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System Development for Sale and Buy Execution in Stock Trading using Knowledge-Based System

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ABSTRACT: Currently, many applications have been developed for buying and selling shares. The main challenge in developing this application is how it is applied in real-time via a mobile phone. In this study, a system that is able to analyze stock trading is designed using several methods at once and is able to execute buying and selling automatically. This system works based on real-time stock data input from several companies that are the object of study. The system will calculate three moving average (MA) values of each company. These values will be used as a reference for analysis using an artificial intelligence method, namely a knowledge-based system. The knowledge which is used in this system is the Moving Average Convergence/Divergence (MACD) method and support resistance. MACD will work by comparing the three MA values of each company and then determining whether there is an instruction to make a sale or not. Meanwhile, resistance support works by comparing the three MA values with the current stock price, then determining whether there is an instruction to sell or not. Users can also set up the system to buy and sell automatically. From the test results of the proposed system, the results of MACD's instructions were 36 purchase instructions with 100% profit, and 54 sales instructions with 7.41% profit and 88.88% loss and 3.71% neither profit nor loss. Whereas for instructions from support resistance, 46 purchase instructions were generated with 100% profit, as well as 45 sales instructions with 37.78% profit and 6.67% loss and 55.55% neither profit nor loss. The proposed system can also provide real-time transaction notifications on the smart phone. With the proposed system, it is hoped that it can make it easier for users to buy/sell shares automatically while still considering the risk factor. Moreover, this system can provide learning for novice users in buying/selling shares.

Keywords: trading, buying, selling, automatically, knowledge-based system

I. INTRODUCTION

Many approaches, ranging from time series forecasting, fundamental, statistical and technological analysis, have been used for stock market prediction [1]. Investment researchers and investors review historical data on prices and amounts and other market-related metrics to obtain an in-depth view of stock trading for better outcomes. By analyzing the past price fluctuations and trading volumes of stocks and indices, technical analysis helps to assess future levels [2]. The activity of buying and selling shares requires careful analysis and observation of price changes that tend to take time [3], [4]. If a share trading actor ignores the stock price changes, he will likely experience a loss. As far as we know, there is no smart phone-based application to automatically execute stock buying/selling by applying algorithms for complex stock analysis. With smartphones, it is possible to have a system that can monitor and analyze stock price changes using a knowledge-based system, then send annotations to the user or automatically carry out the buying and selling process if there are significant changes.

The performance of technical research in many current studies has been recorded in financial markets [5]-[9] studies have contended that in order to benefit from recurring market trends, technological research may be more successful if they combine metrics together analyzed [10]. The productivity of a technical metrics, namely moving average (MA) rules around the world of 75 countries. The results obtained, many important conclusions may be drawn, the most crucial here is that investors using the MACD as a technical indicators investment tool on the share market [11], [12].

In this study, a knowledge-based system will be used. The system will provide thresholds on the algorithm used based on expert knowledge or other documented knowledge in the form of facts, concepts, rules, procedures, and relationships between them, represented in a form understood by the system. Existing stock data will be processed or analyzed by the

system. In this study, the analysis using MACD oscillation to find out the relationship degree between the variable X (moving average convergence divergence) and variable Y (buy and sell signals). Suppose the system finds the appropriate data based on the given restrictions or rules. In this case, the system will automatically send notifications to the user or automatically carry out the buying and selling process. The system is expected to provide sales or purchase instructions precisely so that the trading shares activity will be more comfortable and faster with no complicated observations.

II. METHODS

A. Stock Analysis

Stock analysis includes fundamental analysis and technical analysis. Fundamental analysis includes information about the company's financial and health statements, management of competing companies, and the market situation of these products [13]. Fundamental analysis cannot be observed using computers. This is due to inadequate data and most of them are not numerical based, for example, companies that have problems with government permits or problems with employees.

Meanwhile, technical analysis is a basic method for reading price movements using historical data in the form of a combination of the value of the opening, closing, highest and lowest prices [14]. Technical analysis is performed using various mathematical calculation methods, including MACD and resistance support. The MACD method and resistance support were developed by experts and are commonly used.

B. Knowledge Based System

Sajja and Akerkar stated that the Knowledge Based System (KBS) is an application of Artificial Intelligence (AI). KBS has the ability to compute, store, think process, and store the knowledge [15]. The knowledge used in this study is the Moving Average Convergence/Divergence (MACD) and resistance support. In using MACD and resistance support, a moving average (MA) value is needed which is discussed in the following section.

Moving Average. Moving Average (MA) is the average value of stock price movements within a certain time span or data range [16]. The MA used in this study are three different MA values for each company. MA calculation is expressed in the following Equation 1.

$$MA = \frac{x1+x2+x3....+xn}{n} \quad (1)$$

Where xn is the sample range and n is the number of samples. In this study, if the MA value is not a whole value, then the decimal digits will be omitted. Table 1 is an example of calculating MA with the MA1 range being two data, the MA2 range is three data, and MA3 is four data:

Table 1: Example of MA calculation.

Time	Stock price (Rp)	MA1	MA2	MA3
14:47:24	2150	-	-	-
14:47:40	2155	2152	-	-
14:47:54	2150	2152	2151	-
14:48:10	2159	2154	2154	2153
14:48:24	2159	2159	2156	2155
14:48:40	2152	2155	2156	2155
14:48:54	2150	2151	2153	2155

For example,

$$MA1 = (2150 + 2155)/2$$
$$MA1 = 2152.5$$

Then the value MA = 2152

Moving Average Convergence/Divergence (MACD). Moving Average Convergence/Divergence (MACD) is an indicator that shows the relationship between two moving averages and price [11], [17]. It includes both long-term and short-term moving averages. MACD will detect a sell signal (dead cross) and a buy signal (golden cross) from the intersection of the moving average value. If the moving average with lower data crosses upwards to higher data it is said to be a golden cross. Meanwhile, if the opposite is said to be a dead cross. These two conditions are illustrated in Figure 1.

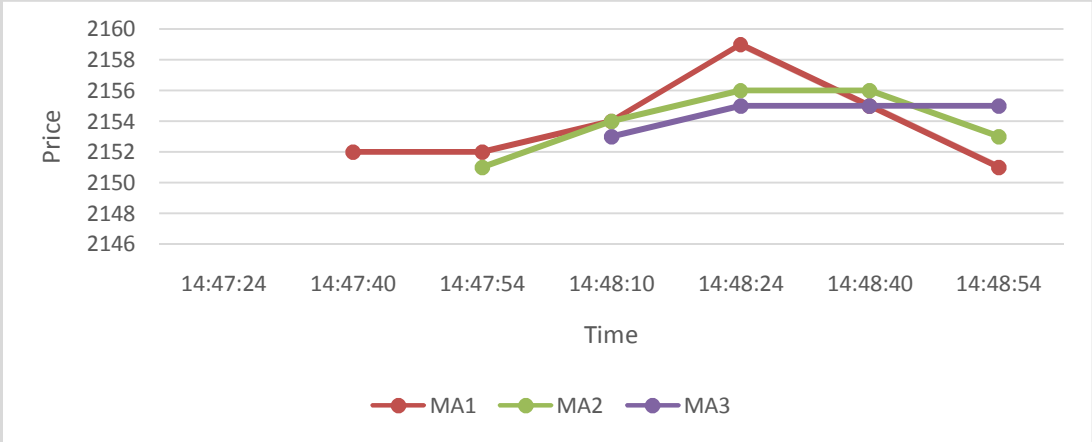

Fig. 1. Examples of dead cross and golden cross.

From Fig. 1 it can be seen that at 14:48.10 there was a golden cross between MA1 and MA2. Before 14:48.40 there was a dead cross between MA1 and MA2 where a sell signal would be detected at 14:48.40 because at that time there was only MA data. Furthermore, at 14:48.40 there was also a dead cross between MA1 and MA3. And the last one before 14.48.40 there was a dead cross between MA1 and MA2 where a sell signal would be detected at 14.48.54 because at that time there was only MA data.

Support resistance. Support is a specific price area that holds market price movements, making it difficult to move lower, as if it were the lower price limit. Meanwhile, certain price area resistance holds market price movements, making it difficult for prices to move higher. Support resistance will detect if the current stock price is close to or more than the highest value of one of the existing moving averages (resistance), and will then be considered a sell signal. If the stock's current value approaches the value or lowest point of the existing moving average (support) it is considered a buy signal.
Support resistance can be expressed by Equation 2 as follows:

$$Sell\ signal \geq x\ \times \max MA$$
$$Buy\ signal \leq y\ \times \min MA \qquad (2)$$

Where x is the percentage of how close the current stock price is to the maximum MA (resistance) value which will be considered a sell signal, and the y value is how close the current stock price is to the minimum MA(support) value which will be considered a buy signal. So here the x and y values are set by the user. If an example of the x value is 99.9% and the y value is 100.005% and MA1 is used as a comparison with the current price, then a resistance value of 2159 and a support value of 2151 is obtained. Then the calculation of buy and sell signals is as follows:

$$Sell\ signal \geq 99.9\%\ \times 2159$$
$$Sell\ signal \geq 2156.841$$
$$Buy\ signal \leq 100.005\%\ \times 2151$$
$$Buy\ signal \leq 2151.10755$$

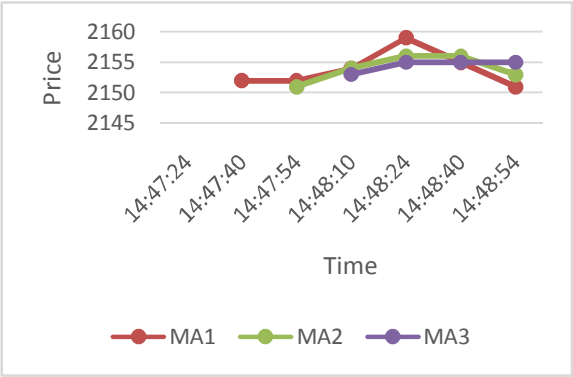

Fig. 2. Chart of stock price movements.

Based on Fig. 2, when the stock value is ≥ 2156,841 it will be considered a sell signal and when the stock value is ≤ 2151.10755 it will be considered a buy signal. So in this example a sell signal occurs at 14:48.10 and 14.48.24 and a buy signal occurs at 14:47.24; 14.47.54; and 14.48.54.

III. DESIGN and IMPLEMENTATION THE SYSTEM

In this study, a system is designed that can analyze and then provide decisions related to buying and selling execution in stock trading. This proposed system uses the Knowledge-Based System method. Input in the form of real-time share price data is then adopted to KBS to determine when to sell or buy stock trading.
The system will read the database containing the stock price data from 8 companies. Then the system will calculate 3 moving averages for each company. The 3 moving averages are as follows:

1. Moving average 60
   Every last 60 stock price data from each company will be calculated the average.
2. Moving average 120
   Every last 120 stock price data from each company will be calculated the average.
3. Moving average 180
   Every last 120 stock price data from each company will be calculated the average.

After calculating the moving average, the three moving average values of each company will be stored in the database. The process of reading the database and calculating the MA starts when a company has at least 180 of the latest stock price data, and will continue to repeat until the system stops.

A. Moving Average Analysis

MACD calculation will be compared with each moving average. If there is a lower MA crossing above the higher MA, it will be considered a buy signal. If there is a lower MA crossing below the higher MA, it will be considered a sell signal.
If a buy and sell signal is found, the system will send data to the database, besides that the system will also send data to the cloud which will be accessed by the user's smartphone. The workflow of this process is shown in Fig. 3.

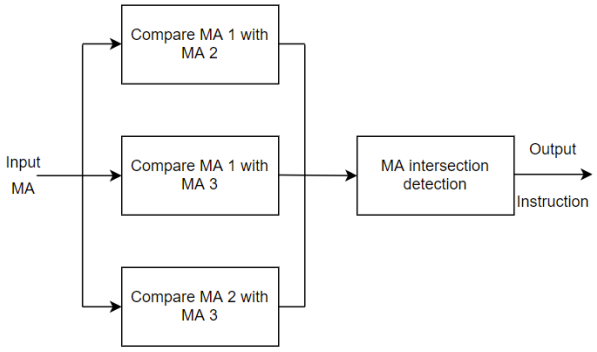

Fig. 3. The workflow of MACD.

B. Support Resistance

In this method, the system will read the moving average database and the latest stock price database from each company. The system will look for the highest and lowest values of the three moving averages for each company, then compare them with the latest prices. The lowest moving average will be the support value and the

highest moving average will be the resistance value [18]. When the latest price approaches or falls below the support value it is considered a buy signal. When the latest price approaches or reaches more than the resistance value it is considered a sell signal. Purchase and sales data will then be stored in the database. The details of the process are illustrated in Fig. 4.

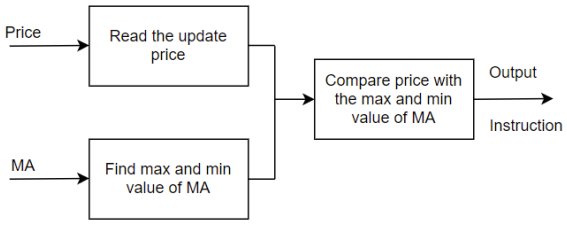

Fig. 4. The workflow of Support resistance.

IV. RESULTS and DISCUSSION

In this study, the proposed system has been tested by comparing the sale and purchase instruction data with the stock data (open, high, low, close) of the company on November 11, 2016. Purchases are compared to the highest price, where purchases below the highest price are considered successful purchases or profit. Sales are compared to prices when open. This system starts running at 2:32 pm, with the assumption that the user owns the shares of each company according to the price at the open, otherwise it is assumed that direct instructions are carried out. The number of lots used in this test is 2.

A. Testing Buy Instructions using MACD

Fig. 5 shows a stock chart taken from the Kimia Farma company. From this data, MACD calculations are then carried out. Tables 2, 3, 4, 5, and 6 are purchase instructions based on MACD calculations from each observed company. Tables 2, 3, 4, 5, and 6 show examples of execution of a proposed system that generate profit for each transaction.

Fig. 5. Open, High, Low, and Close values of Kimia Farma company.

Table 2: Purchase instructions (Kimia Farma).

Price	Time	Method	Status
2500	2016-11-11 15:38:12	MACD	Profit
2500	2016-11-11 15:40:31	MACD	Profit
2500	2016-11-11 15:43:33	MACD	Profit

Table 3: Purchase instructions (Kren).

Price	Time	Method	Status
450	2016-11-11 14:40:08	MACD	Profit
452	2016-11-11 14:49:15	MACD	Profit
452	2016-11-11 15:38:18	MACD	Profit

Table 4: Purchase instructions (PGas).

Price	Time	Method	Status
2390	2016-11-11 15:40:31	MACD	Profit
2370	2016-11-11 16:11:34	MACD	Profit
2370	2016-11-11 16:16:55	MACD	Profit

Table 5: Purchase instructions (BRI).

Price	Time	Method	Status
11925	2016-11-11 14:36:17	MACD	Profit
11950	2016-11-11 14:40:11	MACD	Profit
11950	2016-11-11 14:40:33	MACD	Profit
11950	2016-11-11 14:41:29	MACD	Profit
11950	2016-11-11 14:43:12	MACD	Profit
11950	2016-11-11 14:46:49	MACD	Profit
11975	2016-11-11 14:47:13	MACD	Profit
11975	2016-11-11 14:49:15	MACD	Profit
12000	2016-11-11 14:50:40	MACD	Profit
11975	2016-11-11 14:51:20	MACD	Profit
11975	2016-11-11 14:53:24	MACD	Profit
11975	2016-11-11 14:54:45	MACD	Profit
11975	2016-11-11 15:33:16	MACD	Profit
11975	2016-11-11 15:35:19	MACD	Profit
11975	2016-11-11 15:41:14	MACD	Profit
11975	2016-11-11 15:47:55	MACD	Profit
12000	2016-11-11 15:48:41	MACD	Profit
12000	2016-11-11 15:51:42	MACD	Profit
12000	2016-11-11 15:52:27	MACD	Profit
12000	2016-11-11 15:55:28	MACD	Profit
12000	2016-11-11 15:57:44	MACD	Profit
12000	2016-11-11 16:01:30	MACD	Profit

Meanwhile, testing the MACD method on the share trading company Indosat did not produce a purchase instruction. This is because the golden cross points are not found from the three moving averages, this is due to the stock price data in the database for the company. The number of instructions on a test purchase using MACD is 36 instructions.

Table 6: Purchase instructions (Wijaya karya).

Price	Time	Method	Status
2650	2016-11-11 14:36:55	MACD	Profit
2650	2016-11-11 14:37:31	MACD	Profit
2640	2016-11-11 14:38:48	MACD	Profit
2640	2016-11-11 14:39:30	MACD	Profit
2580	2016-11-11 16:09:21	MACD	Profit

From all these instructions a purchase is generated below the highest price or 100% profit. These instructions were successfully executed by the proposed system because the dataset provided golden cross point information which was then detected by the system.

B. Testing Selling Instructions using MACD

In the sales scenario, the benchmark price is the open price. The open price is the closest price after stock price data starts to enter the database. The benchmark for the share price is the open share price at 14:35 on November 11, 2016. From the test results in the sales instruction scenario using MACD generated 54 instructions, with 7.41% profit, 88.88% loss, and 3.71% no profit and no loss. Unlike the buy instruction in the previous section, which generated 100% profit, in this sell transaction scenario some MA input parameters were not calculated correctly due to incomplete data. As a consequence, it will generate wrong decisions. The errors given are quite large and this is a weakness of the proposed system that needs to be evaluated and becomes an important issue to be resolved in future work.

C. Testing instructions using Support Resistance

In this test, a performance analysis of the support resistance method is carried out using the same data in the MACD method scenario. For testing instructions using support resistance, the constant value x is used as the multiplier of the resistance value (MA maximum). The value of x used here is 1. And the constant value of y is the multiplier of the support value (minimum MA), where the y value used is 0.9975.

From 46 purchase instructions from the system, generate 100% profit, meaning that purchases are made well below the highest price and even 32.6% or 15 purchase instructions are right at the lowest price. Meanwhile, for 45 sell instructions using support 'resistance were obtained with 37.78% profit, 6.67% loss, and 55.55% neither profit nor loss. Support resistance gives better performance than MACD on sell transactions. The generated loss value is much smaller than MACD. Thus, stock players can consider the support resistance method in selling transactions.

D. Testing of Automated Buying and Selling Applications

Testing is also carried out to determine the system's performance in executing buying and selling automatically. Tests are carried out on 181 instructions resulting from MACD analysis and support resistance. The host computer accesses the database from the server computer which performs the analysis process and generates instructions, this process runs by using the local network for the process of retrieving or reading data. From the test it is known that the host computer can carry out the buying and selling process, analyze and execute or carry out the selling or buying process automatically on all instructions (100% of the instructions are executed automatically). Moreover, this system also provides online reporting or notifications that can be accessed via smart phones. This feature will make it easier for users to monitor stock trading compared to the study by Păuna [19] and Thu [20], which is still PC based system. Fig. 6 shows one of the notification displays sent to the smart phone.

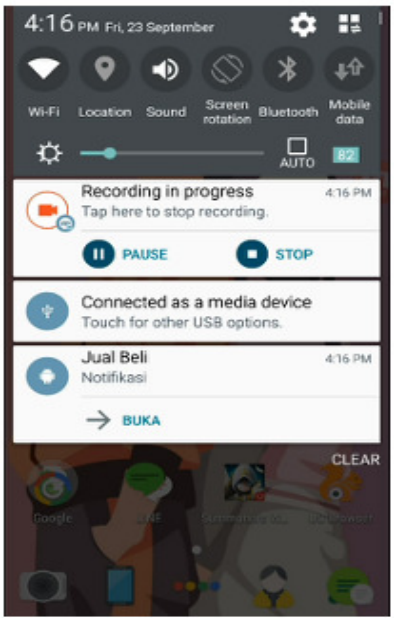

Fig. 6. Transaction notification on smart phone.

V. CONCLUSION

In this study, a system has been designed and implemented to analyze and execute the buying / selling of shares automatically. Instructions are given based on a knowledge-based system method by reference to MACD calculations and support resistance. From the tests conducted, the system is able to execute sell/buy transactions automatically. This system was tested on the stock data of a number of companies. From the simulation it is known that the MACD with 36 purchase instructions generates 100% profit, and 54 sales instructions with 7.41% profit and 88.88% loss and 3.71% neither profit nor loss. Meanwhile, 46 resistance support instructions resulted in 100% profit, as well as 45 sales instructions with 37.78% profit and 6.67% loss and 55.55% neither profit nor loss. MACD's sales instructions generated more losses with 88.88% loss, while support resistance was only 6.67% loss. So that in sales instructions, support resistance has a better performance than MACD. This system can also provide notification automatically to the user if there is a transaction via a smart phone. With this system, it is hoped that it can be used for stock transactions automatically so that it can make it easier for users to execute and monitor the sale / purchase of stock.

Conflict of Interest: All authors declare no conflict of interest.

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