of forecasting
- \(n\) = amount of period

The MAPE calculation equation is as follows \[15\]:

\[
\text{MAPE} = \frac{1}{n} \sum_{t=1}^{n} \left( \frac{|X_t - F_t|}{X_t} \right) \times 100\%
\]

when:
- \(X_t\) = sales
- \(F_t\) = result of forecasting
- \(n\) = amount of period

2.1. Flowchart system

The flow of the application flowchart is first started from the user logging into the system by entering the username and password then the system will process by matching the username and password in the
database, if the username and password match then the system will proceed to the dashboard data page if incorrect then the system will ask to enter the correct username and password to the admin. After successfully logging in the system will directly lead to the dashboard data page and several menus, if there is no menu to be opened the user can log out to exit the application system, aimed at Figure 3 System Flowchart.

![Flowchart of system](image)

**Figure 2.** Flowchart of system.

3. Results and discussion

Linear regression is a measuring tool used to determine whether there is a relationship between variables. The following are sales data for all types of Honda motorcycles from January 2014 to December 2019.

**Table 1.** Data of sales years 2014-2019.

| No. | Type of Motor | Jan | Feb | Mar | Apr | Mei | Jun | Jul | Agu | Sep | Okt | Nov | Des | Years |
|-----|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|
| 1   | VARIO         | 25  | 13  | 24  | 26  | 8   | 5   | -   | 25  | 8   | 7   | 18  | 15  | 2014  |
| 2   | VARIO         | 8   | 5   | 5   | 20  | 15  | 12  | 13  | 16  | 19  | 24  | 17  | 28  | 2015  |
| 3   | VARIO         | 3   | 1   | 2   | 12  | 2   | 9   | 5   | 2   | 5   | 2   | -   | 4   | 6    |
| 4   | VARIO         | -   | -   | -   | -   | 5   | 1   | 5   | 4   | 3   | 5   | 6   | 13  | 2019  |
| 5   | BEAT          | 21  | 24  | 22  | 24  | 20  | 19  | 19  | 24  | 22  | 26  | 24  | 29  | 2014  |
| 6   | BEAT          | 18  | 12  | 14  | 12  | 7   | 9   | 8   | 13  | 15  | 15  | 16  | 24  | 2015  |
| 7   | BEAT          | 13  | 7   | 4   | 7   | 9   | 2   | 7   | 6   | 5   | 8   | 6   | 10  | 2016  |
| 8   | BEAT          | -   | -   | -   | -   | 4   | 5   | 5   | 11  | 11  | 11  | 2019 |
| 9   | SUPRA X       | 23  | 23  | 26  | 18  | 13  | 9   | 8   | 5   | 11  | 17  | 6   | 14  | 2014  |
| 10  | SUPRA X       | 10  | 11  | 9   | 10  | 4   | 9   | 6   | 10  | 13  | 6   | 4   | 12  | 2015  |
| 11  | SUPRA X       | 10  | 9   | 8   | 6   | 5   | 7   | 13  | 6   | 10  | 6   | 11  | 11  | 2018  |
| 12  | SUPRA X       | 7   | 7   | 9   | 9   | 2   | -   | 3   | 2   | 5   | 6   | 5   | 6   | 2019  |
| 13  | SCOOPY        | 8   | 9   | 18  | 9   | 1   | 2   | 6   | 8   | 9   | 12  | 3   | 9   | 2014  |
| 14  | SCOOPY        | 11  | 16  | 4   | 8   | 4   | 9   | 3   | 5   | 2   | 5   | 8   | 4   | 2015  |
| 15  | SCOOPY        | 8   | 7   | 9   | 12  | 10  | 11  | 16  | 9   | 8   | 5   | 12  | 7   | 2016  |
| 16  | SCOOPY        | 18  | 10  | 12  | 15  | 9   | 4   | 7   | 4   | -   | -   | -   | 1   | 2019  |
| 17  | REVO          | 9   | 19  | 26  | 6   | -   | 9   | 10  | 7   | 10  | 2   | 14  | 7   | 2014  |
Table 1. Cont.

|    |     |     |     |     |     |     |     |     |     |     |     |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 18 | REVO | 11  | 6   | 4   | 3   | 5   | 5   | 3   | 10  | 7   | 7   | 5   |
| 19 | REVO | 3   | 1   | 2   | 4   | 6   | 5   | 2   | 3   | 1   | 2   | 3   |
| 20 | REVO | 15  | 9   | 15  | 10  | 11  | 12  | 7   | 16  | 12  | 9   | 6   |
| 21 | MEGAPRO | 3   | 11  | 1   | 6   | 1   | 2   | 3   | 2   | 3   | 4   | 7   |
| 22 | MEGAPRO | 1   | 1   | 1   | -   | 3   | -   | 2   | -   | 3   | 1   | 3   |
| 23 | MEGAPRO | -   | 1   | 2   | -   | -   | -   | -   | -   | -   | 1   | -   |
| 24 | VERZA | 2   | -   | 1   | 2   | 1   | 3   | -   | 3   | -   | 1   | 3   |
| 25 | VERZA | 2   | 1   | 2   | 4   | 3   | 4   | -   | 5   | 1   | 3   | -   |
| 26 | CB 150 R | 2   | -   | 1   | 2   | 2   | -   | 4   | 3   | 5   | 1   | 2   |
| 27 | CB 150 R | 4   | 1   | 1   | 3   | 3   | 4   | 2   | 3   | 3   | 5   | 4   |
|    | Total | 235 | 204 | 222 | 228 | 147 | 153 | 157 | 188 | 188 | 185 | 200 |

Calculation of forecasting sales of Honda motorcycles with type SUPRA X motorcycles, with sales data from the period 1-48 or in January 2011 - December 2014:

\[ b = \frac{(n)(\Sigma XY) - (\Sigma X)(\Sigma Y)}{(n)(\Sigma X^2) - (\Sigma X)^2} \]
\[ b = \frac{(48)(36260) - (1176)(440)}{(48)(36260) - (1176)(440)} \]
\[ b = -0.301 \]

To calculate the value of \( a \), it can be calculated by the following formula:
\[ a = \bar{Y} - b\bar{X} \]
\[ a = 9.17 - (-0.301)(24.5) \]
\[ a = 9.17 - (-7.37) \]
\[ a = 16.54 \]

If the results of the \( a \) and \( b \) values are known then they are entered into the linear regression equation as follows:
\[ Y' = a + bX \]
\[ Y' = 16.54 + (-0.301)(X) \]

So, the linear regression equation above is used for forecasting sales of SUPRA X type motorcycles in the following month by entering the X value, i.e., period. This forecast menu serves as a forecast process for sales using the linear regression method.

**Figure 3.** Forecasting page features.
Then after knowing the results of forecasting, error calculation is needed to find out how accurate the results of forecasting are obtained using the following equation.

The MAD calculation equation is as follows:

\[ \text{MAD} = \frac{1}{n} \sum_{t=1}^{n} |X_t - F_t| \]

\[ \text{MAD} = \frac{163.19}{48} \]

\[ \text{MAD} = 3.40 \]

Equation calculation MAPE as follows:

\[ \text{MAPE} = \frac{1}{n} \sum_{t=1}^{n} \left( \frac{|X_t - F_t|}{X_t} \times 100 \right) \]

\[ \text{MAPE} = \frac{1}{48} \sum_{t=1}^{n} (21.28 \times 100\%) \]

\[ \text{MAPE} = \frac{2128}{48} \]

\[ \text{MAPE} = 44.33 \% \]

The results of the calculation of errors using Mean Absolute Deviation (MAD) of 3.40 and Mean Absolute Percentage Error (MAPE) of 44.33% of these results indicate that the error rate is small and the results of forecasting close to accurate. This forecast menu serves as a forecast process for sales using the linear regression method.

**Figure 4.** Sales features.

### 4. Conclusion

The design of a forecasting system for Honda motorbike sales in the Great Web-based motorcycle using the linear regression method. The design of sales forecasting uses flowcharts, Data Flow Diagrams (DFD), Entity Relationship Diagrams (ERD), Conceptual Data Models (CMD), Physical Data Models (PDM).

Implementation of a forecasting system for Honda motorbike sales in the Great Web-based motorcycle using the linear regression method. From this system we will get the results of motorcycle sales forecasting in the following month. As one example on a beat motorcycle, motor beat data will be processed by the system then a linear regression equation is obtained which is used to calculate motorcycle sales forecasting. In January 2020, the results of forecasting for supra x motorbikes were 12.63 with actual data of 10. To find out how accurate the forecasting results were, the error calculation
using the Mean Absolute Deviation (MAD) was 3.40 and the Mean Absolute Percentage Error (MAPE) of 44.33%. These results indicate that the error rate is small and the forecasting results close to accurate.

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