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Analysis and Forecasting of PT. Bank Rakyat Indonesia (BRI) Stock Price After Covid-19 using Multiple Linear Regression Method

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ABSTRACT

The Covid-19 pandemic that has occurred for approximately two years since 2020 in Indonesia has had a tremendous impact on the domestic economy. The impact is felt by many sectors, including the banking sector. In the banking sector, the economic downturn is also felt by investors, especially stock investors. Due to fluctuating stock price conditions, it also increases the number of uncertainties. This needs to be taken seriously by business people in the banking sector and investors so that companies are still able to operate in the midst of post-pandemic conditions. In times of crisis like today, investors, especially stock investors, have begun to adapt to the development of stock prices by taking an approach using advances in information technology. Updates from the field of information technology such as the use of machine learning with a technical approach or forecasting method have now begun to be utilized. This study aims to Analyze and forecast the closing price of shares of PT Bank Rakyat Indonesia Tbk using the Multiple Linear Regression method using reference stock data before and after covid-19 with a time span between 2018 and 2022. The forecasting results produced an RMSE value of 0.0256 in the condition of 90% training data and 10% test data.

Keyword: Covid-19; Stock; Bank; Forecasting; Multiple Linear Regression

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1. INTRODUCTION

Since emergence in December 2019, the Covid-19 pandemic has had a very serious impact on almost all aspects of human life on earth. Especially in the economic sector, although objectively this pandemic has also had a positive impact on improving the earth's ecological conditions on a scale and extent which is not a joke: global, worldwide, all countries in the world feel it (Anggraini, 2021). As a developing country, Indonesia in the economic sector is also affected by the Covid-19 pandemic in the stock market sector, which is one type of securities traded on the stock exchange (Arthamevia, et al., 2021).

Banking stock are one of the investment instruments that investors are interested in. The condition of changes in banking stock prices that occur in the capital market is influenced by economic conditions and banking regulations (Hijrah, et al., 2023). In addition, the rise and fall of stock prices are also closely related to the rise and fall of the company's value in the eyes of the market, both in micro and macro businesses (Putri, 2020). In general, the Covid-19 pandemic has had an impact on a country's economy including the financial industry, especially the banking sector (Manurung et al., 2022). The growing global sentiment affects investors. Investors are reluctant to invest in high-risk assets and prefer to hold cash (Lailiyah, et al., 2021).

Based on the analysis of the above conditions, it is necessary to take an approach with a machine learning-based forecasting method with the Multiple Linear Regression algorithm. The definition of Linear Regression is a prediction or forecasting method using a straight line to describe the relationship between two or more variables (Komansilan, et al., 2024). Based on previous research, it is known that the results of predicting the share price of Bank Jago with the Multiple Linear Regression method resulted in a Root Mean Squared Error (RMSE) value of 228.130 (Ananda, et al., 2024).

Then, in 2023, research was also conducted using the Linear Regression algorithm using data from PT Bank Rakyat Indonesia and resulted in an RMSE value of 62.592 (Sipahutar, et al., 2023). The results of his research resulted in an RMSE value of 62.592. In this research, using a dataset from PT Bank Rakyat Indonesia Tbk with a time span of 2018 to 2022 and predicted using the Multiple Linear Regression method. The Multiple Linear Regression method is used because the stock dataset has several independent variables that have an influence on the dependent variable, namely the closing price of the stock and tests the level of accuracy. **Table 1** below is a recapitulation of stock trading taken from the *id.investing.com* website and a plot of the stock price movements of HIMBARA (Association of State-Owned Banks) member banks.

Table 1. Stock Price of PT. Bank Rakyat Indonesia period 02/01/2018 – 30/12/2022

Date	Close	Open	High	Low	Vol.	Change %
30/12/2022	4,94	4,87	4,95	4,87	182,09	1,44
29/12/2022	4,87	4,82	4,87	4,8	106,69	1,04
28/12/2022	4,82	4,87	4,88	4,81	134,32	-1,03
27/12/2022	4,87	4,93	4,95	4,86	81,82	-1,22
26/12/2022	4,93	4,9	4,93	4,89	43,59	1,02
23/12/2022	4,88	4,92	4,94	4,88	53,35	-1,61
22/12/2022	4,96	4,91	4,97	4,9	72,73	1,43
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02/01/2018	3,63	3,69	3,72	3,61	91,13	-0,27

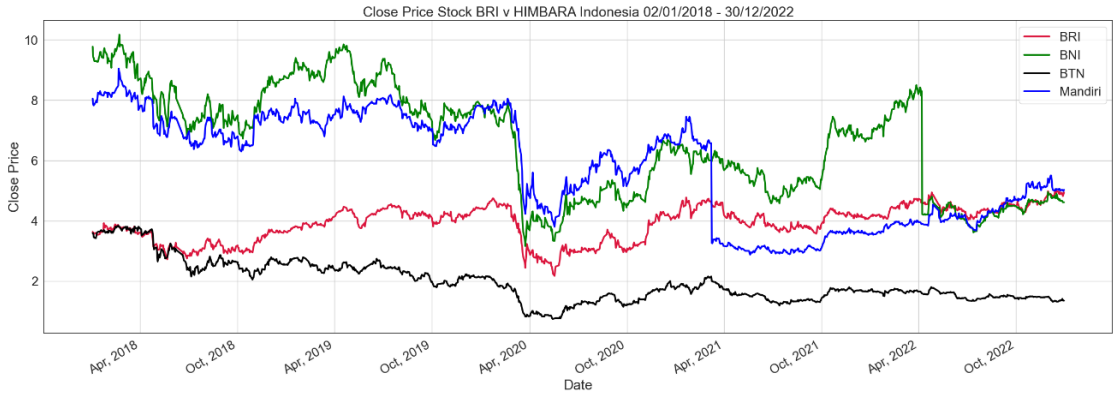

Figure 1. BRI Price Stock Diagram and HIMBARA

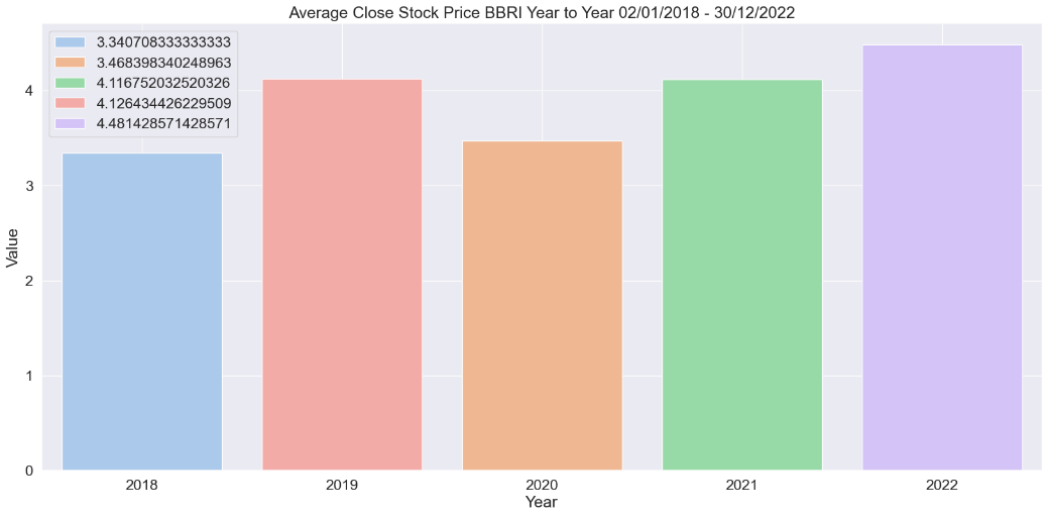

Figure 2. Average Stock Price BRI Period 2018-2022

In **Figure 1**, it can be seen a comparison chart of the closing price movement of shares of PT Bank Rakyat Indonesia (BRI) and the closing price movement of shares of other banks that are still state-owned banks (BUMN). The red line graph shows the movement of the closing price of PT Bank Rakyat Indonesia (BRI) shares which tend to be stable compared to the other three banks. Then, in **Figure 2** is the average value of the closing price of PT. Bank Rakyat Indonesia (BRI) shares. It can be seen that the average value of the closing price of PT Bank Rakyat Indonesia (BRI) shares occurred in 2022, meaning that two years after the pandemic, the average value of the closing price of PT Bank Rakyat Indonesia (BRI) shares showed an increase or improved again. This gives a positive signal by restoring confidence to investors who have invested in the company.

2. RESEARCH METHOD

This research uses quantitative methods with datasets obtained from *id.investing.com* with a span of 4 years. The data is then processed using the Python programming language for simulation. The best forecasting simulation is the simulation that produces the lowest error value.

2.1 Identifying Problems

At this stage, the process begins with correlating some issues raised in the research, research objectives and their relation to data and credible sources.

2.2 Literature Review

Below are some previous researches that become other reference that can be seen in **Table 2** below.

Table 2. Literature Review

Year	Research Title	Description
2024	Prediction of Unilever Stock Using Linear Regression with Rapid Miner (Hartono and Widiantoro, 2024)	Unilever stock prediction obtained best RMSE value with percentage data splitting of 80%:20%. The result of RMSE value is 56.69
2023	Comparison of Linear Regression and Polynomial Regression to Predict BCA Stock Price (Satriyo and Pratama, 2023).	The simulation of prediction using both methods produced good MAPE values. Linear Regression method achieved best MAPE result of 6.55% and Polynomial Regression method achieved best MAPE result of 6.54%
2022	Implementation of Simple Linear Regression to Predict Rice Price in Padang City (Hasibuan et.al., 2022)	Prediction result of rice price in Padang City achieved best RMSE result of 0.126

2.3 Data Acquisition

In this study, the data used is sourced from the id.investing.com website with a time span of 4 years, namely from January 02, 2018 to December 30, 2022. The data used is in the form of quantitative data with a time series.

2.4 Pre-Processing and Data Analysis

At this stage, the data that has been obtained is then processed and analyzed based on statistics and correlation. This data processing aims to clean the data from outliers, fill in empty data values, perform normalization, and select columns that will be used as independent variables and dependent variables. Then the columns in the data are correlated to determine the relationship between variables based on the values formed. In this study, the correlation is calculated based on Pearson's rule. Below is the Pearson correlation function and **Figure 3** is correlation plot of each feature towards the Close feature.

$$r = \frac{n\sum(XY) - \sum(X)\sum(Y)}{\sqrt{(n\sum(X^2) - \sum(X)^2)(\sum n(Y^2) - \sum(Y)^2)}} \quad (1)$$

Description:
r : Correlation coefficient
n : Number of sample (observation)
X : Independent variable
Y : Dependent variable

Figure 3. Correlation Plot

2.5 Feature Selection

After the columns in the dataset are correlated, the next step is to determine the variables that will be used for build model. The selected variables should have a positive relationship because it will increase the accuracy of the prediction results. In this research, the Open, High, and Low columns are independent variables, while the Close column is the dependent variable. Details of independent and dependent variables are shown in **Table 3**.

Table 3. Selection Features

Independent Variables	Dependent Variable
Open	Close
High	
Low	

2.6 Data Splitting

Data split process in forecasting can be done variably with the amount of training data above 60%. In its application to the machine learning process, greater value of training data used more possible to achieve testing results with maximum results. In this research, five data split percentage compositions are applied, namely 70%:30%, 75%:25%, 80%:20%, 85%:15%, and 90%:10%.

2.7 Multiple Linear Regression Model

The Multiple Linear Regression algorithm is an algorithm used to identify the relationship between the response variable and at least two predictor variables. In the regression method, the predicted variable is generally called the dependent variable, this variable is influenced by the independent variable (Usman, et al., 2024).

2.8 Model Evaluation

Evaluation of the machine learning-based forecasting modeling process is done by comparing and calculating the prediction results of true and false values. Calculation of error or model evaluation in this study using the Root Mean Squared Error (RMSE) method. Below is the RMSE formula.

$$RMSE = \sqrt{\sum_{i=1}^{n} \frac{(X_i - F_i)^2}{n}} \quad (2)$$

with:
n : Number of forecasting result
Xi : Forecast data calculated from the model used at time/year i
Fi : Actual data

2.9 Data Visualization

The final forecasting process is displayed in the form of a plot/diagram. This plot shows the final result between the actual value and the predicted value. This is done to make it easier to interpret a result through images and speed up decision making.

3. RESULT AND DISCUSSION

The Multiple Linear Regression algorithm is a method that requires classical assumptions that must be explicitly met (Zapar, et al., 2024). The following is the function of the Multiple Linear Regression algorithm.

$$Y = \alpha + \beta 1\, X2 + \beta 2\, X2 + \beta n\, Xn + e \quad (3)$$

Description:
Y : Dependent variable
α : Constant
β : Regression coefficient
X : Independent variable

4.1. Implementation of Multiple Linear Regression

Figure 5 below is a picture of the implementation process of the Multiple Linear Regression algorithm.

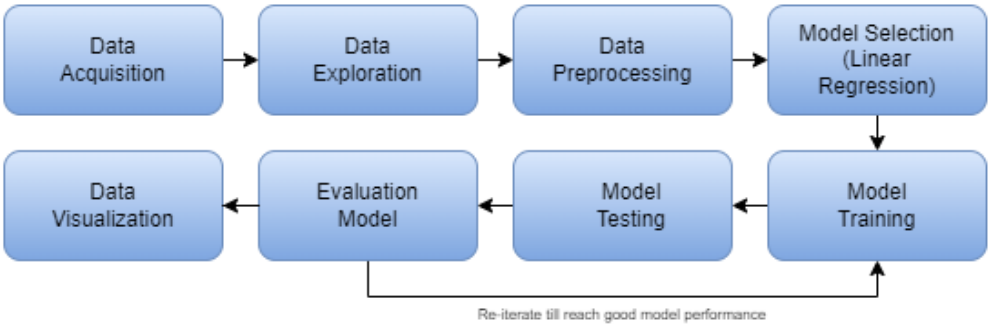

Figure 4. Implementation of Multiple Linear Regression Algorithm

In this study, five simulation stages were carried out with different distributions of training data and test data. The first simulation uses 70% training data and 30% test data. The second simulation uses 75% training data and 25% test data. The third simulation uses 80% training data and 20% test data. The fourth simulation uses 85% training data and 15% test data. Finally, the fifth simulation uses 90% training data and 10% test data. The results of each simulation can be seen in **Figures 5-9** below.

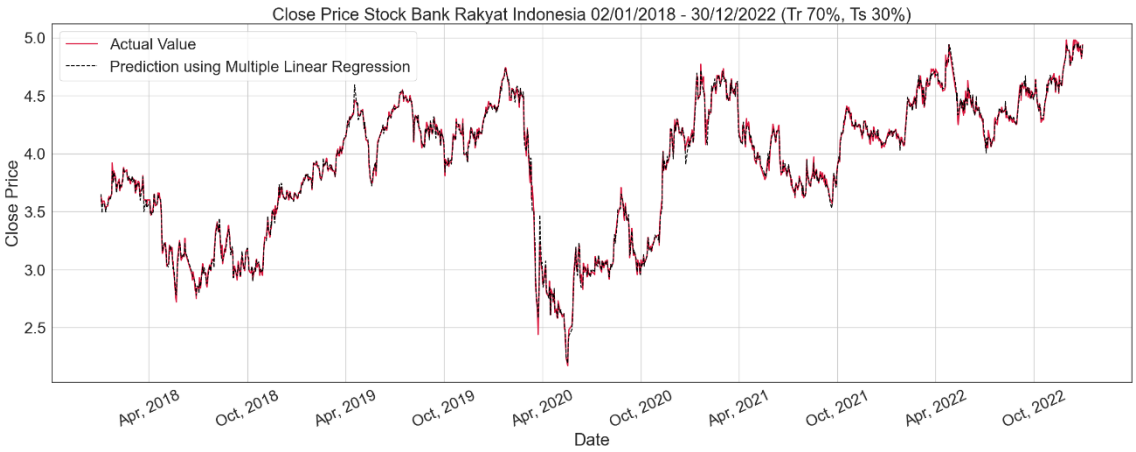

Figure 5. Forecasting result of close stock price using 70% train data and 30% test data

From **Figure 5**, it can be seen that the first stage simulation with the Multiple Linear Regression method with a composition of 70% training data and 30% test data can predict results that are close to the actual closing value of the stock by producing a Root Mean Squared Error (RMSE) value of 0.0302 with forecasting results seen on the red line.

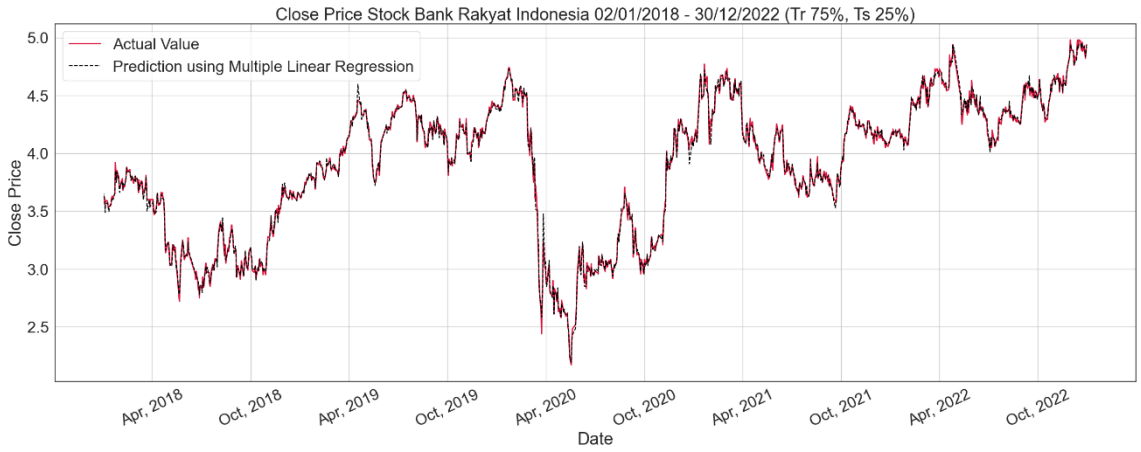

Figure 6. Forecasting result of close stock price using 75% train data and 25% test data

From **Figure 6**, it can be seen that the second stage simulation forecasting using the Multiple Linear Regression method with a composition of 75% training data and 25% test data can forecast the results of closing stock values that are close to the actual stock value by producing a Root Mean Squared Error (RMSE) value of 0.0299 with forecasting results seen on the red line. The forecasting results in this second simulation show a decrease in the RMSE value from the first simulation.

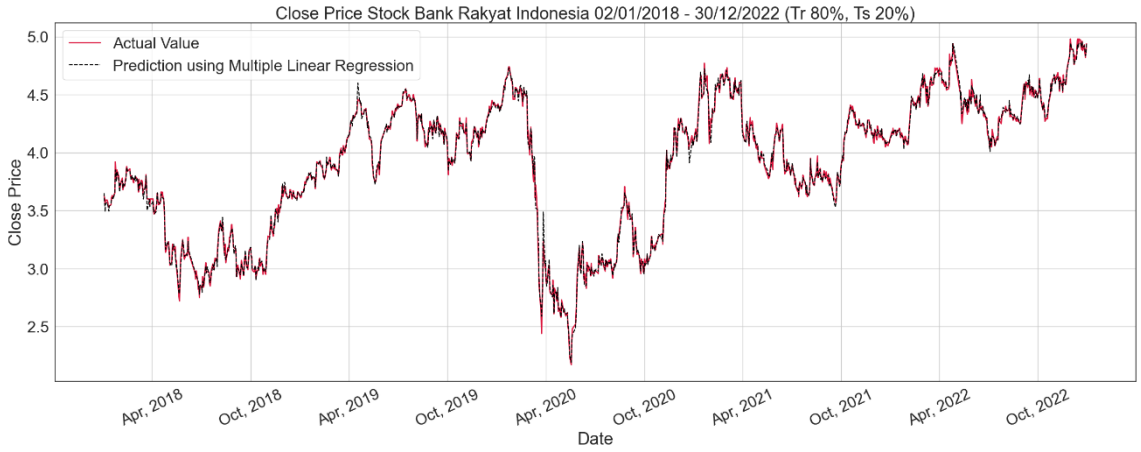

Figure 7. Forecasting result of close stock price using 80% train data and 20% test data

From **Figure 7**, it can be seen that the forecasting simulation with the third stage Multiple Linear Regression method with a composition of 80% training data and 20% test data can predict results that are close to actual shares by producing a Root Mean Squared Error (RMSE) value of 0.0278 with forecasting results seen on the red line. The forecasting results in this third simulation show a decrease in the RMSE value from the first and second simulations.

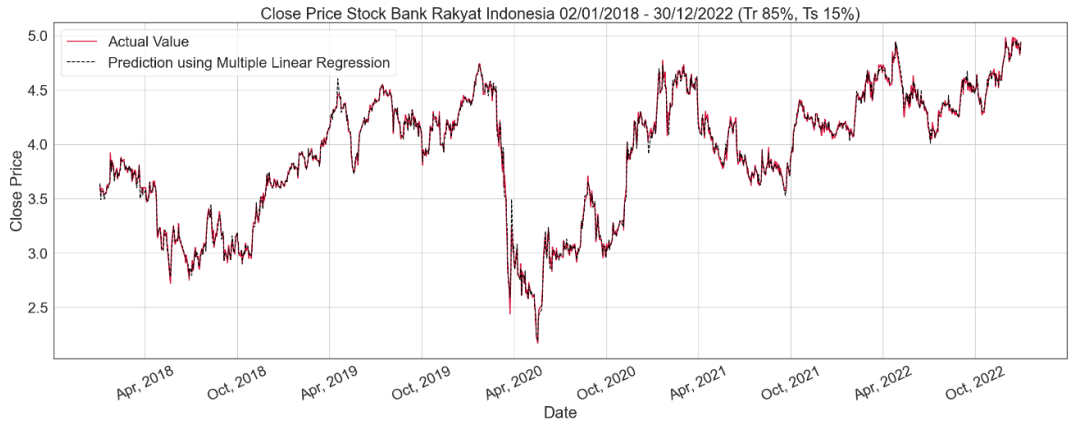

Figure 8. Forecasting result of close stock price using 85% train data and 15% test data

From **Figure 8**, it can be seen that forecasting simulations with the fourth stage Multiple Linear Regression method with a composition of 85% training data and 15% test data can predict results that are close to the actual stock value by producing a Root Mean Squared Error (RMSE) value of 0.0274 with forecasting results seen on the red line. The forecasting results in this fourth simulation show a decrease in the RMSE value from the first, second and third simulations.

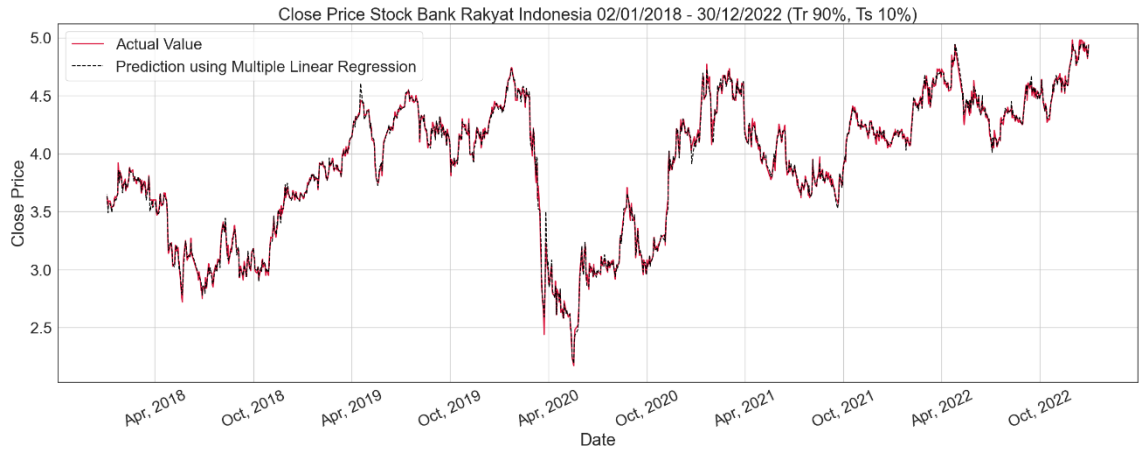

Figure 9. Forecasting result of close stock price using 90% train data and 10% test data

From **Figure 9**, it can be seen that the forecasting simulation with the fifth stage Multiple Linear Regression method with a composition of 90% training data and 10% test data can predict results that are close to the actual stock value by producing a Root Mean Squared Error (RMSE) value of 0.0256 with forecasting results seen on the red line. The forecasting results in this fourth simulation show a decrease in the RMSE value from the first, second, third and fourth simulations.

After conducting a series of simulation tests, it can be concluded that the Multiple Linear Regression algorithm achieves its best performance on the division of 90% training data and 10% test data by producing a Root Mean Squared Error (RMSE) value of 0.0256. Below in **Table 4** is a comparison table of Root Mean Squared Error (RMSE) values from each simulation that has been carried out.

Table 4. Comparison of Root Mean Squared Error (RMSE) value

Data Splitting	**70:30**	**75:25**	**80:20**	**85:15**	**90:10**
***RMSE* Value**	0,0302	0,0299	0,0278	0,0274	0,0256

5. CONCLUSION

From the overall simulation results, it can be concluded that the Multiple Linear Regression method has good performance seen from its low error value with the best Root Mean Squared Error (RMSE) value occurring in the last simulation with a value of 0.0256. The resulting Root Mean Squared Error (RMSE) value has met the objectives of the simulations carried out in this study. This method can be used as an alternative to simple forecasting methods because of its ease of application and it is possible that in the future this Multiple Linear Regression method can be used to forecast more complex data and compared with several other forecasting methods to test its accuracy.

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