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DEVELOPING A SOFTWARE AS A DECISION-MAKER TO SELL AND BUY STOCK USING STOCHASTIC OSCILLATORS AND EXPONENTIAL MOVING AVERAGE METHODS

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ABSTRACT

Stock is one of the income fields that are widely used by investors. The stock market has a high level of interest to many people because it can provide sizeable income to several parties. However, because the stock market movement is very fast, it is not easy to analyze and observe manually because it requires a lot of free time and a special time to analyze and observe it. Therefore, in this study a decision-making system for buying and selling shares automatically and real-time using the Stochastic Oscillator and Exponential Moving Average (EMA) methods. The data collection method used in this study is scraping from the Indonesian stock market website. Scraping data will be processed using the methods that have been mentioned in real-time according to the desired period to produce signals for buying and selling shares. The results of this study have a 77.50% gain based on theoretical calculations in the 30-minute data period.

Key words : Stock Market, Stochastic Oscillator, Decision-making, Scraping, EMA.

1. INTRODUCTION

Stocks are one of the most popular financial market instruments. Therefore, many companies make the stock market as a funding land that is quite profitable for the company. On the other hand, stock is an investment place that is chosen and used by investors because it is considered capable of providing attractive rates of return [1]. In this modern era the activities of buying and selling shares are made easier by the existence of several websites that provide stock trading services. On that website, investors can conduct stock trading transactions and observe the movement of stock prices. However, because stock prices are moving very fast and fluctuating or can even change due to certain factors resulting in the need for a special time to monitor and observe changes in stock prices.

Based on that problems, in this research created an automatic system that could decide the buying and selling decisions automatically in real-time using the stochastic oscillator and exponential moving average method. This system will create using data collection techniques directly from the stock market website. The data that has been collected will be processed by applying the basic theories of technical stock price changes. Furthermore, it can be analyzed with parameters in accordance with stock market conditions so that decisions can be made to buy and sell shares automatically and in real-time.

2. RESEARCH METHOD

2.1 Related Work

In previous studies, there have been many studies conducted on the topic of stock price analysis and also the appropriate algorithm for estimating the stock price. Based on existing research, there are several journals that can be used as references which are then used as a starting point for making this research. One reference is a study conducted by Ryan Maxum entitled " ". This study combines the Bollinger Bands and Fast Stochastic methods so as to produce a return value reaching 0.071% or 19% per year, beating the value of the daily market return [2].

The second study conducted by Loc Luu and Anh Dinh using the moving average method. Loc Luu and Anh Dinh's research was entitled "Using Moving Average Method to Recognize Systole and Diastole on Seism cardiogram without ECG Signal". This study detected signal movement during research on systolic reaching an accuracy of 96% and diastolic reaching an accuracy of 91% [3].

The third study conducted by Mingyuan WU and Xiaotian DIAO conducted an efficiency experiment on the MACD (Moving Average Convergence Divergence), RSD (Relative Strength Index), and KDJ (Stochastic Oscillator) on the China stock market (Shanghai & Shenzhen Stock market). This study uses 2639 data of stock sale and purchase transactions from 2007 to 2015. This study advocates the importance of testing the oscillator efficiency of stock predictions to combine several fundamental factors and adjust them to better serve research and investor and market objectives [4].

The fourth study conducted by Sattam Allahawiah, Sultan Altarawneh, and Aola Altarawneh conducted to determine planning for building maintenance in the education sector. The results from the use of EMIS have varying results in the range 4.23 - 3.79 on weak infrastructure. However, EMIS tools can only be used in the education sector [5].

The fifth study conducted by Jackelou S. Mapa Ariel M. Sison, Ruji P. Medina shows that this method is very good for predicting the causes of traffic accident cases. In that study it was stated that the results of this method produced a mean absolute error of 0.3548 and Root mean squared error of 0.4841. However, this method cannot be implemented because of faster and fluctuating stock data [6].

The last study conducted by Mohammed Akour, Osama Al Qasem, Hiba Alsghaier, Khalid Al-Radaideh show that CNN has the best results. However, in this journal daily data is used which has a slower rate of change of data than changes in stock price data [7].

2.2 Stock Market

Stocks are a fairly popular financial market instrument. Stocks are also one of the choices a company makes when deciding to provide funding to a company. Besides shares are also a marker of ownership of a company [8]. The stock market or commonly known as the stock market is a vehicle for trading stocks and other financial instruments [9]. In general, the stock market is not much different from the traditional markets that we have known so far. In these two markets, there are sellers, buyers as well as price bargaining activities. In this modern era, the stock market has greatly developed in information systems. Buy and sell on shares occurs generally in the stock market. Generally, companies sell their shares to raise funds for the smooth running of the company's business. The shareholders are not the owners of the company, but the shareholders own a portion of the shares issued by the company [8]. For example, if a company has 1000 shares and a shareholder owns 10 shares of the company, that person owns and can claim 1% of the company's assets and income.

2.3 Technical Analysist

Technical analysis was initially applied in the equity market, but then gradually it was widely used in various types of buying and selling markets [10]. Technical analysis is generally useful for identifying and predicting emerging trends [11]. The basis of technical analysis is the assumption that people will always make the same mistakes as people have done before. There are several concepts in technical analysis [12], they are:

1. Market action discounts everything
2. Prices move in trends
3. History repeats itself

2.4. Stochastic Oscillators

The Stochastic Oscillators Method is one of the first technical analyzes discovered by Dr. George Lane in 1950. Stochastic refers to current prices relative to the price range over a certain period of time [13]. In technical analysis, oscillators are the most common type of indicator and have a limited range. With this range, there is a signal where we are advised to overbought or oversold [2]. There are two components to the Stochastic Oscillator, Smoothed Line and Fast Line. Over the years, the Stochastic Oscillator has remained one of the most popular momentum-catching signals for long-term and short-term investments.

Stochastic Oscillator Fast Line is a technical analysis that functions to compare two prices, namely the current closing price with an estimated price for a certain period of time [14]. Fast Stochastic uses Simple Moving Average (SMA), which can make it more sensitive in price changes and also has more signals, but due to the large number of signals it can cause many false signals due to increased volatility. On the other hand, Smoothed Stochastic uses the SMA method of Fast Stochastic. Stochastic formulas can be seen in equations (1) (2), and (3)

$$Fast\ \%K = \frac{(C - L)}{(H - L)} \times 100 \quad (1)$$

$$Slow\ \%K = 3\ period\ SMA\ of\ Fast\ \%K \quad (2)$$

$$\%D = 3\ period\ SMA\ of\ Slow\ \%K \quad (3)$$

%K = Fast Line

%D = Smooth Line

SMA = Simple Moving Average

C = Recent Close Price

L = The lowest range in N-Period

H = The highest range in N-Period time

Figure 1: Example of a Stochastic Oscillator Graph

In figure 1 above, the red line is the *%K* or the stochastic line. Whereas the blue line is the *%D* or the smoothed line of the *%K* line.

2.5. Exponential Moving Average

Exponential Moving Average (EMA) is one type of Moving Average (MA) which gives a bigger and more significant weight to the latest data. EMA is basically almost the same as Simple Moving Average (SMA). The difference between EMA and SMA is the type of data used, EMA only uses the latest stock data while SMA uses all data. EMA is known as a very efficient means for estimating results [15].

Exponential Moving Average is also commonly referred to as exponentially weighted moving average [16]. EMA reacts more significantly to current price changes than the Simple Moving Average (SMA). The EMA formula can be seen in equation (4)

$$EMA_i = (C - EMA_{i-1}) \times \left(\frac{2}{n+1}\right) + EMA_{i-1} \quad (4)$$

EMA_i = Current EMA
EMA_{i-1} = Previous EMA
C = Recent Close Price
n = The amount of data used

Figure 2: Example of an EMA Graph

In the picture above, there are five example of different lines that present each ema in different periods. The ema period in the picture above consists of 5, 10, 20, 50 and 100.

2.6. Web Scraper

Web scraper is a technique of extracting information from a site using software. Web scrappers explore websites using low-level HTTP (Hypertext Transfer Protocol) or use a web browser such as safari or chrome. This technique also converts unstructured data from a site, usually in HTML format, into a structured data and can be stored in a database or spreadsheet [17]

3. SYSTEM DESIGN AND OVERVIEW

In this research a stock trading system will be created automatically using real-time data and analysis conducted directly by a computer that has the following components:

1. Data and Database

   The data collected consists of a list of Indonesian shares and real-time transactions of buying and selling Indonesian shares. Data is taken from the Indonesian stock market website using scraping with requests method. The data that has been taken and then processed into JSON-shaped data and stored in a database. The database in this system is in the form of NoSQL using MongoDB DBMS (Database Management System) as a storage area with JSON data format. This database is used to store the results of data processing after scraping and technical analysis of stored stock data.

2. Back-End and Front-End

   Back-end in this system using Python programming language for data collection, data processing, decision making, and data presentation. JavaScript programming language is used to handle event-stream data flow on a website. All systems will be put on the server as a place for data processing. As for the front- end on this system using HTML, jQuery, and CSS which are used to handle the appearance of the website.

3. Server

   Server on this system using to handle data scraping, data processing, and decision-making processes. In addition, the server is also used as a webserver, as well as a place to store all this final project data.

3.1. System Overview

The system created is the application of buying and selling shares automatically using the Stochastic Oscillator and Exponential Moving Averages (EMA) methods as the decision maker to buy and sell. This application was created with the aim of providing convenience in selling and buying shares. It is hoped that this application can be trusted and can be developed for further research

The overall system flow can be seen in Figure below. The picture below shows the process flow from the first process, which is data collection to the last process, namely the process of buying and selling. At the initial stage, the system will run the process of data retrieval. Furthermore, the second process will be carried out, namely processing data that uses data retrieval results in the previous stage and has an output in the form of a buy or sell decision. Finally, the buying and selling process that uses data from previous processing.

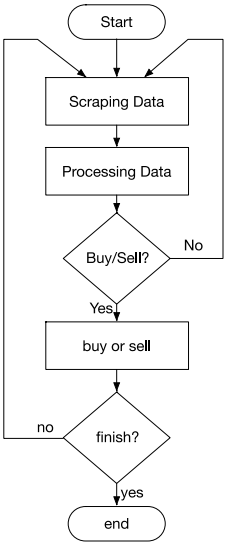

Figure 3: Flow Chart System

3.2. Scraping Data

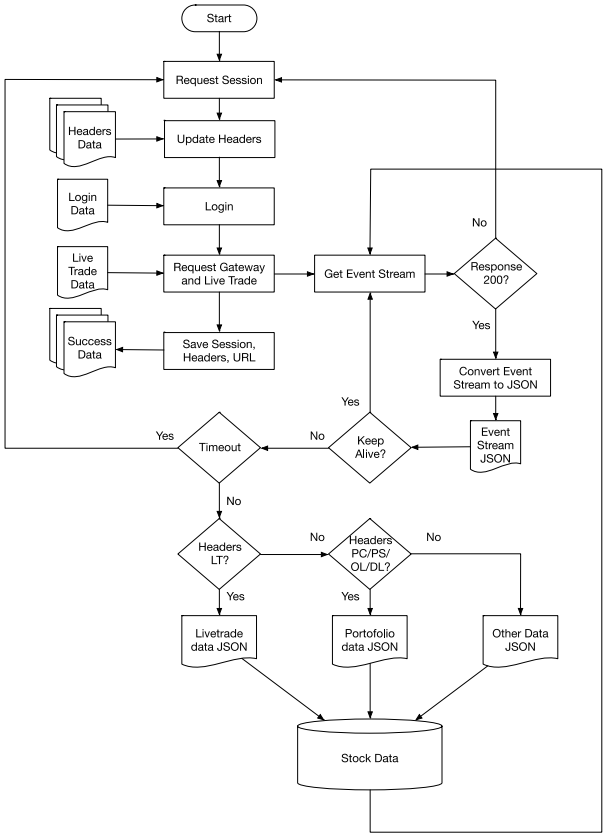

Figure 4: Flow Chart Scraping Data

In the data scraping flow diagram above in figure 4, it can be seen that before getting the event stream data from the gateway page, certain parameters are needed so that the data can be retrieved. The data needed is the request header and login data. After that, a request is made to the gateway page and request live trade data. Data obtained from the event-stream will then be stored in the database.

In this scraping system, the required headers data is obtained based on the results of the analysis on the intended stock market website. The purpose of changing the header when requesting data is that the system still behaves like someone who is requesting data, not a program that is requesting data. The data headers contained in this system shown in the table below.

3.3. Scraping Data

In the data processing flow diagram below in figure 5, it can be seen that the scraping data discussed in the previous discussion will use the data to predict stock movements. But it is necessary to divide the data so that the data processed has been divided according to the desired period. In this study, a period of one minute was used.

After the data are separated per minute, then the Stochastic Oscillator and Exponential Moving Average methods are searched. However, because both methods require prior data movement in the calculation process, it is necessary to read the old data before processing the new data.

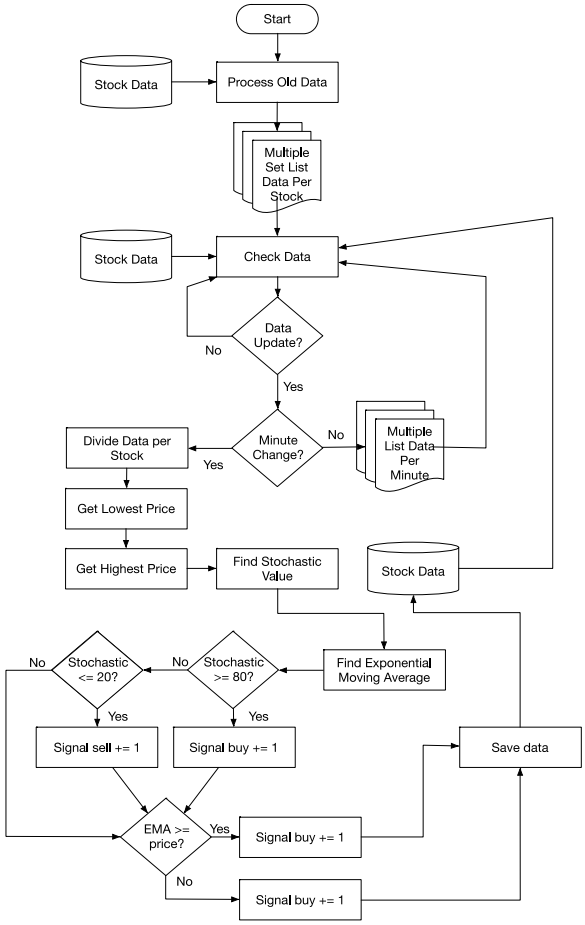

Figure 5: Flow Chart Processing Data


```
{'header': 'LT', 'time': '08:55:00', 'stock': 'ADRO', 'clr0': '#ffc8ff', 'board': 'RG', 'pric
e': '1,565', 'chg': '-15', 'pchg': '-0.95', 'pchgx': '-0.94936705', 'vol': '1', 'val': '156.5
K', 'bcode': 'ZP', 'clr1': '#ff0000', 'scode': 'AK', 'clr2': '#ff0000', 'clr': '#FF0000', 'bo
rderno': '1431822976', 'sorderno': '1431836288', 'bytype': 'F', 'sltype': 'F', '': ''}
```


Figure 6: Data Before Process


```
{ "_id" : ObjectId("5e0a0f2c18fc399987bd1262"), "date" : "30122019", "name" : "ADRO", "period
" : 1, "data" : { "time" : 1577670900000, "high" : 1565, "low" : 1565, "open" : 1565, "close"
 : 1565, "vol" : 580800, "sum" : 908952000, "avg" : 1565, "fast_x" : 0, "fast" : 33.333333333
333336, "smooth" : 44.44444444444445, "ema" : [ 1574.9978912533757, 1577.2099531501258, 1578.
539388281013, 1580.5645675350338, 1582.6815603502412 ], "ses" : 1579.5798704052663, "sma" : [
 1577, 1578.3333333333333, 1578.5833333333333, 1581.1333333333334, 1582.35 ], "bol_hi" : 1585
.615007703243, "bol_lo" : 1571.5516589634235, "bol_stat" : 2, "ses_stat" : 1, "ema_stat" : [
1, 1, 1, 1, 1 ], "sma_stat" : [ 1, 1, 1, 1, 1 ], "sto_stat" : 0, "status" : "0" } }
{ "_id" : ObjectId("5e0a0f2c18fc399987bd1263"), "date" : "30122019", "name" : "AKRA", "period
" : 1, "data" : { "time" : 1577670900000, "high" : 3870, "low" : 3870, "open" : 3870, "close"
 : 3870, "vol" : 1900, "sum" : 7353000, "avg" : 3870, "fast_x" : 100, "fast" : 100, "smooth"
: 100, "ema" : [ 3868.2210964861565, 3864.626137997489, 3861.00592210888, 3858.8479270112475,
 3860.046208052642 ], "ses" : 3859.553466322781, "sma" : [ 3870, 3863.333333333333, 3857.1666
666666665, 3858.666666666666, 3856.6666666666674 ], "bol_hi" : 3874.3719969980743, "bol_lo" :
 3839.9613363352587, "bol_stat" : 0, "ses_stat" : 2, "ema_stat" : [ 2, 2, 2, 2, 2 ], "sma_sta
t" : [ 1, 2, 2, 2, 2 ], "sto_stat" : 1, "status" : "0" } }
```


Figure 7: Data After Process

3.4. Buy and Sell

In the sale and purchase system flow chart below in figure 8, it can be seen that the processing data that has been discussed in the previous discussion will use the data to predict the buying and selling process. But it is necessary to check the availability of these shares so that the shares purchased are shares that are not yet owned, as well as shares sold are shares that are already available. When a stock is in the process of an order and there is a new signal, the existing order data must be changed with a new order data. Therefore, it is necessary to check orders every time there is a new signal.

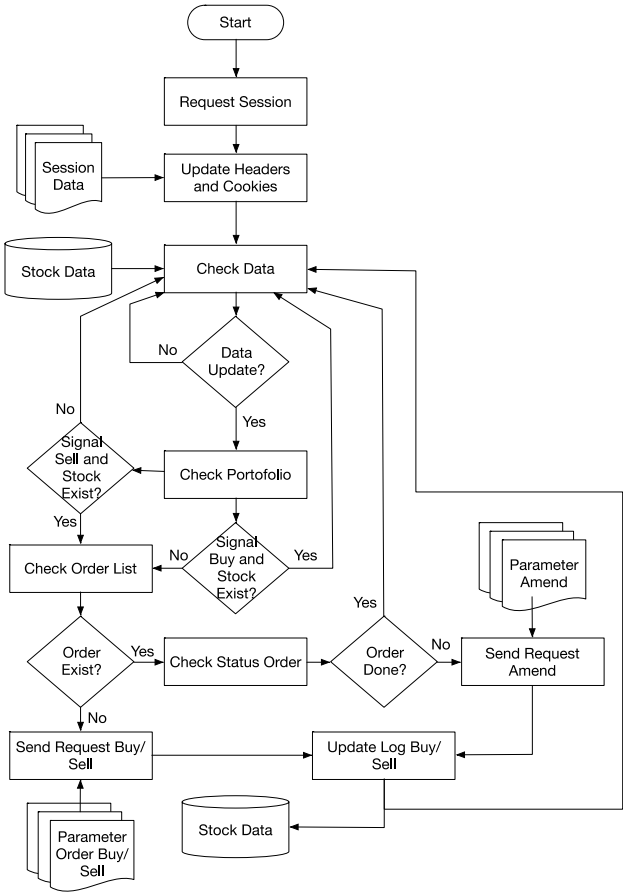

Figure 8: Flow Chart Buy and Sell System

3.5. Unified Model Language

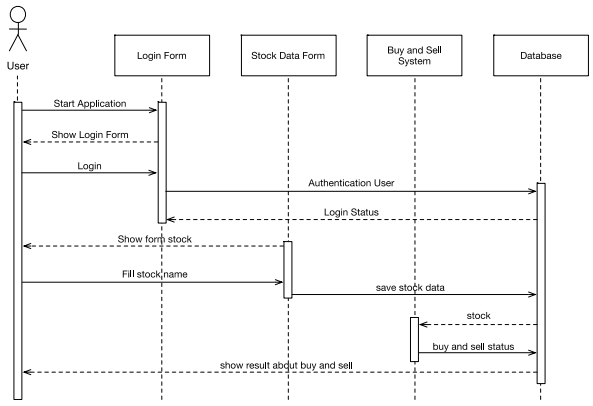

Figure 9: Sequence Diagram

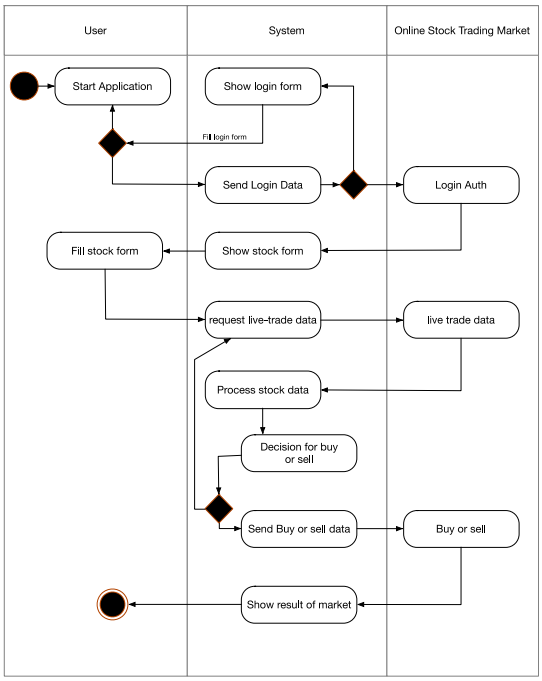

Figure 10: Activity Diagram

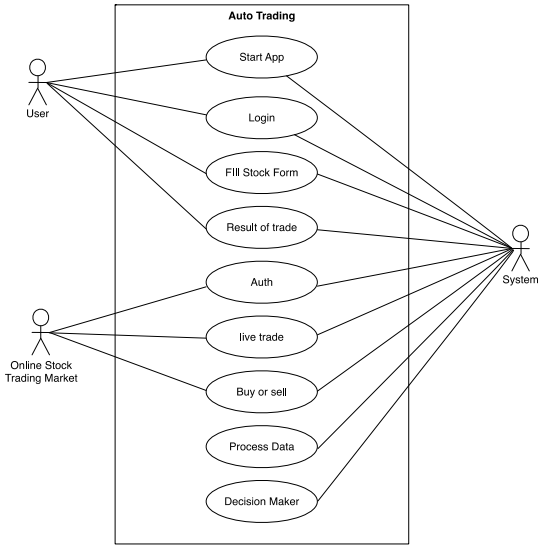

Figure 11: Use Case Diagram

4. IMPLEMENTATION AND TESTING

4.1. Implementation

Implementation of the decision-making application for buying and selling automatic shares includes the implementation of data collection, data processing, and buying and selling. Implementation of data collection consists of a website targeting data collection, live trade data collection, portfolio and orders. Implementation of data processing consists of per-minute data processing, data processing using the stochastic oscillator method, data processing using the Exponential Moving Average method. Implementation of buying and selling consists of automatic selling, and automatic buying.

1. Retrieval of Live Trade Data

   The figure below is an example of the process of retrieving data from the stock market website gateway page. The data taken is already in the form of JSON, but because there is too much noise then the data that is not used must be discarded.

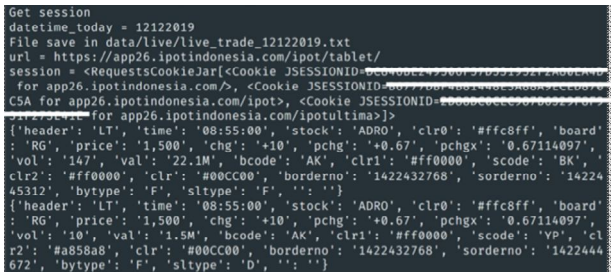

Figure 12: The Process of Taking Live Trade Data

2. Retrieval of Portfolio and Order Data

   The figure below is an example of the process of retrieving data from the stock market website gateway page. In contrast to live trade data collection, portfolio and order data have different parameters. But basically, all data is sent through the same request and is also obtained through the same gateway page as well.

Figure 13: Portfolio and Order Data Collection Process

3. Previous Data Processing

   The figure below shows an example of data processing before, from the picture can be seen that the amount of data previously processed amounted to 222784 data. This data was obtained from data from the previous 5 days that had been processed. Retrieval of previous data is needed because some methods require prior data to be calculated.

Figure 14: Previous Data Processing

4. Per-minute data processing

   The figure below is an example of per-minute data processing results. Judging from the pictures it can be seen that the data processed per minute is in the range of 840 to 3119. The amount of data per minute is always different every time. In this research, we check the incoming data every time, if the minutes of the data are the same as before, then the system will enter the data into an array. However, if the minutes of the data are different, then the previous data will be processed, and new data will store into the next array.

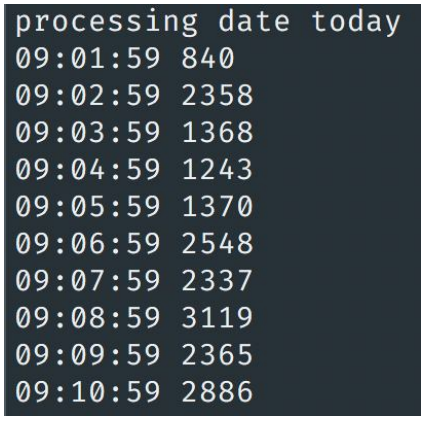

Figure 15: Per-minute data processing

5. Data Processing with Stochastic and EMA

   The following are examples of the results of calculations using the stochastic oscillator and exponential moving average methods. Figure 16 is an example of data that has been previously processed. The processed data will have a value from each method. After the data is processed, then the data is stored in a database for the purpose of buying and selling shares.

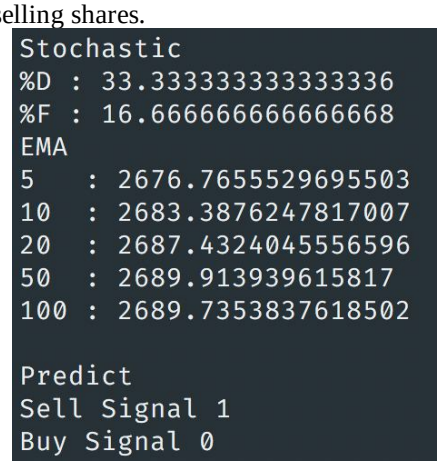

Figure 16: Data Processing with Stochastic and EMA

6. Implementation of Buy and Sell

   The picture below is a log of the results of the implementation of buying and selling. The data sequence is [Stock] [Buy / Sell status] [Price] [Lot] [Time]. Data that has been processed using Stochastic and EMA will have their respective signals. In this study used number 1 as a sell signal and number 2 as a buy signal.

   The system will check every change from the database, if the database has changes or updates, the

system will check the type of signal issued from each share. If the shares have a sell signal, the system will first check the availability of shares in the portfolio, if the shares are available and there are no orders at the time, the shares will sell the shares. But if there are no shares or there is an order, the system does not make a transaction, or the system will amend the shares if there is already an order.

Conversely, if the signal is a buy signal, the system will check whether the stock already exists or not, if it already exists, then no stock purchase will be made. If a stock does not yet exist and there is no order, the stock will be bought by the system. If there is an order, the shares will be amended according to the price determined by the system

```
WTON BUY 450 1 10:59:25
APLN BUY 180 1 11:29:54
BHIT BUY 66 1 13:31:07
APLN SELL 179 1 13:58:37
BHIT SELL 67 1 14:02:28
BHIT BUY 66 1 14:09:22
BWPT BUY 114 1 14:14:25
WIIM BUY 174 1 14:22:58
```

Figure 17: Implementation of Buy and Sell

4.2. Testing

The testing scenario in this study uses current and pre-processed stock market data. First, scraping the data using a program that has been made. Second, data processing and decision making are carried out according to the method used. Then the data that has been processed is processed for giving a buy or sell signal using the specified method. After that, selling and buying shares are carried out. The above test will calculate profit and loss from the sale and purchase of these shares. Data from the sale and purchase will be processed to calculate the advantages and disadvantages of this method using equation (5) and equation (6)

$$gain\ \% = \frac{SP - CP}{CP} x\ 100 \quad (5)$$

$$loss\ \% = \frac{CP - SP}{CP} x\ 100 \quad (6)$$

SP = Buy Price
CP = Sell Price

In the table below is an example of the results of the calculation of buying and selling. Data taken from buying and selling results is taken. The profit value is calculated from the difference between the selling and buying price.

Table 1: Example of Sell and Buy Calculation Results

Stock	Purchase Price (Rp)	Selling Price (Rp)	Lot	Profit (Rp)
BBKP	264	266	1	200
BTPS	4140	4110	1	-3000
DYAN	133	132	1	-100
TBIG	5600	5775	1	17500
GGRM	54850	54775	1	-7500
KBLI	585	595	1	1000
SILO	6900	7150	1	25000
KLBF	1585	1595	1	1000
BUMI	86	86	1	0
SIMA	52	51	1	-100
BTEK	56	60	1	400
ERAA	1625	1610	1	-1500
TELE	306	310	1	400
INCF	51	51	1	0
NZIA-W	212	220	1	800

Furthermore, the results of the buy and sell calculations will be calculated to find the profit, loss and find the ideal period for the stock price at a certain price. In the table below is the result of calculating the percentage of profit and loss using a one-minute period starting from November 6, 2019 to December 30, 2019.

Table 2: Testing 1 Minute Period

Price	Percentage	
	Profit	Loss
< 200	49.56%	50.44%
200 - 5000	43.07%	56.93%
> 5000	84.76%	15.24%
Total	43.07%	56.93%

From table 2 it can be seen that stocks with prices above Rp 5,000 have the highest percentage of profits in a one-minute period, that is 84.76%. Whereas shares with prices ranging from Rp 200 to Rp 5,000 had the largest percentage of losses in a one-minute period, that is 56.93%. Furthermore, in the table below is the result of calculating the percentage of profit and loss using a five-minute period starting from November 6, 2019 to December 30, 2019.

Table 3: Testing 5 Minute Period

Price	Percentage	
	Profit	Loss
< 200	59.39%	40.61%
200 - 5000	62.37%	37.63%
> 5000	95.29%	4.71%
Total	61.50%	38.50%

From table 3 it can be seen that stocks with prices above Rp 5000 have the greatest percentage of profits in a five-minute period, that is 95.29%. Whereas shares with prices below Rp 200 had the biggest percentage loss in a five-minute period, that is 40.61%. Furthermore, in the table below is the

result of calculating the percentage of profit and loss using a ten-minute period starting from 6 November 2019 to 30 December 2019.

Table 4: Testing 10 Minute Period

Price	Percentage	
	Profit	Loss
< 200	63.79%	36.21%
200 - 5000	68.51%	31.49%
> 5000	75.00%	25.00%
Total	67.68%	32.32%

From table 4 it can be seen that stocks with prices above Rp 5000 have the greatest percentage of profits in a ten-minute period, that is 75.00%. Whereas shares with prices below Rp 200 had the largest percentage loss in a ten-minute period, that is 36.21%. Furthermore, in the table below is the result of calculating the percentage of profit and loss using a 15-minute period starting from November 6, 2019 to December 30, 2019.

Table 5: Testing 15 Minute Period

Price	Percentage	
	Profit	Loss
< 200	67.82%	32.18%
200 - 5000	72.82%	27.18%
> 5000	69.62%	30.38%
Total	71.35%	28.65%

From table 5 it can be seen that just like the one-minute period, shares with prices between Rp 200 and Rp 500 had the highest percentage of profits in the fifteen-minute period, that is 72.82%. While shares with prices below Rp 200 had the largest percentage of losses in the fifteen-minute period, that is 32.18%. Furthermore, in the table below is the result of calculating the percentage of profit and loss using a thirty-minute period starting from 6 November 2019 to 30 December 2019

Table 6: Testing 30 Minute Period

Price	Percentage	
	Profit	Loss
< 200	68.42%	31.58%
200 - 5000	79.90%	20.10%
> 5000	83.72%	16.28%
Total	77.50%	22.50%

From table 6 it can be seen that stocks with prices above Rp 5,000 have the greatest percentage of profits in the thirty-minute period, that is 83.72%. Whereas shares with prices below Rp 200 had the greatest loss percentage in the thirty-minute period, that is 31.58%

Table 7: Speed Comparison for Scraping Data using Selenium vs Requests

Category	Selenium	Requests
Open Browser	1.22362 s	0.00005 s
Get Website URL	0.91952 s	0.27085 s
Login	2.50332 s	1.10431 s
Get Cookies	0.69306 s	0.03769 s
Get Gateway Live Stream	0.09348 s	0.01684 s
Total	**5.43299**	**1.42973**

In table 7 above is the result of scraping data testing to test the speed of scraping using module requests compared to using the selenium module. 100 trials were used for each module. From the table above it can be seen that using the request module is faster than using the selenium module

5. CONCLUSION

Based on the results of research and testing that has been done in this paper, it can be concluded that:

1. Scraping data using the request module is faster than using the selenium module.

2. Analysis over a period of thirty-minute has the greatest advantage, that is 77.50%. While the analysis in the one-minute period had the biggest loss, that is 56.93%.

3. Stocks with prices below Rp 200 have the biggest advantage in the analysis with a thirty-minute period, that is 68.42%.

4. Stocks with prices ranging from Rp 200 to Rp 5,000 have the biggest advantage in the analysis with a thirty-minute period, that is 79.90%.

5. Stocks with prices above Rp 5,000 have the biggest profit in the analysis with a five-minute period, that is 95.29%.

Based on the results of research and testing that has been done in this paper, suggestions for further research are:

1. Combine with other methods to add a percentage of profit.

2. Use fundamental analysis such as text preprocessing from the news in order to know the comparison between technical methods and fundamental methods.

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