Application of Triple Exponential Smoothing Method to Predict LQ45 Saham Stock Price

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Abstract. The capital market is one of the investment models that is currently growing so rapidly because there are more and more digital-based investment platforms that can be accessed using mobile smartphones. The amount of interest in investing makes many people who experience losses due to not understanding the investment risks. For this reason, it is necessary to have the ability to analyze technically based on historical data. The object of this research is LQ45 shares in three companies, Indofood Sukses Makmur Tbk (INDF), Unilever Indonesia Tbk (UNVR), and Aneka Tambang Tbk (ANTM). The method used in this research is the Triple Exponential Smoothing method which is a prediction method that utilizes the statistical analysis method. The variables used in this study are historical prices ranging from Open, High, Low, and Close prices. The stages used are the collection of 125 historical data, where the data is taken through the Google Finance financial database. Then the Triple Exponential Smoothing calculation process is carried out, the data is stored in the database and presented in the form of graphs and tables. By using the parameter values = 0.13 and = 0.87 in the end it produces a Mean margin error level of Open price -0.10681%, High price -1.1156%, Low price 1.4616%, and Close price -0.2504%. The results of the study mean the margin of error is between -0.1% to 1%. The application of Triple Exponential Smoothing can be applied to predict stock prices. This research is to help investors analyze stock price movements.

Keywords: Triple Exponential Smoothing, LQ45 Stock, Prediction, Stock Price, Implementation.

INTRODUCTION

The development of technology today makes all activities easier because access to information is easier and can be reached by anyone. One of the activities that has become easier due to the development of IT is asset management activities such as investment management. The fulfillment of increasingly diverse life needs makes people try to guarantee financial conditions by investing for financial freedom in the future, so that investment becomes popular in the community, one of the investment instruments is capital market investment [1]. Nowadays, stock investment has become very popular, people are increasingly interested in investing considering the easier access and facilities in stock investment, thanks to the easier access to financial technology that facilitates access to information and stock transactions, such as trading and investing applications. Along with the development of the investment world, the general public began to recognize financial investment. People are starting to realize the importance of investing in the future. Because from year to year the number of Indonesian investors is increasing. The increase in the number of investors is due to the increasing public interest in investing [2].

LQ45 is an actively traded stock and its price continues to fluctuate with the intensity of its trading. However, losses are impossible to avoid, even for experienced investors. For that we need a solution, namely a tool that can help young investors in managing their stock portfolios. Like a tool that can analyze the company's prospects based on technical analysis that utilizes historical data on the company's stock prices for a certain period. In addition, an application that can provide complete information about the company's financial condition is also needed [3]. In this study, the author uses LQ45 shares as an example of data in the study because LQ45 shares have good liquidity in the stock market. The author develops a platform that can connect investors with access to complete information on companies that will later be included in their stock portfolios. The method used in this research is Triple Exponential Smoothing, which is a forecasting method using time series or time series. The Triple Exponential Smoothing method used in this study is to test its accuracy in the case of predicting the price movement of the LQ45 index and an application will also be developed that can predict the stock price of the LQ45 index in the future [4].

There are several previous studies related to the research topic that the author did, such as research conducted by [5] Implementation of Exponential Smoothing in the process of predicting stock index prices, in this study found predictions of stock price movements in several strategic sectors, such as agriculture, mining, construction to financial, where the results of the study found that future fluctuations occurred with an erratic movement model caused by various factors. Then research conducted by [6] by examining the most optimal LQ45 stock portfolio model. Where the LQ45 stock which is in one index model becomes the object of research. Then the variables used are LQ45 stock price data from several strategic sectors. The result is a list of companies that have the most optimal movement in a certain period, this study will provide additional references regarding technical data analysis for stock prices.

Another study by [7] Application of Triple Exponential Smoothing in Forecasting the Monthly Inflation Rate of Aceh Province in 2019 – 2020. The variables used are parameter alpha (α) = 0.045; beta (β) = 0.034 and gamma (γ) = 0.49 with the results of the study that the monthly inflation rate in Aceh Province tends to rise in June and December and is low in February to April. The monthly inflation rate of Aceh Province in 2019 is estimated to be in the range of -0.41 to 0.71. Meanwhile, in 2020, the inflation rate of Aceh Province is estimated to be in the range of -0.47 to 0.65. The author also takes reference from a previous research journal from [8] entitled Bitcoin-Rupiah Exchange Rate Forecasting Application Using the Double Exponential Smoothing Method, where the study concluded that the Exponential Smoothing method has an accuracy of up to 70% in the Bitcoin Cryptocurrency case study.

Another research on predicting stock prices was carried out by [9]. His research used the Long Short Term Memory (LSTM) method in the process of predicting stock prices. The LSTM method is combined with a machine learning process or Machine Learning. From this study, 97% accuracy was obtained using historical stock price data in 5 companies such as GOOGLE, APPLE, MICOROST, AMAZON and VIX for the last 10 years. Another study using the KNN and K-means algorithms in the process of predicting stock prices, for data collection companies are grouped into 3 parts, namely companies with small capitalization (Small Cap), medium (Mid cap Company), and large capital (Big Cap) with Rupee currency, This study shows a success of 0.013, which means the algorithm is quite accurate and the resulting Beta is 0.609, which means for the last three months [10]. The application of the Hidden Markov Model (HMM) method to predict the stock prices of Apple, Google, and Facebook. The first step is to use the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) criteria to check the performance of the number of HMM statuses. Then tested again with the nave model to predict stock prices and compare the prediction results. The results show that companies using the HMM method get higher returns than using nave forecasts [11].

There have been several previous studies that have been carried out by the author on the creation of application systems, including a plagiarism document detection system [12], a student scientific work classification system [13], a Allah and Muhammad lafadz pattern detection system [14] a genuine online shop checking system or dropship on Shopee. [15] and Application System for 3 Kg Elpiji Gas Distribution Location Mapping [16]. Based on the results of previous studies, no one has investigated the problem of applying the Triple Exponential Smoothing method to predict stock price movements in the LQ45 index. For this reason, the author is interested in researching this problem. The problem in this research is that in the LQ45 Stock trading process, accurate and in-depth analysis is needed regarding the future LQ45 Stock price movements, in this case several technical analysis steps are needed to observe the current LQ45 Stock price movements. The analysis requires tiring and complicated calculation stages, so it takes a lot of time, for that we need an application system that can measure the price movement of LQ45 Shares in the future. Many investors and traders who are still beginners experience difficulties in the process of investing and trading transactions in the Capital Market which often cause losses in the process of managing assets owned by investors and traders. The purpose of this study is to produce solutions and products from these solutions in the form of an application system that can calculate historical data on the LQ45 stock price index to predict future price movements. With this application, it is hoped that it can help novice investors in analyzing stock price market movements and determining how to take steps in order to maximize profits.

METHODS
A. Types and Sources of Data
This research was conducted in the city of Lhokseumawe at the Universitas Malikussaleh Investment Gallery, starting in February 2021 until completion. This research was conducted online where the data was obtained from the Google Finance financial database, the data used is historical data from the

Indofood Company (INDF) starting from January 2 to July 4, 2020 or about 125 days. Which later the data is stored as a database for the application of the prediction method. Data sourced from API Market Stock, is a credible data source to monitor stock ranking data of national companies in real-time and prolonged. The data that has been obtained from the latest API Market Stock will later be calculated using the Triple Exponential Smoothing method to obtain results that refer to the prediction of a company's stock price.

B. Triple Exponential Smoothing Method

The Triple Exponential Smoothing method is a forecasting method proposed by Brown, using a quadratic equation. This method is more suitable to be used to make forecasts with data experiencing tidal waves. With data that experiences ups and downs and fluctuates, it must be calculated using triple forecasting. As is the case with Linear Exponential Smoothing which can be used to forecast data with a basic trend pattern, a higher smoothing form can be used if the basic data pattern is quadratic, cubic, or higher order. Therefore, quadratic smoothing the basic approach is to include an additional level of smoothing (triple smoothing) and apply quadratic forecasting equations [17] [18].

In this study, the method used is Triple Exponential Smoothing which is used as a method to process stock price data, the working steps of the Triple Exponential Smoothing Method are as follows:

1. Calculating a single smoothing value with the symbol (S′t):

$$S't = aXt + (1-a)S't - 1 \tag{1}$$

2. Calculating the double smoothing value with the symbol (S″t):

$$S''t = aS't + (1-a)S''t - 1 \tag{2}$$

3. Calculating the triple smoothing value with the symbol (S‴t):

$$S'''t = aS''t + (1-a)S'''t - 1 \tag{3}$$

4. Determine the value of the smoothing constant:

$$at = 3S't - 3S''t + S'''t \tag{4}$$

5. Determine the value of the slope/trend

$$bt = \frac{a}{2(1-a)^2} \left(6 - 5a \right) S't - (10 - 8a) S''t + (4 - 3a) S''' \tag{5}$$

6. Determine the magnitude of the seasonal value:

$$ct = \frac{a^2}{(1-a)^2} (S't - 2 S''t + S'''t) \tag{6}$$

7. Determine the magnitude of the forecasted value:

$$Ft + m = at + bt(m)\frac{1}{2}ct(m) \tag{7}$$

C. System Schematic

The following system scheme in the LQ45 stock price forecasting research can be seen in Figure 1.
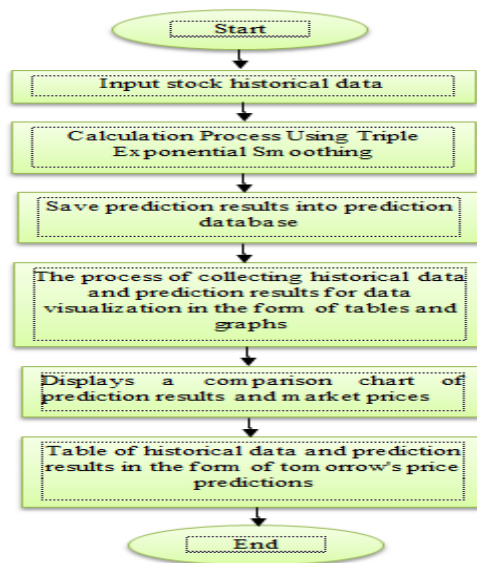

Figure 1. System Schematic

The system schematic above is a schematic that describes the overall system design process as follows:

1. Start: is the initial initialization process to start the application.
2. Stock historical data input: is the process of entering Open, High, Low, Close price data.
3. Calculation using the Triple Exponential Smoothing method: is the process of applying the Triple Exponential Smoothing algorithm to predict stock price data
4. Save the prediction results into the prediction database: the process of storing the prediction results of stock price data that has been calculated using the Triple Exponential Smoothing algorithm.
5. Historical data collection and prediction results for data visualization In the form of tables and graphs: is the process of collecting historical data and prediction results to be presented in the form of tables and graphs, aiming to make it easier to predict stocks
6. Displays a comparison chart of prediction results and market prices.
7. Table of historical data and prediction results in the form of tomorrow's price predictions: after all the above processes are carried out, a table containing the prediction results is generated by comparing today's prices with tomorrow's prices
8. End is the process of completing an application.

RESULT AND DISCUSSION

A. System Description

In this study, the author will test the Triple Exponential Smoothing method or abbreviated as TES to predict stock price movements from historical data and existing databases. This method will calculate today's stock price data sample using alpha and beta parameters to get the results of tomorrow's stock price forecasting. Data samples are taken periodically from the last 5 years. The author will take data from the previous year to see the performance of this method as measured by the level of accuracy of its success. This system will process input in the form of sample data from stock prices in a certain period, the sample for each period is 125 samples/stock prices from 3 different companies. The sample will be processed using the Triple Exponential Smoothing method which will produce stock price forecasts the next day. In this process, the accuracy of the accuracy can vary because this method uses two parameters that will determine the forecasting results, also determine the level of accuracy of the forecasting. These parameters are also determined randomly, with Trial and Error to produce the best parameters that can produce the best level of accuracy. After generating the output, the system will present the data in the form of tables and graphs which will explain the movement of stock prices and the movement of predictions of the stock price. This chart will help investors because the movement of data is displayed visually so that it is easier to understand.

B. Calculation of Triple Exponential Smoothing

In this manual calculation, the author uses historical data from the Indofood Company (INDF) from January 2 to July 4, 2020. It can be seen in table 1 below.

Table 1. Indofood Company Historical Data (INDF) in 2020

No	Tanggal	Open	High	Low	Close
1	1/2/2020	11,275	11,300	11,100	11,150
2	1/3/2020	11,150	11,275	11,050	11,250
3	1/6/2020	11,250	11,550	11,175	11,500
4	1/7/2020	11,550	11,550	11,200	11,500
5	1/8/2020	11,300	11,550	11,300	11,550
6	1/9/2020	11,550	11,550	11,400	11,525
7	1/10/2020	11,550	11,575	11,475	11,525
8	1/13/2020	11,600	11,600	11,525	11,550
..	....	....	....	....	....
125	7/4/2020	9,425	9,525	9,400	9,425

(Source: Idx.com, 2021)

With the parameters used:
Alpha : 0.13
Beta : 1 – 0.13 = 0.87

1. First Smoothing
The first smoothing is the first step taken in this method, to smooth the forecasting results. At this stage, the sample price is multiplied by the first parameter (Alpha), the result is then multiplied by the price that has been multiplied by the second parameter (Trend) with the formula:

$$S't = aXt + (1 - a)S't - 1$$

S'1 = Rp. 11,275
S'2 = (0,13) Rp. 11,300 + (0,87) Rp. 11,275 – 1 = Rp. 11,277.25
S'3 = (0,13) Rp. 11,100 + (0,87) Rp. 11,277.25 – 1 = Rp. 11,253.21
S'4 = (0,13) Rp. 11,105 + (0,87) Rp. 11,253.21 – 1 = Rp. 11,238.79

2. Second Smoothing
The second smoothing is the next step in this method, in the same way as the first step. This is to smooth the forecasting results. The difference lies in the values of Xt and S"t which are the results of the first smoothing. Here's the second smoothing formula:

$$S''t = aS't + (1 - a)S''t - 1$$

S''1 = Rp. 11,275
S''2 = (0,13) Rp. 11,277.25 + (0,87) Rp. 11,275 – 1 = Rp. 11,274.29
S''3 = (0,13) 11,253.21 + (0,87) Rp. 11,274.29 – 1 = Rp. 11,270.55
S''4 = (0,13) Rp. 11,238.79 + (0,87) Rp. 11,270.55 – 1 = Rp. 11,265.44

3. Third Smoothin
The third smoothing is the next step in this method, in the same way as the second step. This is to smooth the forecasting results. The difference lies in the values of Xt and S"t which are the result of the second smoothing. Here's the third smoothing formula:

$$S'''t = aS''t + (1 - a)S'''t - 1$$

S'''1 = Rp. 11,275
S'''2 = (0,13) Rp. 11,274.29+ (0,87) Rp. 11,275 – 1= Rp. 11,273.91
S'''3 = (0,13) Rp. 11,270.55 + (0,87) Rp. 11,273.91 – 1 = Rp. 11,272.47
S'''4 = (0,13) Rp. 11,265.44 + (0,87) Rp. 11,272.47– 1 = Rp. 11,270.56

4. Constant(at)
In this step we will find the constant value in forecasting with the following formula:

$$at = 3 * S't - 3 * S''t + S'''t$$

A1 = 3 (Rp. 11,275) – 3 (Rp. 11,275) + Rp. 11,275 = Rp. 11,275
A2 = 3 (Rp. 11,277.25) – 3 (Rp. 11,274.29) + Rp. 11,273.91 = Rp. 11,282. 87
A3 = 3 (Rp. 11,253.21) – 3 (Rp. 11,270.55) + Rp. 11,272.47 = Rp. 11,220.44
A4 = 3 (Rp. 11,238.79) – 3 (Rp. 11,265.44) + Rp. 11,270.56 = Rp. 11,190.66

5. Slope (bt)
In this step we will find the Slope value, which is the value of the forecast difference with the following formula:

$$bt = \frac{a}{2(1-a)^2}[(6 - 5a)S't - (10 - 8a)S''t + (4 - 3a)S'''t]$$

B1 = $\frac{0,13}{2(0,87)^2}$ * [(Rp. 60,321.25) – (Rp. 101,024) + (Rp. 40,702.75)] = Rp. 0

B2 = $\frac{0,13}{2(0,87)^2}$ * [(Rp. 60,333.28) – (Rp. 101,017.63) + (Rp. 40,698.81)] = Rp. 1.24

B3 = $\frac{0,13}{2(0,87)^2}$ * [(Rp. 60,204.67) – (Rp. 100,984.12) + (Rp. 40,693.61)] = Rp. - 7.37

B4 = $\frac{0,13}{2(0,87)^2}$ * [(Rp. 60,127.52) – (Rp. 100,938.34) + (Rp. 40,686.72)] = Rp. - 10.64

6. Parabolic

In this step, the trend level will be measured in the stock price prediction process, where this will determine the historical data margin and prediction results, the calculation is carried out using the following formula:

$$ct = \frac{a^2}{(1-a)^2}(S't - 2S''t + S'''t)$$

C1 = $\frac{0,13^2}{0.87^2}$ (Rp. 11,275 – Rp. 11,275 + Rp. 11,275) = Rp. 0

C2 = $\frac{0,13^2}{0.87^2}$ (Rp. 11,277.25 – Rp. 11,274.29 + Rp. 11,273.91) = Rp. 0.06

C3 = $\frac{0,13^2}{0.87^2}$ (Rp. 11,253.21 – Rp. 11,270.55 + Rp. 11,272.47) = Rp. - 24.32

C4 = $\frac{0,13^2}{0.87^2}$ (Rp. 11,265.44 – Rp. 11,265.44 + Rp. 11,270.56) = Rp. - 31.76

7. Forecast (Forecasting Results)

To determine the results of the Forecast we must add up the final results of each period constant, with the formula:

$$Ft = at + bt + \frac{1}{2}ct$$

F1 = Rp. 11,275 + Rp. 11,275 + 1 + $\frac{1}{2}$ Rp. 11,275 (1^2) = Rp. 11,275

F2 = Rp. 11,282. 87 + Rp. 1.24 + 1 + $\frac{1}{2}$ Rp. 0.06 (1^2) = Rp. 11,284.05

F3 = Rp. 11,220.44 + Rp. - 7.37+ 1 + $\frac{1}{2}$ Rp. - 24.32 (1^2) = Rp. 11,200.91

F4 = Rp. 11,190.66 + Rp. - 10.64 + 1 + $\frac{1}{2}$ Rp. – 31.76 (1^2) = Rp. 11,164.14

Then the results of the calculations that have been done are as follows:

Table 2. Forecasting Results

Open (Rp)	High (Rp)	Low (Rp)	Close (Rp)
11,275.00	11,284.05	11,200.91	11,164.14

The result of the forecasting above is the price of 4 stock price points such as the Open Price or the opening price, then the High price, the highest price on that day, Low the lowest price, and Close the closing price.

8. Comparison of Real Price Data With Forecasting To Measure Accuracy.

In this study, the forecasting is done daily, where each forecasting result is used to predict tomorrow's movement. For this reason, it is necessary to test data on real data the next day, then the data will be tested as follows:

Table 3. Comparison of Real and Predicted Data

Data	Open (Rp)	High (Rp)	Low (Rp)	Close (Rp)
Actual Price	11,275.00	11,300.00	11,100.00	11,150.00
Prediction	11,275.00	11,284.05	11,200.91	11,164.14

Then the results of the comparison are as follows:

a. Finding the Value Difference
   Difference=Ft-Xt
   Open : Difference = Rp 11,275.00 − Rp 11,275.00 = 0

   High : Difference = Rp 11,284.05 − Rp 11,300.00 = Rp − 15.95

Low : Difference = $Rp\ 11{,}200.91\ -\ Rp\ 11{,}100.00\ =\ Rp\ 100.91$

Close : Difference = $Rp\ 11{,}164.14\ -\ Rp\ 11{,}150.00\ =\ Rp\ 14.14$

b. Finding Percentage Value

$$\textbf{Percentage} = \frac{\boldsymbol{Ft - Xt}}{\boldsymbol{Xt}} \ast \textbf{100\%}$$

$Open:\ Percentage = \frac{(Rp\ 11{,}275.00 - Rp\ 11{,}275.00)}{Rp\ 11{,}275.00} \ast 100\% = 0\%$

$High:\ Percentage = \frac{(Rp\ 11{,}284.05 - Rp\ 11{,}300.00)}{Rp\ 11{,}284.05} \ast 100 = -0.14\%$

$Low:\ Percentage = \frac{(\ Rp\ 11{,}200.91 - Rp\ 11{,}100.00)}{Rp\ 11{,}200.91} \ast 100\% = 0.90\%$

$Close:\ Percentage = \frac{(Rp\ 11{,}164.14\ -\ Rp\ 11{,}150.00\ )}{Rp\ 11{,}164.14} \ast 100 = 0.13\%$

So that the results are obtained in table 4.

Table 4. Results of Comparison of Predictions and Historical Data

Data	Open (Rp)	High (Rp)	Low (Rp)	Close (Rp)
Real Data	11,275.00	11,300.00	11,100.00	11,150.00
Forecasting	11,275.00	11,284.05	11,200.91	11,164.14
Difference	-	-15.95	100.91	14.14
Percentage	0%	-0.14%	0.90%	0.13%

From the prediction results above, it can be concluded that the movement of the LQ45 index price can be predicted using the Triple Exponential Smoothing method, which will calculate the difference and percentage results. In this price range, it can be seen that the margin percentage between the predicted results and the real data is less than 1% so it can be concluded that there is no big difference between the predicted results and the actual price (real data).

9.   Comparison Graph Between Historical Data and Predicted Results
In the chart below, you can see the movement of market prices and prediction results, where market prices are marked in blue and forecasts are marked in orange.
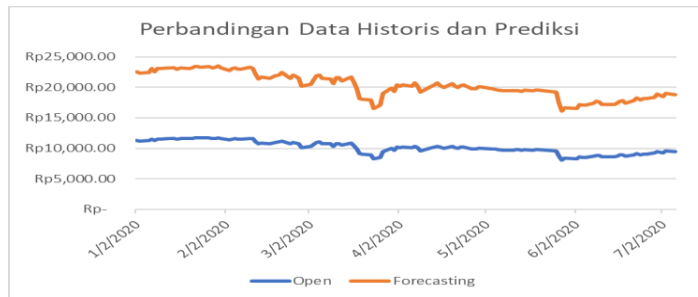
a.   Open Price Chart

Figure 2. Comparison Graph of Open Prices and Predicted Results
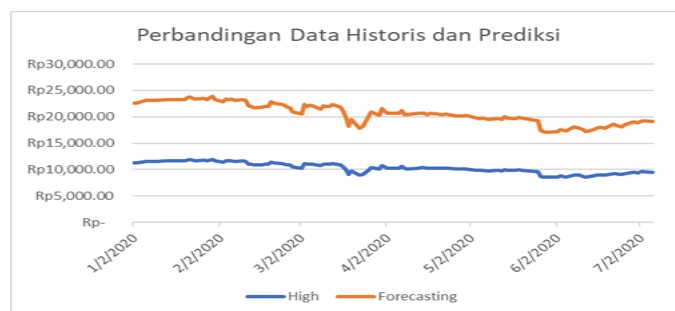
b. High Price Chart

Figure 3. Comparison Graph of High Prices and Predicted Results
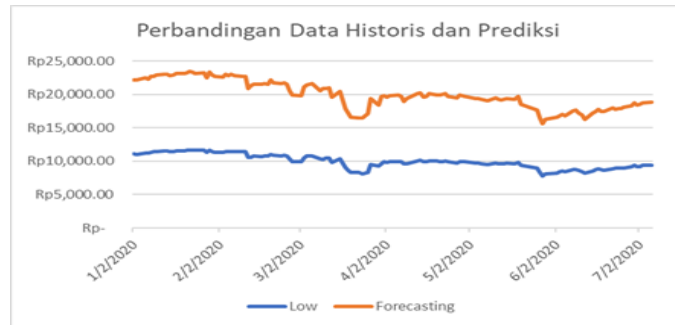
c. Low Price Chart

Figure 4. Comparison Graph of Low Prices and Predicted Results
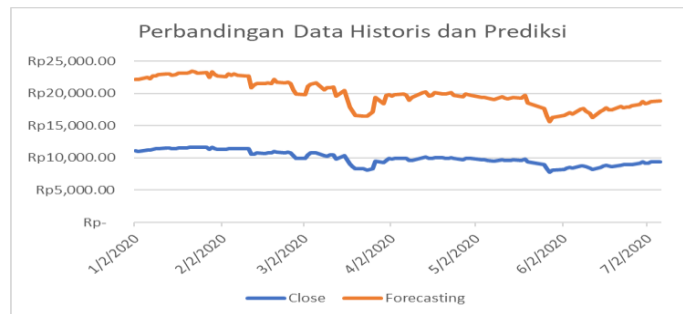
d. Price Chart Close

Figure 5. Comparison Graph of Close Prices and Predicted Results

In the chart above, you can see the movement of market prices and prediction results, where market prices are marked in blue and Forecasting is marked in orange. With the mean percentage difference between predictions and real data to measure accuracy:

Table 5. Accuracy Measurement Results

Price	Accuracy
Open	-0.10681%
High	-1.1156%
Low	1.4616%
Close	-0.2504%

From the table above, it can be concluded that the accuracy results are different for each price point such as Open, High, Low, and Close. But apart from the High price point, the Mean Percentage generated reaches 1%. This means that the margin of error between the actual price and the predicted result is only slightly different.

C. System Implementation

The results of testing the latest stock price data are implemented into the system, resulting in a comparison of market prices and predictions. Prediction results can be seen in Figure 6.
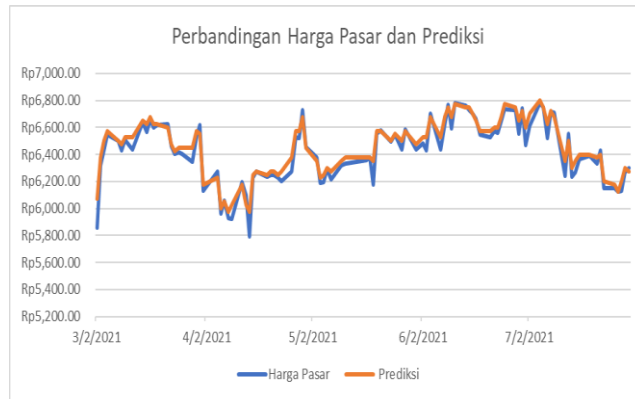
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Figure 6. Graph of Market Price Comparison and Predictions

1. Front End page

This page is the main page display that will be used by the user. This page contains charts of stock price movements for all companies, stock prices by market, list of companies LQ45 and information on stock prices. Besides, if you want to see stock price movements or predictions in one of the companies that we are interested in, just click on one of the company names which can be seen in Figure 7.
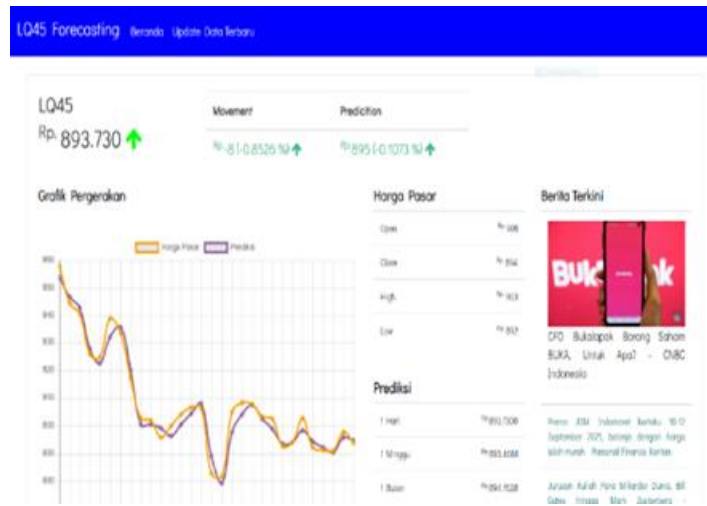

Figure 7. Application Main Page

2. LQ45 Company Index Prediction Details page

This page displays one of the prediction results of the LQ45 stock company, namely the INDF (Indofood) company which was taken by the author as the object of research. Where the prediction results and historical data will be displayed in the form of a table, then it will be visualized in the form of a graph can be seen in Figure 8.

Figure 8. INDF Company Index Prediction Details

3. Prediction Chart Page

This page contains the history of stock price data that has been inputted and forecasted in the form of monthly prediction charts and annual charts, which can be seen in Figure 9.
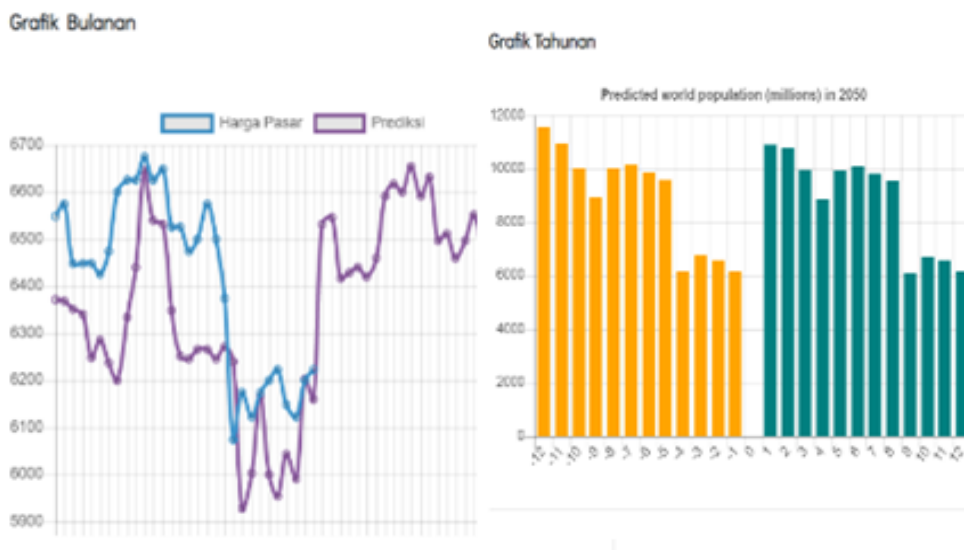

Figure 9. Monthly and Yearly Prediction Graph Page

CONCLUSION

Based on the research that has been done, the stock price prediction system built can predict stock prices well, with the selected parameter values, namely alpha 0.13 and beta 0.87. In the process, starting from calculating the first to third smoothing, determining Constants, Slopes, and Parabolics, to completing the process by producing Forecasting, the results of the measurement of the margin error level are Open prices with a margin error of -0.10681%, High prices with a Mean margin error level. -1.1156%, Low prices with a margin of error of 1.4616%, Close prices with a margin of error of -0.2504%. Based on this explanation, it can be seen that the average margin of error between historical and predicted data ranges from -0.1% to 1%, meaning that the prediction difference from the application of the triple exponential smoothing method can be said to be almost accurate due to the low margin value, so this method can be used in the prediction process. LQ45 stock price.

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