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Fundamental analysis and technical analysis integrated system for stock filtration

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Abstract Fundamentals and technical investigation is a technique which enhances decision making for stock investors. The fundamental analysis includes looking at any information, other than the trading patterns of the stock itself, which can affect the cost and the perceived value of a stock. Technical analysis is an exchanging apparatus utilized to assess securities and endeavor to forecast their future development by breaking down insights accumulated from exchanging action, such as price movement and volume. This system utilizes data mining techniques to analyze various stock information and the factors to create a logical decision model. This helps new and inexperienced investors to make less errors as well as make the stock market more approachable to the general community. This research focuses on a high performance stock selection using the fundamental analysis of individual stocks, which is reflected in the financial statements. Ten criteria calculated from stock financial statement reports are proposed for the analysis. The 10 years of historical fundamental information on organizations recorded in Thailand stock exchange were clustered into three groups and used the fundamental criteria to classify the interesting return stocks selection. The multilayer perceptron neural network is used in the training process to verify the clustering results. For the technical analysis, experimental results reveal that the exponential moving average technique is the most favorable and thus being selected to apply in our system. To affirm the productivity of the suggested stocks, an experiment using information from the system's decision model based on the Stock Exchange of Thailand data in the year 2015 is conducted. After the activities from 5000 simulated portfolios, the average returns of the ports are positive. In fact, the ports gain almost three times higher than the average market yield. This indicates the efficiency of the system's stock filtering and decision making capabilities.

Keywords Business intelligence · Stock trading · Decision support · Clustering · MLP neural network

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1 Introduction

Investing in stock markets can be either fortunate or disastrous. Without sufficient trading experience and business knowledge, it is less likely that a person can make a profit. Yet, to encourage new investors, there have been a number of tools or systems which can help reduce errors and make their decisions more efficiently. Amongst them, otal return index (TRI) is one of the most popular indexes. This index measure the stock performance from capital gains, losses, rights offerings and dividends. According to TRI data from 2003 to 2012, the average return of Thailand's stock market was 20% per year. This was higher than the investment in USA, Europe and Japan as displayed in Table 1.

Focusing on the same period of 2003–2012 in Thailand, investment in the stock market has significantly higher return rates when being compared to investment in gold, government bond, and 1-year fix deposit as can be seen from Table 2. It is noted that the average inflations during this period is 3.1%.

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Table 1 The comparison of nominal return from investment in worldwide stock market from 2003 to 2012. (Include the inflation)

	Thailand SET50 TRI	MSCI Asia (Excluding Japan) TRI	MSCI World TRI	Dow Jones Industry Average TRI	Euro Stoxx 50 TRI	Japan Nikkei 225 TRI
Accumulation	526.80%	177.30%	46.30%	43.80%	32.30%	17.90%
Average	20.10%	10.70%	3.90%	3.70%	2.80%	1.70%

*S*ource: Thailand stock exchange market and Bloomberg [1]

Table 2 The comparison of real return from invest in Thai market from 2003 to 2012. (Exclude the inflations)

	Thailand SET50 TRI	Gold	Govt. bond TRI	One-year fix Deposit (Average of 5 Thai banks)	Thailand inflation rate
Accumulation	491.70%	206.30%	14.10%	−13.30%	35.10%
Average	20.10%	10.70%	3.90%	3.70%	2.80%

*S*ource: Thailand stock exchange market, Thailand commercial department, and Bloomberg [1]

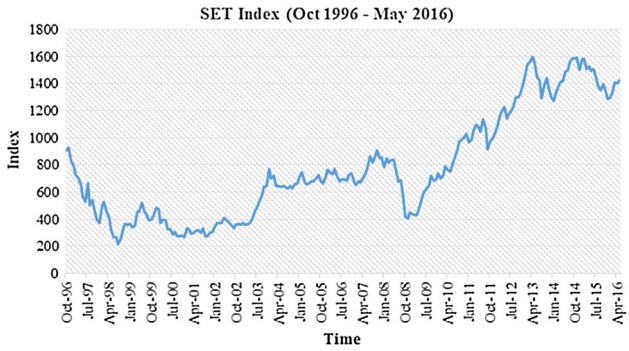

Fig. 1 The approximately 20 years of SET index [3].

Despite the fact that the return from stock investment in Thailand is high, the population of stock traders remains low. There are only 1,278,884 accounts in April 2016 [2,3]. Only 494,624 of these accounts are active. According to a report, the estimation of total population in Thailand in 2016 is 65,987,689 [4], which mean that less than 2% of the total population are investing in the stock market. Furthermore, this reveals that approximately only 1% of them are active.

In the long term consideration, the growth of the stock market in Thailand is increasing as see in Fig. 1. Anyway, if the investors consider only few information and spent a short time to invest, they might lose their money. Since the real world market the price always swings to correction the real price of the stock and recheck the business profits. One of the main obstacles which prevent the majority of people to enter the stock trading is the difficulties to understand the fundamentals of the investment as well as the information on each stock. The total of more than 700 stocks in 25 sectoral indices of the eight industry groups can cause major confusion to inexperienced traders. Many of the new investors decide to stop their investment after losing profits. An efficient decision support system which can help the new investors to achieve a favorable return will highly likely to increase the attractiveness of a stock exchange industry. This will increase funding flow in the market and ultimately make the economy sustainable. Despite the low percentage of current investors in Thailand, the number of new traders seems to be gradually increasing. To encourage this growth, stock broker agencies have developed several software tools for investors [5]. Most of these software are online platform and can be distributed and accessed conveniently. Yet, in order to efficiently harvest the software, the investors still need to have a certain level of experience therefore they can manage and set some criteria of the stock analysis by themselves. Currently, two popular stock categorization system involves the fundamental and the technical analyses. Firstly, the fundamental analysis is used to analyze the real value of the stock, to cluster and select the profitable company's shares and evaluate the growth opportunities. Secondly, the technical analysis is an analysis method to find the right moment to buy or sell shares. Combining both methods together, it is able to pick high potential stocks. This helps the investors to buy or sell them at the right moment, resulting in reduced risks of loss [2,16]. This research combines the advantages of both aforementioned stock analysis methods to advise the investors on high potential stocks and appropriate trading times. This research extends the concept of [6], which proves that using the fundamental information to analyze the stock selection results better yields than using technical analysis. It enhances the capability of the previous system by suggesting appropriate timing to trade the stocks. In this research, ten popular financial criteria defined in [7–9], are processed by a multilayer perceptron (MLP) neural network in the fundamental analysis. The second section of this paper describes two main methods for stock analysis, including fundamental and technical analysis. The third section is the stock clustering investigation section and the objective to cluster stocks in this paper. The fourth section of this paper discusses the overall structure of the system. The experimental results and the conclusion are in Sect. 5 and 6 respectively.

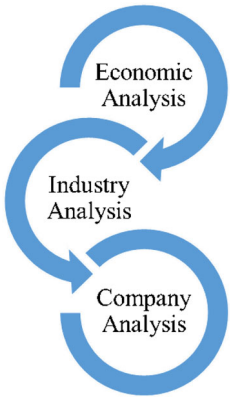

Fig. 2 Top-down fundamental analysis

2 Categories of analysis methods

Two main theories are implemented in this research. Firstly, fundamental analysis is used for selecting the stocks. Secondly, technical analysis proposes the most appropriate timing or the trading.

2.1 Fundamental analysis [6]

Fundamental analysis in this research is a top down approach to project the actual value of a stock. It collects information from three business layers, i.e. from economy to industry and, finally, the company (see Fig. 2). Firstly, fundamental analysis investigates the economy, both globally and nationally, by focusing on essential financial information such as gross domestic product (GDP), industrial production, producer price index (PPI), inflation rate, interest rate, and employment rate. This information indicates the market attractiveness. Then, the analysis moves on to national industry level. Information on each business sectors such as total sales, price levels and data on competitions, are used to locate the most attractive industry. Finally, fundamental information on each company in that distinguished industry, such as revenues, earnings, potential growth, profit margins, current market price, business policy, and return on equity, are used to project the actual value of its reality, resulting in the identification of the most attractive stocks.

2.2 Technical analysis [19]

Technical analysis studies the stocks past financial behaviors and use them to predict their future movement. This helps investors to allocate the most appropriate period to either perform or not perform the trading. Generally, technical analysis involves three principles. Firstly, "Price discount everything" means that technical analysis regards that market price already reflect all essential information on the stocks. This includes economic factors, financial factors and market psychology. As a result, the price movements are an adequate

Fig. 3 Principles of technical analysis

information for analysis. Secondly, "Price move in trend" reflects that the movement of the price is more likely to follow its historical direction than against it. Finally, "History repeat itself" indicates the repetitive nature of the stock market. Despite of the turnover of traders, changing technologies and key player in the business, price movements are likely to have a particular development pattern. Figure 3 illustrates the principles of technical analysis.

With technical analysis, it is possible to forecast future movements such as moving averages, price pattern, candlesticks and other indicators. Figure 4 illustrates a model which suggests appropriate time to buy, sell or hold the stocks. This model is created by information from technical analysis.

3 Stock clustering investigation methods

There are many algorithms proposed for the stock analysis system. The basic idea is using the historical index of the stock exchange market as a dataset to predict the trend of the stock. Many interesting ideas are proposed to develop the decision support system for stock analysis. The correlation analysis of the stock price volatility and the online information sentiment are used for demonstration of the effect of sentiment of stock value in [8]. Similar idea indicating that news affected a stock price led to the algorithm proposed in [9]. The other popular ideas involve using statistic techniques and information of stock index to analyze trends of the stock market [10–13]. This research attempts to increase the capability of a stock analysis system by adding the use of information on the real performance of stock companies to the normally used data on stock index. Classification and clustering techniques are implemented to manage the supervised and unsupervised dataset. Firstly, the unsupervised information about companies operation are clustered by specific objective that is to screen the consistently high performance companies. Secondly, the companies are labeled by clusters they belong to and this information is used to create the classification model. There are more than 700 active companies in Thailand Stock market in 2016. In order to apply fundamental factors to filter for high performance companies, their consistency of operation is one of the most favorable factors. Thailand stock market has operated since 1975, thus any companies which have the record of 10 years consistency are considered as the first priority. As a result, the fundamental information of 300 companies, which have been operating consistently from 2004 to 2013

Fig. 4 Example of a recommendation system based on technical analysis [7]

Fig. 5 The 10 years profit versus 10 years returns scatter plot graph of 300 companies in Thailand stock market

are considered. Firstly, all basic information about company statement are analyzed to calculate the accumulated profit during these 10 years as well as the return of each stock. The return of each stock is calculated by the summation from the 10 year margin, capital gain and dividend yield. The performance of the companies in the stock market is illustrated in the scatter plot in Fig. 5. The x axis signifies the profit during their 10 years of operation, the y axis demonstrates the return of each stock during the same period. Each point represents the company that operates consistently in 10 years. The size of the point is the market capital, or the market value, calculated from the closing price multiply with a total share of each stock. The color of each point represents the profit ratio, the closer to dark color mean the higher profit of each stock.

There are many possible criteria to cluster the performance of these 300 companies. To achieve the general purpose of investors, the high potential companies group should have better returns than the 10 year average of inflation rates. The return of the best companies cluster should not only perform better than inflation, but also better than the 10 year average return of the average SET index [14]. In Fig. 5, class 1 represents the best returns companies cluster, class 2 represents the good returns companies cluster and class 3 represents the cluster of the companies those have returns of lower than the 10 year inflation rate. The concept of this section is applied to the experiment for the system design. The next section demonstrates how to verify that the fundamental information, can classify the class of the company's performance.

4 Overall structure of the system

The structure of the fundamental and technical integration system for stock filtration is categorized into three parts. The overall structure, including the fundamental analysis part, technical analysis part and the recommendation part respectively. Figure 6 shows the structure of the overall system. The details of all parts are described in the following section.

4.1 Fundamental analysis part

The high return stocks concept described in Sect. 3 is applied to cluster the companies. In order to apply this concept to classify the stock in the future, the companys financial statement is used to create the input parameters. Total 10 financial ratio values [6,16] are calculated using as the input variables

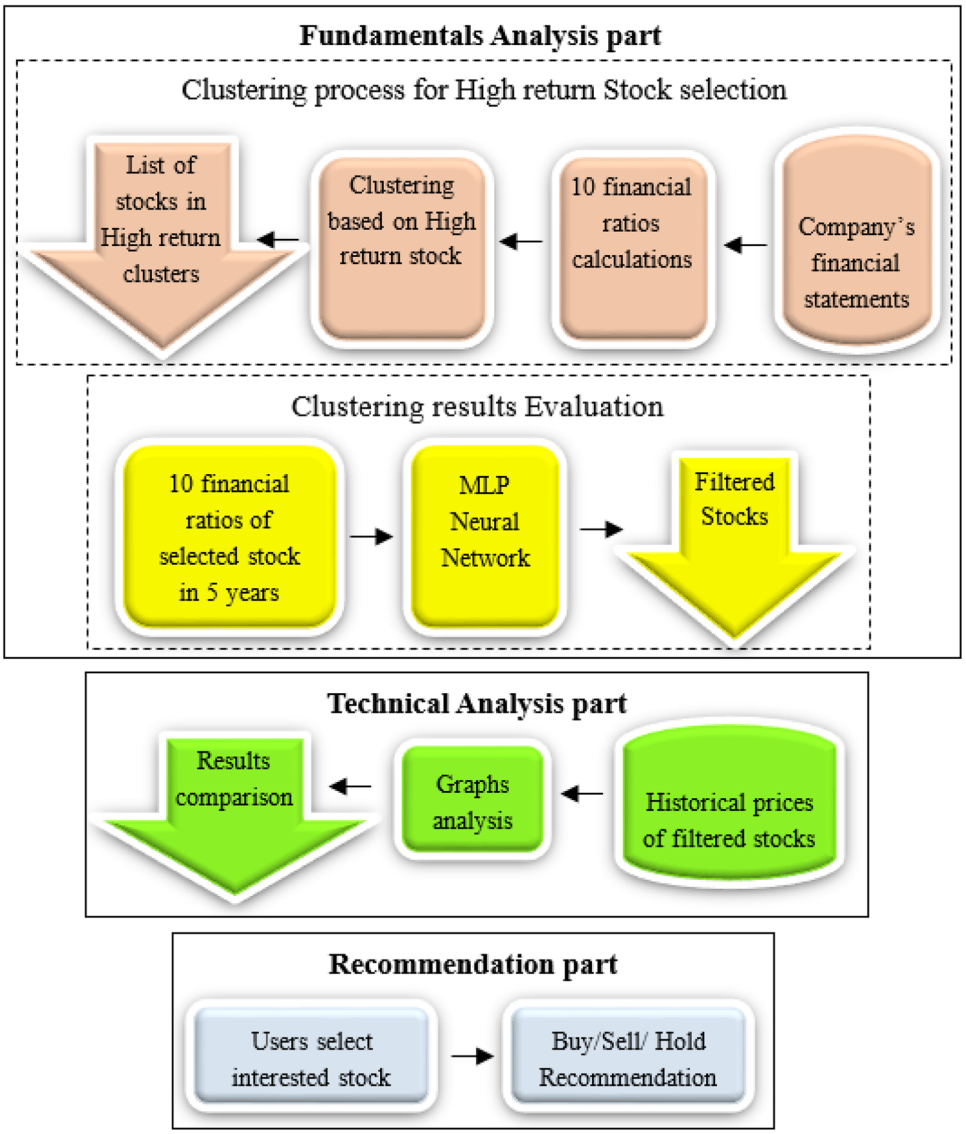

Fig. 6 Overall structure of the Fundamental and Technical Integrated System for Stock Filtration

of the classification model. The details of each parameter are displayed as follows.

Price to earnings ratio (PE): is the ratio to estimate the performance of the company, can be calculated as

$$PE = \frac{M_v}{EPS} \tag{1}$$

where M_v is the market value per share,and EPS is the earnings per share, usually derived from the last four quarters.

Book value per share (BVPS): is value to measure the valuation of the stock using the historical costs. The BVPS is calculated by

$$BVPS = \frac{(Tot_E - P_E)}{Tot_s} \tag{2}$$

where Tot_E is the total shareholder equity, P_E is the preferred equity, Tot_s is the total outstanding shares.

Return on equity (ROE): is value to measure the profitability of the company [15]. The value can estimate the ratio of company profit generation with the invested money of shareholders. The ROE can be calculated as

$$ROE = \frac{Net_{in}}{S_E} \tag{3}$$

where Net_{in} is the net income for the full fiscal year, before paying dividends to the common stock holder but after dividends to the preferred stock. S_E is the equity of shareholders, not include preferred shares.

Dividend payout ratio (DPR): is the value to estimate the ability of company's earnings can support the dividend payment. The DPR defines the percentage of net income per common share, calculate as

$$DPR = \frac{DPS}{DPS} \tag{4}$$

where DPS is the annual dividends per common share, and DPS is the earnings per share.

Dividend yield (DY): is the indicator of how much the company pays the dividend to the shareholders. The DY can be calculated as

$$DY = \frac{DPS}{PPS} \tag{5}$$

where DPS is the annual dividends per common share, and PPS is the price per share.

Price to book ratio (PB): is used to compare the market value of the stock to its book value. The low PB value can imply that the stock is cheap or the company has something wrong with the fundamental information. The PB is calculated by

$$PB = \frac{P_s}{(Tot_a - Int_a)} \tag{6}$$

where P_s is the stock price, Tot_a is the total asset, and Int_a is the intangible assets and liabilities.

Total current asset (CA): is the accounts that present the total value of all assets. The assets, expect to able convert into cash within one year.

$$CA = C + C_{eq} + Acc_{rec} + Inv + S_{mark} + Ex_{pre} + Liq_{conv} \tag{7}$$

where C is the cash, C_{eq} is the cash equivalents, Acc_{rec} is the accounts receivable, Inv is the inventory, S_{markis} the marketable securities, $Ex_{pre}$is the prepaid expenses, and Liq_{conv} is the other liquid assets that can be readily converted to cash.

Gross debt service ratio (GDS): is the preliminary assessment about the potential borrower, whether it is too much or not. The value lower than 30% is considered an acceptable level of debt. The GDS is calculated as

$$GDS = \frac{P_{AM} + P_{tax}}{In_{Gross}} \tag{8}$$

where P_{AM} is the annual mortgage payments, P_{tax} is the property taxes, and In_{Gross} is the gross family income.

Current ratio (CR) is value to measure the ability of the company to pay the short-term and the long term obligations. The CR is calculated from

$$CR = \frac{Cur_A}{Cur_{lia}} \tag{9}$$

where Cur_A is the current assets, and Cur_{lia} is the current liabilities.

Fig. 7 The details of the training and testing dataset in each experiment

Earnings per share (EPS) Uis the value use as the company's profit indicator. The EPS usually use as the method to classify the outstanding shares, calculated by

$$EPS = \frac{(I_{net} - D_{ps})}{Avg_S} \tag{10}$$

where I_{net} is the net income, D_{ps} is the dividends on preferred stock, and Avg_S is the average outstanding shares.

The stocks are clustered into three groups, the cluster of high average profit is considered and divided into three classes, including class 1, class 2 and class 3. The neural network is used to evaluate the clustering results and the correlation of the proposed criteria. Class 1 is the most favorable, the stocks in this class have the return higher than the 5-year average return of the market. The stocks in class 2, also considered good, even they have the return lower than the 5-year average return of the market, but higher than the average inflation rate over the past 5 years. Finally class 3 is the stocks that have the return less than the average inflation rate over the past 5 years, the stocks classified in this class is not fed into the next part of the system. The outstanding stocks as the concept described in Sect. 3 is applied in 5 experimental to verify that the 10 fundamental parameters can use to classify the class of the stocks. The multilayer perceptron are used as the stock classification model. The 10-year historical data set of SET from 2004 to 2013 are divided into five groups. Only 300 from total companies, those are operating continuously during the considered period. The details of the training data set and the testing data set of each experiment are displayed in Fig. 7.

The 3-layer neural network is used as the classification model in this part. The structure of the model is 10-8-3, which mean 10 nodes in the input layer, 8 nodes in the hidden layer and 3 nodes at the output layer respectively. The Sigmoid function is used as the activation function in every node in the

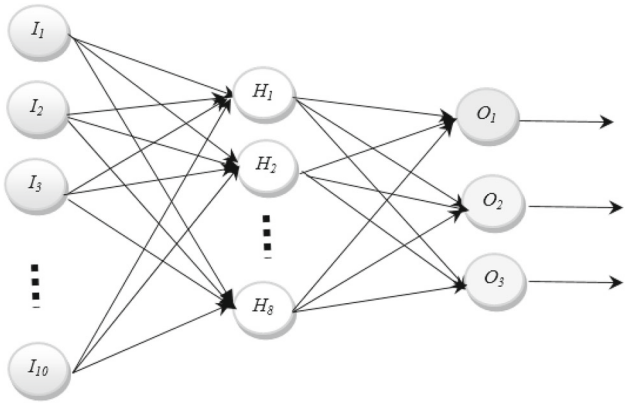

Fig. 8 Structure the stock's fundamental classification model

hidden and output layers. The structure of the fundamental classification model is displayed in Fig. 8.

The output from each output node is $o_j(n)$, and calculated by

$$o_j(n) = f(a_j(n)) \tag{11}$$

The value of $a_j(n)$ can be calculated as

$$a_j(n) = f\left(\sum_{i=1}^{n} w_{ij}(n)x_i(n) + b_j\right) \tag{12}$$

where $w_{ij}(n)$ is the weight between node i of the previous layer to node j of the current layer, $x_i(n)$ is the input from the previous layer, and b_j is the bias of each node in the current layer. The back-propagation algorithm is us to modify the weights and bias in the network. The error from each output node is calculate by

$$e_j(n) = t_j(n) - o_j(n) \tag{13}$$

In an equation (13) t_j represent the target output of each node. The weights of next iteration $(n + 1)$ are updated by

$$w_{ij}(n + 1) = w_{ij}(n) + \Delta w_{ij}(n) \tag{14}$$

The $\Delta w_{ij}(n)$ in equation (14) is calculate from

$$\Delta w_{ij}(n) = \eta \delta^i_j(n) x_i(n) \tag{15}$$

where η is the learning rate that identify by the developer. The $\delta^i_j(n)$ is the gradient calculate from

$$\delta^i_j(n) = \begin{cases} e_j(n) f'(a_j(n)); \, outputlayer \\ f'(a_j(n)) \sum_{i=1}^{k} \delta^l_i(n) w_{ij}(n); \, hiddenlayer \end{cases} \tag{16}$$

In an equation (16) the $f'(a_j(n))$ is the differentiation of the Sigmoid activation function.

4.2 Technical analysis part

The stocks classified as class 1 and class 2 are fed to the interesting stocks list. The second part is using technical analysis to find the proper time to suggest the investor to trade. Many technical algorithms are used in the stock value trend analysis [16,17]. Four commonly used of the technical analysis algorithms [18,19] are applied in the preliminary experiment in this research. The first technique is the Moving Average Convergence Divergence (MACD). The MACD is an index that tracks the price trends. The value is calculated from the 2 difference on a moving average of the historical prices. If the MACD is high, indicates that the price trend is upward. On the other hand, if the MACD is low, reflecting the downward trend of stock prices. The second technique is the Exponential Moving Average (EMA). The EMA is a type of moving average of the historical prices. The EMA gives more weight to the latest data. The trend of the prices indicates by the exponent values those plotted on the price chart. The third technique is the Stochastic Oscillator (STO). The STO is a technical index that measures the momentum of the closing price compared to the price range over a specific time period. The time period of the moving average of the market movements is sensitive to the oscillator. The positive value of STO shows that the prices are likely to rise trend indicates that the stock price will rise further, and vice versa the stock prices are likely to go lower if the STO value is negative. The last technique is the Relative Strength Index (RSI). The RSI is a momentum indicating the swing of the price, attempt to determine the condition of overbought and oversold. The high value of RSI indicates investor to buy the stock rather than sell it. On the other hand the low value of RSI shows that investor should sell the stock rather than buying. From the experimental results, combined with the objective that good investment should not invest too frequently. The EMA is selected to use in the technical analysis part of this research. The reasons are EMA provides the highest profit and the average period of holding the stocks is not overly short. The exponential moving average in the n days, , can be calculated as

$$EMA(n)_t = m * (C - EMA(n)_{t-1}) + EMA(n)_{t-1} \tag{17}$$

where $EMA(n)_t$ is the value of $EMA(n)$ on considered date, $EMA(n)_{t-1}$ is the $EMA(n)$ value of the day before, n is the number of days in the considered period, C is the current closing value of the stock, and m is the smoothing constant.

The proper smoothing constant [20] calculate by

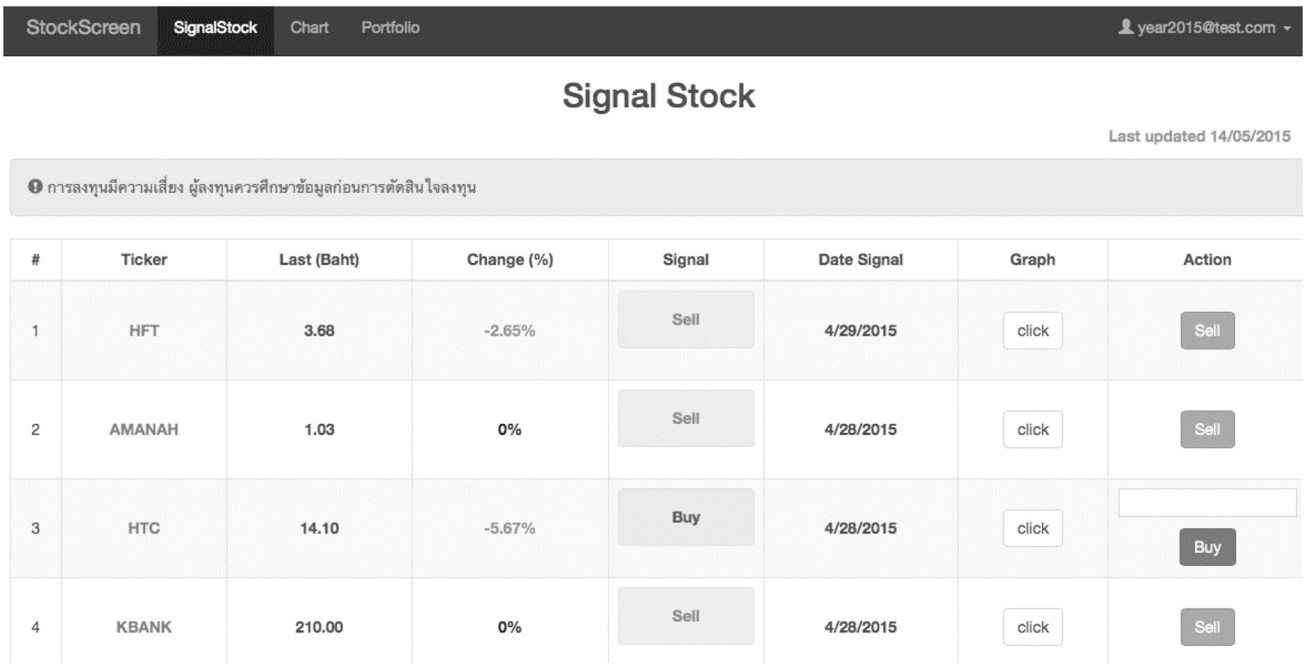

Fig. 9 Example display of the signal stock menu

$$m = \frac{2}{n+1} \tag{18}$$

where n is number of day in the considered period. The initial value of $EMA(n)$ is estimated by using $SMA(n)$, calculate from

$$SMA(n) = \frac{\sum_{i=1}^{n} P_i}{n} \tag{19}$$

where $SMA(n)$ is Simple Moving Average in days, n is total desire day, and P_i is the closing value of the stock on day i.

4.3 Recommendation part

The final part is the recommendation part, the list of high return stocks, those classified as class 1 and class 2 from fundamental analysis part are listed for the investors. Each investor can select their own interested stocks from the list. This part provides maximum 30 interested stocks for individual investors. The added stocks are fed into the second part using the technical analysis to suggest the trading action. The investor can use the recommend actions from this part to support their trade decision. The display of this section is divided into three parts: a signal stock, charting and portfolio. The example of the signal menu is shown in Fig. 9.

In Fig. 9, column 'ticker' is the list of the individual investors selected stocks those system recommend to buy or sell are displayed. Column 'date signal', displays the date that the recommendation started. Investors can make their final decision by clicking the buy or sell button in column 'action'. The 'click' button in column graph, links to the Chart menu as displayed in Fig. 10.

The graph of each stock is displayed in the chart menu. The information, including the EMA (20) and EMA (60). The stock prices, including open, high, low and close are displayed. The candlesticks represent the margin of the open and close prices. The period of time to display the graph can be adjusted at the top left menu.

Figure 11 is the display of the portfolio menu, which summarize the total profit or loss of the investors own stocks.

5 Experimental method and results

The experiment from each part of the overall structure results as follows. Firstly, the results from the fundamental analysis. The 10 years of financial report of companies in Thailand stock market are utilized to generate two features including the 10 year average profit and the 10 year return. The preliminary clustering results are displayed in Fig. 5, the red circles represent the stocks those have high average profit, the orange circles are stocks, those have good average profit and the green and yellow circles are stocks, those have low average profit. The size of the circle represents the difference of the price in 10 years. Only 300 companies from more than 700 active companies of the cluster represented by red circle are listed as an interesting stock for the fundamental analysis in the next step. The 10 years of historical information are divided into five experiments to verify the correction to the proposed ten criteria and the high average return and profit

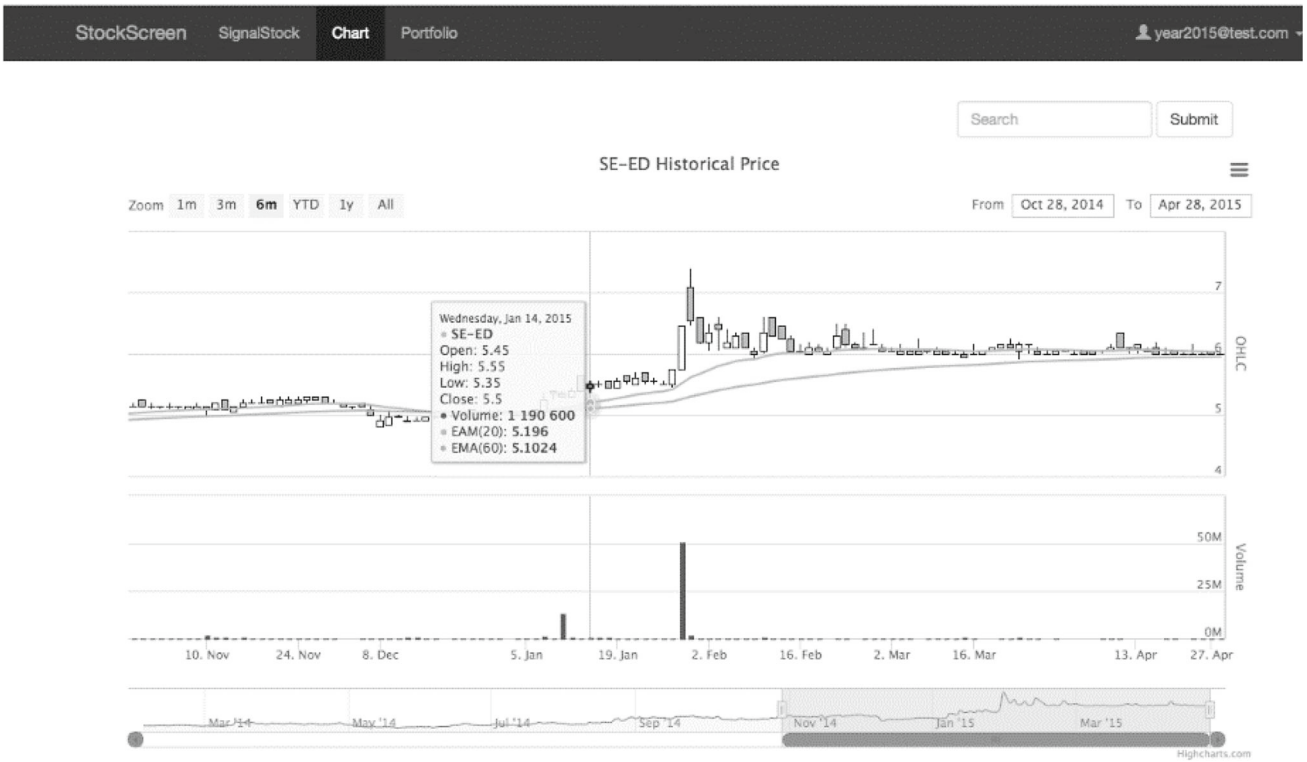

Fig. 10 Example display of the chart menu

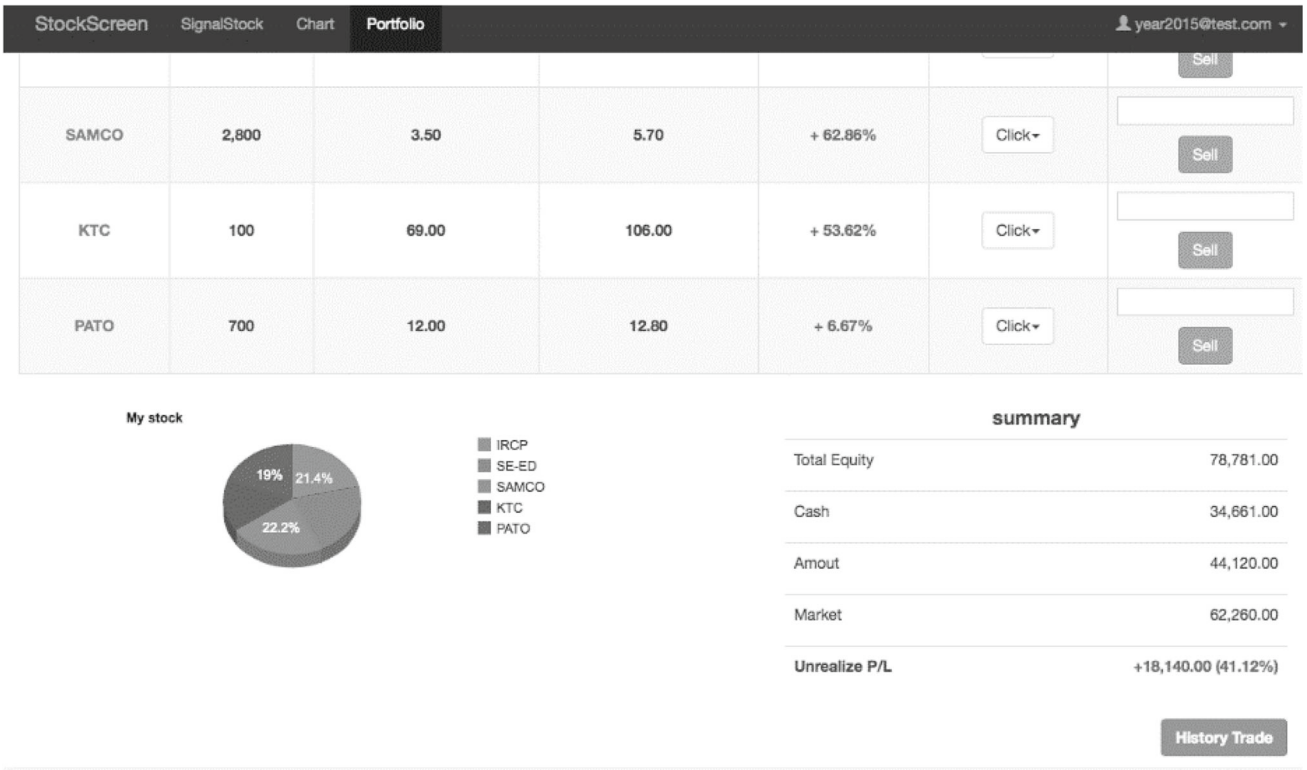

Fig. 11 Example display of the portfolio menu

Table 3 The classification results from the MLP in fundamental analysis part

Year	Accuracy
2009	89.50%
2010	63.20%
2011	82.10%
2012	83.10%
2013	91.60%

Table 4 Please write your table caption here

Tool	Average Earning (%)	Average chance to profit (%)	Maximum loss (%)	Average hold days
MACD	14.07	39.13	−5.39	34.96
RSI	-4.01	44.51	−9.32	65.63
EMA	22.23	49.63	−4.52	65.92
STO	9.95	63.73	−3.39	30.79

of the stock. The stock classification, based on 5 years historical information on the ten financial ratios is used as input to the MLP to classify the high return stock in the year 6. The structure of the MLP is 10-8-3 designed according to the principles MLP to achieve better performance without requiring sophisticate calculations [21]. The number of nodes in the next layer should be available in approximately 75% of the previous layer node.

The evaluation of 5 years classification models of a stocks classification is shown in Table 3. Each row shows the percentage of correct classification of the stock performance. The accuracies from year 2009 to 2013 are 89.50%, 63.20%, 82.10%, 83.10%, and 91.60%, respectively. The average of the 5 years in the experimental is 81.90% which very favorable. The experiment of the second part is the return results from using four aforementioned technical tools. It simulates the trading based on buy and sell signals from each technical tool. Total 5000 experiments are simulated using each tool. The starting budget of each experiment is 1 million Baht. The term of the acquisition is set to be not more than 10 stocks and the value of each stock is limited to not more than 10% of all available funds. The real value from the Stock Exchange of Thailand during September to December in 2014 is used in the simulation.

Table 4 summarizes the results from the technical analysis. The first column signifies the four techniques used in the experiment. The second column, average earning (%), is the average results the experiments. The average chance to profit, the third column, is the percentage of the total experiments that return in profit. The fourth column, maximum loss, is the maximum percentage of the experiment which ultimately result in loss. Finally, the average hold days show the average days the stocks are held before being sold. It can be seen from Table 4 that two of the four techniques, EMA and STO have the more preferable results. Indeed, EMA results in the best average earnings (22.23%). Although the chance to profit of this technique is less than the STO, but in the long run, the high average earning is more compelling. Each loss from EAM is acceptable while the profit margin is satisfactorily high. The number of days to hold the stock is not too short, so the investors do not need to trade often. On the other hand, RIS does not return an adequate result considered from its negative average earning. MACD, in contrary, seems to perform better than RIS. Yet, all of its yield are noticeable lower than EMA. As a result, EMA is selected as the most appropriate technical tools to be implemented in this system.

Indication signals to buy or sell of each stock use EAM20, shown by the blue line and EMA60 shown by the red line. Buy Signal is activated when the EMA20> EMA60 or blue lines is start moving above the red line. Sell Signal is activated when the EMA20< EMA60 or blue line start moving below the red line [22] as shown in Fig. 12. The final experiment is to test the integration of the stock filtering system with strong fundamental and technical factors. The objective is to test the functionality of the decision support of the developmental system. The settings of the trail are described as in Table 5.

The initial capital of each port is 100,000 Baht The test data is derived from the actual trading from Stock Exchange of Thailand during 01/01/2015 02/25/2015. Total of 5000 investors buy and sell stocks according to the recommendation from the system. The trade is committed on the next day after receiving the signal from the system. The maximum number of stocks per port is 10. The investors do not buy more stocks than 10 of total equity. If the system recommended to buy more stock than the port can hold, the investors will randomly buy the recommended stocks. The prices of the stocks are based on the actual data from the date that the transactions take place. In other words, the system will recommend the trade from today's stock value while the investment will take place and be calculated from tomorrow's worth.

The results of the experiment are shown in Table 6. The average return of the simulated 5000 yield significantly higher than the increase in the stock index.

The simulated investors make an average of 19.05% profit within less than 2 months. On the other hand, the rate of return of the stock market from SET index gained only 6.75%. In other words, the developed system yields 12.31% higher return than the stock market. This signifies the effectiveness of the techniques used in the system.

6 Conclusion and discussion

This research proposes a decision support system for stock investors based on two analysis techniques, i.e. fundamental analysis and technical analysis. It is intended to assist inexperienced traders to consistently choose their stocks and time

Fig. 12 Example of EMA technique use in action system

Table 5 The details of the experiment

Topic	Details
Number of investors	Total 5000 portfolios are generated to represent 5000 individual investors
Number of interesting stocks	Each investor can select not more than 10 stocks in their ports
Condition to buy stocks	Each time to buy the new stock in port, the total money to invest should not over 10% of total equity
Final decision	To simulate the real world situation, each port is randomly following the recommendation of the system
Buy or Sell condition	Buy or sell will be operated on the next day at the open price, after the signal from the system

Table 6 The results from the system compared to the stock market (SET Index)

	Start date	End date	Return
SET Index	1497.67	1598.66	6.74%
Average 5000 ports	100,000.00	119,052.00	19.05%

of trading. The fundamental analysis is the combination of two steps work, including clustering for high average profit stocks selection. The second step is using the 10 proposed criteria as input in neural network and verify the correlation with the highest potential stocks from clustering step. While the technical analysis is used for selecting the most appropriate period for trade actions. The results demonstrate that, based five experiments on 5-year historical data from the stock market of Thailand, totally 10 year period those include both "Bull" and "Bear" market, utilizing the fundamental factors to create an MLP classification model leads to an effective filtering of stocks with high performance. This is consistent with the principles of fundamental analysis, which is generally implemented to select profitable stocks. Then, the technical factors using EMA recommends suitable time of trading which subsequently yields a satisfactory average outcome on investment. The simulated investments based on the recommendation of the created framework show a promising performance. Their average yield is significantly higher than the increase in the market index. This work proposes the new combination of 10 criteria for stocks clustering, the elite and accuracy shown from 10 year period information. The favorable results demonstrate by the extend usage, which the combination with technical analysis and verify be the genuine circumstance of information in the year 2015. Nevertheless, this experiment is still in its investigation period. In fact, investments also have other external factors that investors need to consider before trading. It is unfortunate that such additional historical data on the Stock Exchange of Thailand are stored separately and some of them are not entirely available to public. This makes the complete information collection and preprocessing processes sophisticated. An assistive system which can draw data from several databases will potentially be an proficient apparatus or a number of applications for stock analysis.

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