

# Robusta London Coffee Price Forecasting Analysis using RNN- LSTM

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## Robusta London Coffee Price Forecasting Analysis Using *Recurrent Neural Network – Long Short Term Memory* (RNN – LSTM)


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Coffee price forecasting has a significant role in preventing price fluctuations at a time. Therefore, a method is needed that can be used to forecast the price of coffee. This study discusses the analysis of coffee price forecasting using the *Recurrent Neural Network – Long Short Term Memory* (RNN – LSTM) method. This study will be determined the best LSTM model that aims to get the results of forecasting the price London robusta coffee with the smallest *Root Mean Square Error* (RMSE) and *Mean Absolute Percentage Error* (MAPE) values. Using the LSTM model with units of 128 and dropouts of 0.1, forecasting the price of London robusta coffee has an RMSE value of 1,303 and MAPE of 3.53%. Therefore, the LSTM model can indicate the cost of London robusta coffee with an accuracy rate of 96.47%.

Keywords: Coffee price forecasting, LSTM, Units, Dropout, RMSE, MAP.


### ABSTRACT

#### 1. Introduction

Most of the activities in everyday life are related to mathematics and statistics. Various benefits are caused by this science, one of which is estimating an event that may occur in the future, commonly called prediction or forecasting.

Prediction or forecasting is a science used to estimate future events so that policymakers can use forecasting results in taking strategic policies to solve problems in the future [1]. When forecasting, a proper method is needed to produce the lowest possible error value.

Coffee is a brewed drink of coffee beans that have been roasted and smashed into powder. There are four known coffee groups: arabica coffee, robusta coffee, liberika coffee, and easel coffee [2]. Coffee is also a people's commodity cultivated for a long time and can become a source of income for many coffee farmers worldwide. In addition to being a source of people's income, coffee is the leading export commodity and head of state foreign exchange income. Nevertheless, coffee commodities often experience price fluctuations due to the global market's imbalance between demand and coffee supply. With these fluctuations, a forecasting method is needed to predict the selling price of coffee in the future. This fact is supported based on robusta London Coffee History

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Data for the period January 2008 - October 2021 obtained from the website investing.com shows that coffee prices are unstable. The decision to determine the selling price is a problem that must be sought to be resolved. Because if we decide the price is too high, it will be challenging to sell, and vice versa. If the price is too low, it can cause losses for coffee farmers.

One method that can be used is Long Short Term Memory (LSTM) which is the development of a recurrent neural network (RNN) based on Gao, Chai. Liu's research on predicting stock movements the following day using the Moving Average (MA) method produces a Root Mean Square Error (RMSE) value of 40.9691. Exponential Moving Average (EMA) delivers an RMSE weight of 24.6726. The Support Vector Machine (SVM) returns an RMSE value of 21.8863. The LSTM returns an RMSE value of 20.4688 [3]. The Susanti and Adji's research on the prediction of the Composite Stock Price Index (JCI) using the Autoregressive Integrated Moving Average (ARIMA) method to predict it obtained the conclusion that the model received could not be generalised for too far a period [4]. The purpose of using this LSTM is to avoid these problems and be able to produce the smallest RMSE value to predict the price of coffee.

To solve the problem of predicting difficulties, we can use the Recurrent Neural Network – Long Short-Term Memory (RNN-LSTM) method [5]. This method will focus on making accurate predictions of a variable. The best predictions or forecasting are based on the degree of prediction error, where the smaller the error rate produced, the more precise a method is used in predicting. Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPE) are the error rate calculations.

Based on the above exposure, researchers are interested to find out how accurate the RNN-LSTM method is in predicting the price movement of London Robusta Coffee. Therefore, the researchers raised the study's title, "Analysis of London Robusta Coffee Price Forecasting Using Recurrent Neural Network – Long Short Term Memory (RNN – LSTM)."

## 2. Research Method

The data used in this study is secondary data obtained from <https://id.investing.com/> regarding data on the history of London robusta coffee futures for 13 years, starting from January 2008 to October 2021, on a weekly scale. The data amounts to 722 table-shaped tables with the Date, Last, Opening, Highest, and Lowest columns.

In this study, researchers will display the best LSTM model for predicting the last price or close on London Robusta Coffee using the Recurrent Neural Network – Long Short Term Memory (RNN-LSTM) method with the help of Python software powered by Google Colab. Then, the resulting model will be evaluated based on RMSE and MAPE values.

The steps taken in this research method are as follows:

1. Inputting data on the history of London robusta coffee obtained through <https://id.investing.com/> into Google Colab.
2. Visualize data by creating a time series graph to view the data flow.
3. Dividing data preprocessing is by scaling data using MinMaxScaler, then dividing the data into training data and data testing.
4. We are building a model by applying RNN-LSTM.
5. Make predictions to see price predictions on London robusta coffee's "Last" index.
6. Validate models using RMSE and MAPE.
7. View the visualisations resulting from the predicted models obtained.
8. Do forecasting to get prices on the "Last" index of London robusta coffee.
9. View visualisations that result from the predicted data.
10. Present conclusions based on the results obtained.

As for the image form, the steps are taken as follows:

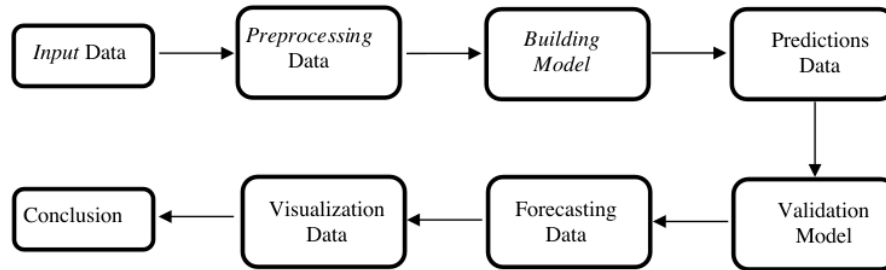


Figure 1. Research Steps

### 3. Results and Analysis

LSTM is one form of RNN that can be used to predict or predict the current and future coffee prices using coffee history data that has been obtained before. The data obtained cannot be analysed directly because it is still raw. The coffee history data has five columns: Date, Last, Opening, Highest, and Lowest. The coffee history data listed in the table below is only part of it. This aims to be used as an overview of the comprehensive data amounting to 722. The value of the currency used in the coffee history data is the US Dollar currency.

The first step in carrying out the forecasting process using LSTM is determining the input to be used. Coffee history data has four indices: Last, Opening, Highest, and Lowest. Then, the last used index of the four indices starts from January 13, 2008, to November 7, 2021, with a weekly period.

After inputting data, it is then scaling the data. Data scaling is a transformation process that aims to change the value of data from the original form to another form so that the data can be used more efficiently and produce the smallest possible error value. The technique used in scaling data this time is the MinMaxScaler technique, or it can also be called *Min-Max Scaling*. *Min-Max Scaling* is a data transformation technique that adjusts data values by a range or interval of minimum values to a maximum weight of [0.1]. When written in mathematical form, *Min-Max Scaling* can be written as follows:

$$x' = \frac{x - x_{min}}{x_{max} - x_{min}} \quad (1)$$

After scaling the data, do the data sharing into training and testing. Training data is data used to train LSTM algorithms, while data testing is data used to determine the performance of LSTM algorithm introduced before when they want to do forecasting. The data composition to be used is 80% for training data and 20% for data testing. Of the 722 data available, it will be divided as much as 80% into training data (577 training data) and 20% into data testing (145 data testing).

After sharing training data and data testing, the construction or building model of LSTM will be carried out using one input layer and one output layer. Then, the number of neurons can also be called units used in the hidden layer, namely 16, 32, 64, and 128. Epochs will be used at 50 periods and dropouts of 0.1 and 0.2. To find out the exact number of units and dropouts can be determined by applying hyper tuning to units and dropouts that have been predetermined. There are no rules in determining the number of units and dropouts, so the number of units and dropouts is obtained by applying hyper tuning so that the resulting model can be optimal in forecasting the price of coffee. The following are the test results using hyper tuning at the number of units 16, 32.64, and 128, dropouts of 0.1 and 0.2, and epochs of 50:

```

Best: -0.003600 using {'LSTM_unit': 128, 'dropout': 0.1}
-0.006765 (0.004613) with: {'LSTM_unit': 16, 'dropout': 0.1}
-0.006550 (0.004388) with: {'LSTM_unit': 16, 'dropout': 0.2}
-0.006230 (0.004700) with: {'LSTM_unit': 32, 'dropout': 0.1}
-0.005444 (0.004318) with: {'LSTM_unit': 32, 'dropout': 0.2}
-0.004535 (0.002421) with: {'LSTM_unit': 64, 'dropout': 0.1}
-0.004674 (0.002487) with: {'LSTM_unit': 64, 'dropout': 0.2}
-0.003600 (0.001628) with: {'LSTM_unit': 128, 'dropout': 0.1}
-0.004015 (0.001679) with: {'LSTM_unit': 128, 'dropout': 0.2}

```

Figure 2. Building Model LSTM

Based on Figure 1, it can be seen that the best LSTM model produced has units or can also be called LSTM units of 128 and dropouts of 0.1. This model will then be used to forecast the price of coffee.

After building the LSTM model, a price prediction experiment on the "Last" Index of London Robusta Coffee will be conducted. This is done to determine whether the previously formed LSTM model can predict the price of coffee or not. If you can expect the price of coffee, then the LSTM model can also be used to predict the price of coffee in the future. Here are the results of the price predictions on the "Last" Index of London Robusta Coffee:

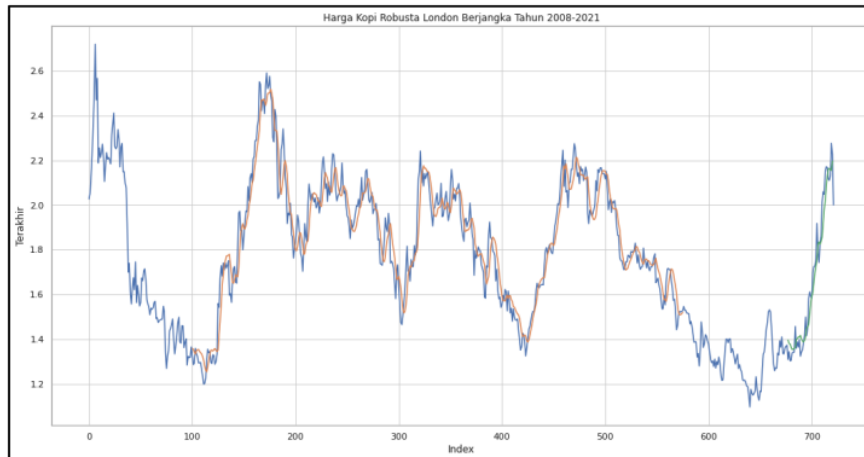


Figure 3. Robusta London Coffee Price Prediction Plot

Based on Figure 2, it can be seen that the lines that appear there are three colours, namely, the lines are blue, orange, and green. The blue line interprets the plot using the original data; the orange line interprets the story of the prediction result using training data, and the green line analyses the field using data testing. It can be concluded that the LSMT model with units of 128 and dropouts of 0.1 can predict prices on the "Last" Index of London Robusta Coffee well because the plot of the orange and green lines moves closer to the blue line plot.

After making a prediction, how much the LSTM model generates an error value will be seen. This is done to ensure further the LSTM model's accuracy in predicting coffee prices. If the accuracy rate is significant and only produces a small error value, then the LSTM model can be used to forecast future coffee prices. Here are the RMSE, MAPE, and accuracy levels:

```

1 math.sqrt(mean_squared_error(y_test,test_predict))
1.3028276075025023

1 from sklearn.metrics import mean_absolute_percentage_error
2 MAPE = mean_absolute_percentage_error(y_train, train_predict, sample_weight=None, multioutput='uniform_average')
3 MAPE
3.5299598413753484

1 # Test Accuracy
2 Accuracy = 100 - MAPE
3 print(Accuracy,'%')
96.47004015862466 %
    
```

Figure 4. LSTM Model Validation

Based on Figure 14, it can be seen that the resulting RMSE value is 1,303. It can be interpreted that the LSTM model can predict the price of a coffee with a small error rate because it produces a small RMSE value. Then furthermore, a MAPE value of 3.53 can be called 3.53%. As a result, it can be interpreted that the average percentage of absolute errors or MAPE of the LSTM model is 3.53%. Therefore, the LSTM model with units of 128 and dropouts of 0.1 can predict and forecast prices on the "Last" Index of London Robusta Coffee with an accuracy rate of 96.47%.

After knowing the level of accuracy of the LSTM model to be used, then there will be forecasting of coffee prices for the next 30 weeks as follows:

Table 1. Price Forecasting Results On London Robusta Coffee Last Index

Date	Forecasting Data	Recent Data
11/7/2021	2,146321	2,315
11/14/2021	2,139573	2,270
11/21/2021	2,132030	2,308
11/28/2021	2,124435	2,386
12/5/2021	2,116758	2,376
12/12/2021	2,108985	2,439
12/19/2021	2,101127	2,462
12/26/2021	2,093210	2,488
1/2/2022	2,085267	2,435
1/9/2022	2,077335	2,341
1/16/2022	2,069451	2,335
1/23/2022	2,061648	2,193
1/30/2022	2,053961	2,181
2/6/2022	2,046416	-
2/13/2022	2,039041	-
2/20/2022	2,031857	-
2/27/2022	2,024880	-
3/6/2022	2,018128	-
3/13/2022	2,011610	-
3/20/2022	2,005335	-
3/27/2022	1,999309	-
4/3/2022	1,993536	-
4/10/2022	1,988017	-
4/17/2022	1,982751	-
4/24/2022	1,977336	-
5/8/2022	1,972969	-
5/15/2022	1,968445	-
5/22/2022	1,964158	-
5/29/2022	1,960102	-
6/5/2022	1,956270	-

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Based on Table 5, the value generated in the Forecasting Data is not much different from the value in the Latest Data on the London Robusta Coffee "Last" index from November 7, 2021, to January 30, 2022. So this can be interpreted for price forecasting in the "Last" Index of Robusta Coffee London will decrease until June 5, 2022. This price drop chart can be seen as follows:

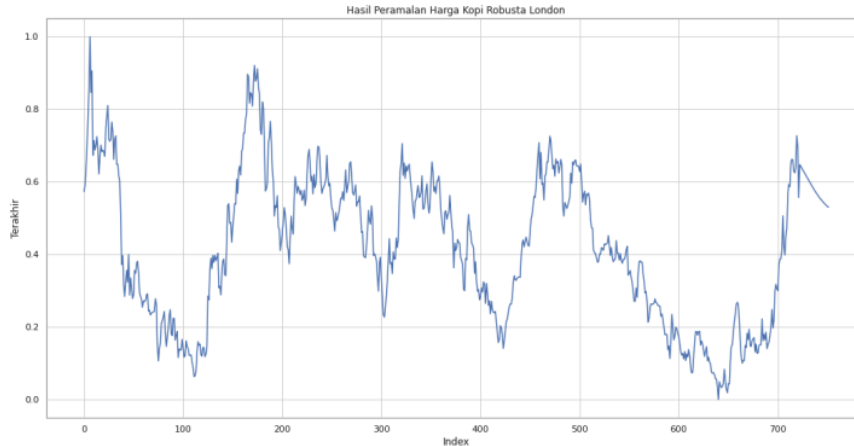


Figure 5. Robusta London Coffee Price Forecasting Plot

#### 4. Conclusion

Based on the results and discussions, the following conclusions are obtained:

1. The LSTM method can predict or forecast prices on the "Last" Index of London Robusta Coffee using units of 128 and dropouts of 0.1.
2. Based on RMSE and MAPE values, the LSTM method only produces a small error value, namely RMSE of 1.303 and MAPE of 3.53%. This value can be interpreted that the accuracy rate of this LSTM method being 96.47%. Therefore, this LSTM method will be used as well as possible to predict or forecast the price of other goods because this method only produces a small error value.
3. Based on the results of coffee price forecasting using the LSTM method, it turns out that the price in the "Last" Index of Robusta Coffee London will decrease from November 7, 2021, to June 5, 2022.

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