Forecasting System by Smoothing Method
For Trading in Stock Exchange of Thailand (SET)

ระบบพยากรณ์ราคาหุ้นโดยวิธีปรับให้เรียบ
สำหรับการซื้อขายหุ้นในตลาดหลักทรัพย์แห่งประเทศไทย

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บทคัดย่อ

การผนวกเทคโนโลยีสารสนเทศและการวิวัฒนาการทางวิทยาศาสตร์ข้อมูล (Data science) ได้พัฒนาขึ้นโดยใช้ระบบคอมพิวเตอร์สำหรับการพยากรณ์ราคาหุ้นที่ซื้อขายในตลาดหลักทรัพย์แห่งประเทศไทย ตามหลักนั้น ลักษณะเฉพาะของสภาวะแวดล้อมมักมีอิทธิพลต่อราคาหุ้นในแต่ละประเภทธุรกิจโดยมีนัยสำคัญที่แตกต่างกันดังนั้นจึงมีความจำเป็นที่จะต้องใช้วิธีการที่แตกต่างกันในการพยากรณ์ราคาหุ้น งานวิจัยชิ้นนี้นำเสนอระบบการพยากรณ์ราคาหุ้น (Stock forecasting system) โดยการใช้เทคนิค 3 แบบของวิธีการปรับให้เรียบ (Smoothing methods) คือ เทคนิคค่าเฉลี่ยเคลื่อนที่ (Moving average) เทคนิคค่าเฉลี่ยเคลื่อนที่ถ่วงน้ำหนัก (Weighted moving average) และเทคนิคปรับให้เรียบแบบเอ็กซ์โปเนนเชียล (Exponential smoothing) ซึ่งทุกเทคนิคที่ใช้นำเสนอกระบวนการการพยากรณ์ราคาซื้อขายทั้งหมด 5 รูปแบบ ได้แก่ ราคาเปิด ราคาปิด ราคาสูงสุด ราคาต่ำสุด และราคาปัจจุบัน (Real time) ระบบนี้ได้ออกแบบให้มีความยืดหยุ่น เพื่อให้นักลงทุนสามารถกำหนดเงื่อนไขที่จำเป็นต้องระบุได้ด้วยตนเองสำหรับแต่ละเทคนิคของการพยากรณ์ แทนที่ผู้เขียนโปรแกรมจะเป็นผู้กำหนดเงื่อนไขเหล่านั้นแต่เพียงผู้เดียว ประโยชน์ของการใช้ระบบนี้คือมีการนำเสนอข้อมูลทั้งในเชิงพรรณนาสถานการณ์ของตลาดหุ้นที่ซื้อขายในตลาดตามความเป็นจริงและข้อมูลเชิงวิเคราะห์ (Diagnosis) โดยการพยากรณ์ราคาหุ้นนี้ได้ตอบสนองผู้ลงทุน เพื่อนำไปใช้ประกอบการพิจารณา

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ตัดสินใจในการลงทุน นอกจากนั้นแล้วผลงานวิจัยนี้มีส่วนช่วยส่งเสริมการเติบโตของเศรษฐกิจโดยรวม
ผ่านการลงทุนที่เพิ่มขึ้นในตลาดหลักทรัพย์แห่งประเทศไทย

คำสำคัญ: ตลาดหลักทรัพย์แห่งประเทศไทย, พยากรณ์ราคาหุ้น, ค่าเฉลี่ยเคลื่อนที่,
ค่าเฉลี่ยเคลื่อนที่ถ่วงน้ำหนัก, ปรับให้เรียบแบบเอ็กซ์โปเนนเชียล,
ค่าคลาดเคลื่อนกำลังสองเฉลี่ย

ABSTRACT

The convergence of information technology and data science innovation is developed using a computational base as a stock price forecasting system offers trading in Stock Exchange of Thailand (SET). Traditionally, a particular circumstance of each business may influence different patterns in time-series of stock price, so it requires different techniques to forecast the prices. This paper presents the forecasting system which employs three techniques of smoothing methods: moving average, weighted moving average and exponential smoothing. All techniques provide the process to forecast five types of trading prices: open price, closed price, maximum price, minimum price and average in real-time price. This system is flexibly designed and allows investors to be able to specify the input conditions for the particular predictable techniques in conformance to each technique instead of using the programmer restriction. The result of the system implementation provides descriptive information, including reports of market situation and diagnosis of predictable prices so as to serve investors for consideration and decision for investment. This contribution would aim to promote economic growth by stock markets as a whole.

Keywords: Stock Exchange of Thailand (SET), Stock Forecasting, Smoothing Method,
Moving Average, Weighted Moving Average, Exponential Smoothing,
Mean Square Error (MSE)

Introduction

The stock market now becomes a global business. The trade flows of stock market and its index can affect the national economy; for example, a case of progressing economy in a booming period would reflect the increment of stock market index. The stock market index

can be used as one indicator for economic creditability. Many countries have established stock markets to promote their economic growth. Thailand has also appointed this strategy to a five-year plan of "National Economic and Social Development Plan to support the promotion of economic growth and stability as well as to develop the Kingdom's standard of living" in the year 1961. Hence, Thailand Capital Market was established in order to support the national plan to promote economic growth and mobilize additional capital for national economic development. The first trading of stock was officially started since 1975 under the name "The Securities Exchange of Thailand" and the name was formally changed to "The Stock Exchange of Thailand" (SET) in January 1, 1991 (SET, 2017).   Significantly, many Thai people, institutes, the organizations both the private and the public sectors increasingly have the interests to invest in the stock markets of Thailand.

Presently, many Thai businesses are trying to enhance their company profiles by proposing the companies to be members in stock markets or Stock Exchange of Thailand (SET). They organize activities to promote their companies and file the required information for trading their stocks officially in a stock market. On the other hand, a lot of people have experiences on trading stock in SET market. It is a crucial market that can bring new generation of people participated with this business. Although it is not difficult to trade the stock, it is not easy to make profits. In such a case, some investors can gain a lot of profits in a short time while others may lose a huge amount of money. There are both successful and failing traders at a particular period of time. Some people may consider investing in a stock trading as gambling because there is no certainty of investment. Even though most investors cannot predict the accurate trend of individual stock price or even the whole market, they are still interested in the realm of stock market by chance without having any experiences or by word of mouth from a successful investor. However, they have not learned how to invest wisely of their asset.

The system of stock market at present provides the investors to manage by themselves via the Internet online. Meanwhile, it provides the fare public information about the market and stakeholders. The investors can use this information as a criterion for their consideration before the investment. Hence, information technology has been developed over the time. Now it is transformed during the era of business intelligence (BI). Most of the activities in the business intelligence and analytical platform are driven from descriptive to diagnostic patterns, including predictive and prescriptive analysis. It aims to decentralize the empowerment of organization to perform diagnostic analytics. The analytical information is simply reported in a form of single page which the information can be distinguished into three important features: monitoring, analysis and management. Hence, only one screen of

computer base could bring to a high performance management in business (Ramesh et al., 2014). Convergence of information technology and statistical theory could bring the new paradigm of data technology at this period and could help manage to make a decision efficiently. This innovation could bring the researchers with great effort to develop the system in relevant to the investment in a stock market.

One challenging task of investors is learning how to cope with the vulnerable situation in a stock market. The long-run of investment in a stock market is how well the investors can anticipate the future variation. They should attempt to develop an appropriate strategy to obtain the competitive advantage and earn profits from their investment. Wise investors probably learn and experience with planning for the future. They can search for a reliable method to predict or forecast the possibility of the future trend indexes and individual prices. Forecasting is a very challenging task that can result in improving the business performance in various industrial and managerial operations (Jay and Barry, 2014). An accurate result from forecasting method could help a manager to manage and make decision efficiently so as to profitably gain from the organization.

This paper presents the development of computer-based application systems to forecast stock prices from a stock market in Thailand. The forecasting process is implemented and integrated using the three techniques of smoothing method: moving average, weighted moving average and exponential smoothing. The forecasting targets five trading prices: close price, open price, low price and high price and average price. These variables are interesting and would be worth taking into account when investing in a daily trading. This systematic approach aims to offer an appropriate alternative for investor's decision in conformance with the time series of the actual trading.

Literature Review

There are two approaches that are wildly used in forecasting: qualitative and quantitative (Jay and Barry, 2014). The quantitative approach is categorized in association with time-series method, which would be used with the assumption of the future as a function of the past. Conceptually, time series data consist of four separate components: trend, cyclical, seasonal and irregular in combination with specific values provided for the time series (David et al., 2011). Thus, it is an appropriate method for usage as it can predict the trading prices in a stock market. Meanwhile, regression, an associative forecasting, is usually considered altogether several variables (factors) in relation to the quantity.

There are many factors to be considered by investors to pursue their investment such as company's profile, dividends, stock price and consumption. Over the last three decades, Asian economy was notified by the sign and trading activities from Hong Kong and Japanese stock market. These two developed countries become a magnet in Asia, which bring a lot of investors from both Europe and the United States to invest in this region. They have been the prominent stock markets in Asia and all around the globe. Their stock indexes are very challenging to be predictable by many investors and earn the profits from them. During 1990, T.C.E. Cheng Y.K. Lo K.W. Ma, *et al*. (1990) used the multiple regression analysis techniques to forecast Hong Kong stock price indexes. They considered four factors: unemployment rate, trade balance, consumer price index and money supply in order to evaluate the stock price indexes. The result of their work showed that these factors are significant leading to the stock price indexes. The data used were depicted from the daily closing price. To conclude, these models can be used in the real situation to enhance the investment in the stock market.

Macroeconomics is influenced by the stock market as shown in the work of Angela J, *et al*. (2015). This work studied the connections between stock markets and macroeconomics using the theoretical information to guide an empirical investigation about the collective long-run relationship among stocks price, dividends, output and consumptions. They use regression method to analyze the data. Moreover, the result found that there is a relationship between stock price and dividend variables as the output responds to the changes in stock equilibrium. This work is the proven ability using information technology to manage the stock market as it affects global business. The global economy has been affected by a stock market as shown in the research work of Monica Sinhania (2013). This work revealed the volatility of stock returns as it impacted on the global financial crisis.

The assumption of the time forecasting series model is based on the past for future forecasting. This model is widely used in different types of business such as supply chain, production, sales and stock market. There are three simple linear functions of the time series forecasting model: moving average, weighted moving average and exponential moving average which are appropriate for litter record keeping of the past data and are fairly used to predict the future. These functions are employed to forecast weekly sales of Nike Air Jordans and quarterly earning report of Microsoft stock. (Jay and Barry, 2014). Dow Jones Industrial Average, a stock market index industry also employed time-series to predict future values of the global market with accuracy (Wikipedia, 2018). However, under complex condition and large observation in forecasting function, the exponential smoothing would assign greater weight on more recent observation and the so called exponential weighted moving average (EWMA) would be used instantaneously. EWMA is an alternative property of Generalize

Autoregressive Conditional Heteroskedasticity (GARCH) model that Prateek Sharma and Vipul used in an experiment to forecast the daily volatility of each of the stock by using 3,395 observations from 21 stock indices. They reported that the result provides the best one-step-ahead forecast of the daily conditional variance and is a more robust choice of performance evaluation criteria for different market conditions and data-snooping bias. (Prateek and Vipul, 2015).

This research work to make use of innovation in technology and the time series forecasting technique to assist investors who trade stock in Stock Exchange of Thailand in real-time trading. The systems would consider the series of public data from market without the disturbance of environmental factor.

Stock Price Forecasting System by Smoothing Method for Stock Exchange of Thailand (SET)

A Stock forecasting by smoothing method is proposed to be used in the system of Stock Exchange of Thailand (SET) as a tool to assist the investors who intend to trade stocks in the stock market in Thailand. This proposed system is a comprehensive system that integrates three techniques of smoothing method: moving average, weighted moving average and exponential smoothing into a single system. It provides a result with appropriate options as an alternative to an investor's decision.

This system provides five important trading prices in daily: open price, highest price, lowest price and average price. These five categories of prediction could serve various types of predictable price for investors. The first category is open price. Some optimistic investors prefer to keep challenging during the day-time trading and perhaps expect to earn some profits during the booming economy, so the open price would be the option for their prediction. The second category is closed price. Some investors prefer to confront the risk using the following time F(t+1). Hence, they prefer to invest with the close price. The third category is the highest price. This is an alternative for the investors who hold stocks on hand; they expect to possibly sell their stocks with the highest profit as they can earn. The fourth one is the lowest price; it is an option for the investors who may consider buying the best price of stocks. The fifth option is the average price from real-time trading. The average price is the actual value that the system imports the data from Stock Exchange of Thailand (SET) through the website as www.set.or.th. With the average price from the database and the real-time trading, the system will calculate the time F(t+1) for the investor's consideration.

The system architecture is designed to serve investors on the Internet as a web-based technology using the concept of clients and server architecture (Kenneth and Julie, 2013, Kenneth and Jane, 2016). as described in Figure 1.
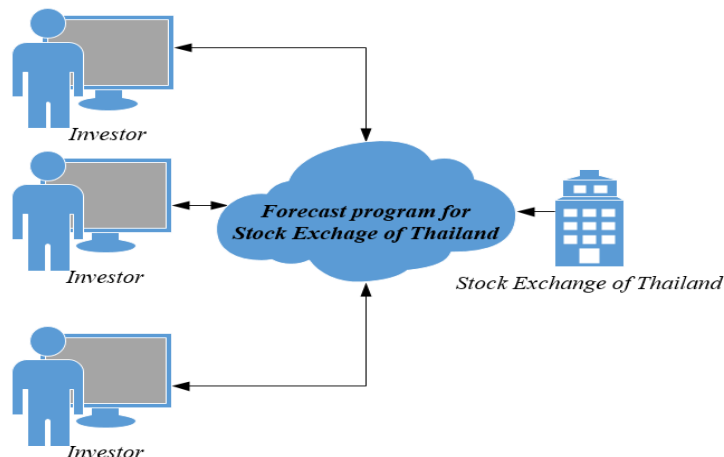

Figure 1: System Architecture of Stock forecasting system by smoothing method for Stock Exchange of Thailand

Each technique requires different conditions to calculate the prediction value provided by the program. Investors can specify the given condition required for each method by selecting the provided graphical user interface (GUI). GUI will activate to the forecasting techniques; WA is moving average, WMA is the weighted moving average, and EMA is exponential smoothing.

The expected outcome proves the information in a form of business intelligent report. The report reveals both the descriptive and analytic patterns to serve investors with three important features: monitoring, analysis and management. The descriptive report provides four categories of the top ten trading: top-ten value in monetary, top-ten trading in volume, top-ten gainer and top-ten looser. The monitoring view of information captures daily news which is posted from the stock market. From this alert news, the investors can read the reports of the current insightful circumstances of each company (stock) appeared with a sign of uncommon trading, which can be an indication of speculative stock. This process is terminated by implementing the process of regular expression and is searching for the trading price from the database on www.set.or.th as described in Figure 2. The process of this system works as described in Figure 3.

Get plain html contents from url;

http://www.set.or.th/set/historicaltrading.do?symbol=stock_code&ssoPageId=2&language=th&country=TH

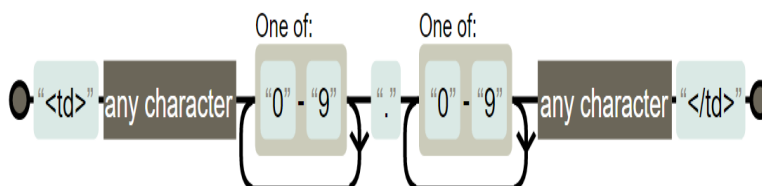*Regular Expression pattern: "<td>.([0-9]*\.[0-9).</td>"*

Figure 2: Regular Expression of checking the stock
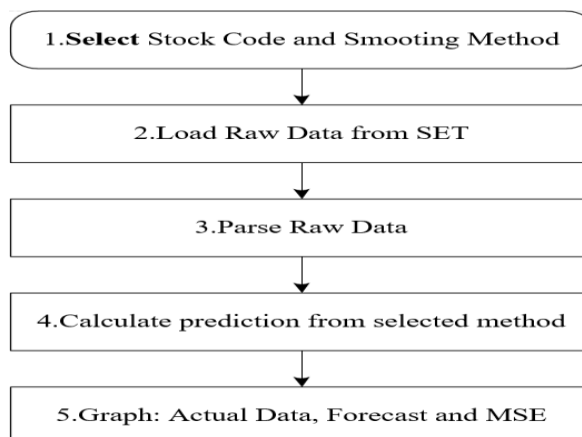
Source: set.or.th

Figure 3: The flow of Forecasting Process

The flow of data that is imported from www.set.or.th has been manipulated throughout the prediction process as described in Figure 4.
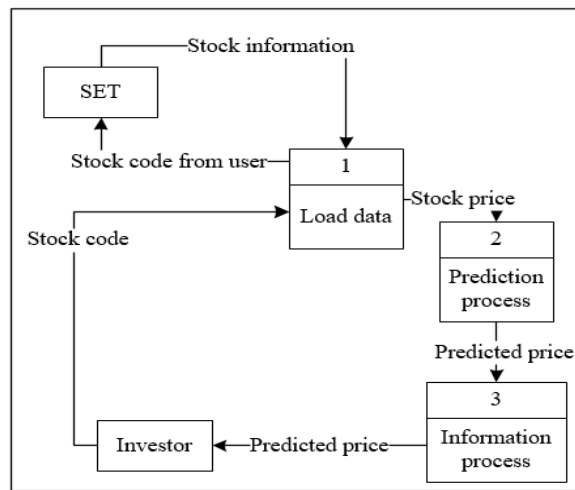
Figure 4: Data Flow Diagram of Forecasting Process

1. Moving Average Technique

Moving Average method uses the average of the most recent data point or the amount of trading points that will be considered. Then the investors will use it for calculation of the next value or forecasting value using the expression of equation 1.

$$Moving\ average = \frac{\sum(\text{most recent n data values})}{n} \tag{1}$$

The moving average process is constructed as the procedure;

Input: Price history of stock index in array A, Number of data values in N
Output: The moving average value

1	*Declare s*
2	*for i = 1 to N do*
3	*s = s+A[i]*
4	*End for*
5	*MA = s/N*
6	*Return MA*

To use moving average to forecast the price, the investors need to select the number of data values to be included in the moving average. The term moving means that every time a new trading price becomes available for time series, it replaces the oldest value. Then a new average is computed and the average will change (move). As a new trading price become available, there is no specific on the number of data values to be used in moving average. Hence, the approaches of trial and errors are drawn to be used, and the minimum MSE of

those numbers would be the best. [7] In fact, this system is very flexible as it allows the investors to specify the number of average.

2. Weighted Moving Average Technique

To use this method, it needs to assign the different weight values for each data point or each trading point. The concept is that the more recent trading the investors have, the better prediction is for the future. When the most recent trading data is assigned to the highest weighting in the index and weight decrease for the former data value, trading price of time $t_{(n-1)}$ will be assigned to the highest values rather than the date $t_{(n-2)}$ and so on. To use this method, firstly, the investors must select the numbers of trading data to be included in the weighted moving average. Then they can choose weighted average for each of the data value, and the forecasting value would be computed by equation 2. The requirement of selecting the weights for data value must sum to one.

$$\bar{x} = \frac{\sum w_i x_i}{\sum w_i}$$
(2)

Where

$\bar{x}$ = average item

w_i = weight of ith item

x_i = value of the ith item

The process of weighted moving average is constructed as the procedure;

Input: Price history of stock index in array A, Number of data values in N

Output: The weighted moving average value

```
1    Declare wma
2    for i = 1 to N do
3    wma = s+(A[i]*(i/N))
4    End for
5    Return wma
```

3. Exponential Smoothing Technique

This is a special case of the weighted moving average method in which only one weight is given to the most recent data observation as the last trading value. Then, the weights for the trading farther into the past would be automatically computed and become smaller. The

weighted given to the actual trading time t is α. Then the weighted to the forecast in period Ft is $(1-\alpha)$. This process is computed by equation 3.

$$F_{t+1} = \alpha Y_t + (1-\alpha)F_t \qquad (3)$$

Where;

$F_{(t+1)}$ = forecast of the time series for period t+1

Y_t = actual value of the time series in period t

F_t = forecast of the time series for period t

α = smoothing constant $(0 \leq \alpha \leq 1)$

The process of weighted exponential smoothing is constructed as the procedure;

Input: Price history of stock index in array A, Number of data values in N, actual price of yesterday in y price, the exponential smoothing of t-1 in lema

Output: The exponential smoothing value

    1   Declare ema

    2   ema = α *yprice+(1- α)*lema

    3   Return ema

This method provides the forecast of weighted average to all past of trading, but it will not be saved to compute the forecast for the next period. For instance, once the smoothing (α) is assigned, there are only two pieces of trading data needed to compute the forecast. The system provides the investors to assign smoothing constant (α) to weight for a certain stock code.

4. Forecast Accuracy Measurement

The accuracy of forecast is measured by mean square error (MSE). Conceptually, the desirable accuracy could be seen at minimum MSE, (Jay and Barry, 2014). and it is computed by equation 4.

$$MSE = \frac{\sum (Y_t - F_t)^2}{n-1} \qquad (4)$$

Where

Y_t = actual value of the time series in period t

F_t = forecast of the time series for period t

n = number of data to be used for consideration

To obtain small MSE, there are difference approaches for each technique. For instance, the moving average is selected for trial and error so as to identify the number of values and to minimize MSE. The same analogy is applied to the exponential smoothing; a smoothing constant (α) would be the trail of and compared to the MSE value before selecting the one (α) that produces the minimum MSE. The principle for consideration can observe the data pattern. If the time series contain substantial random or highly fluctuating variability, a small smoothing constant is better for selection. In case of the weighted moving average conceptually, the recent past is a better predictor in general than the old past, so the higher weighted average would be assigned to the recent trading data. However, when time series is highly variable in such a case, equal weight would be assigned to compute the forecasting and is applied to the system as it fit to the pattern of the trading pattern at this period. The system allows the user to indentify the number of data value to be weighted and also for each trial, the means square errors (MSE) will be automatically calculated for consideration.

Forecasting Results

To demonstrate the forecasting system, when the system is started up, the current trading information from SET is reported into the four categories of trade stock codes. Along with a descriptive report, the investors would see the real-time trading information from Stock Exchange of Thailand (SET). The reports reveal up to four categories: top-ten trading, monetary volume, the gainer, and the looser.

The example reports are described in Figure 5a, 5b, 5c, and 5d respectively. Each category report provides details of the stock name, quantity, monetary trading and changing percentage, increment or decreasing consideration. To gain the benefits from this report, the investors can notify various views such as monitoring the variability of each stock, observe the speculating signs. In case of the abnormal quantity trading from the history, the low consistence at a long-run may appear in a high volume with a very high percentage increment. The investors can redirect to check its historical trading prices and the company profile from www.set.or.th.

Top Value

หลักทรัพย์	มูลค่า AOM ('000 บาท)	ล่าสุด	เปลี่ยนแปลง (%)
PTT	5,920,304.05	56.50	- (-)
AOT	2,131,338.02	71.75	+0.75 (+1.06%)
EA	1,808,840.82	36.50	+1.75 (+5.04%)
IRPC	1,723,230.28	6.95	-0.10 (-1.42%)
KTC <XD>	1,613,345.40	348.00	+13.00 (+3.88%)
CPALL <XD>	1,580,474.15	87.00	- (-)
PTTGC	1,349,447.58	98.00	+1.00 (+1.03%)
SCC	1,335,341.80	470.00	+2.00 (+0.43%)
BH	1,301,943.60	195.00	-11.00 (-5.34%)
PTTEP	1,227,893.00	133.50	+1.00 (+0.75%)

Figure 5a: Trading information of top-ten trading in monetary

Source: www.set.or.th on April 27, 2018.

Top Volume

หลักทรัพย์	ปริมาณ AOM (หุ้น)	ล่าสุด	เปลี่ยนแปลง (%)
TRITN	251,131,000	0.34	+0.01 (+3.03%)
IRPC	248,709,300	6.95	-0.10 (-1.42%)
U	168,239,700	0.02	-0.01 (-33.33%)
TMB	147,266,300	2.36	- (-)
TRUE	109,272,400	7.65	+0.15 (+2.00%)
PTT	104,864,700	56.50	- (-)
SUPER	97,136,600	1.07	- (-)
BLAND	53,385,800	1.85	-0.01 (-0.54%)
EMC	53,385,400	0.20	- (-)
EA	50,486,800	36.50	+1.75 (+5.04%)

Figure 5b: Trading information of top-ten trading in volume

Source: www.set.or.th on April 27, 2018.

Top Gaineres

หลักทรัพย์	ปริมาณ AOM (หุ้น)	ล่าสุด	เปลี่ยนแปลง (%)
MAX	23,480,100	0.03	+0.01 (+50.00%)
AQ	19,559,100	0.04	+0.01 (+33.33%)
SOLAR	5,909,400	3.26	+0.30 (+10.14%)
PDJ	232,300	3.04	+0.16 (+5.56%)
BJCHI	1,236,900	2.30	+0.12 (+5.50%)
EA	50,486,800	36.50	+1.75 (+5.04%)
PE <NP>	2,501,800	0.43	+0.02 (+4.88%)
MONTRI	300	5.75	+0.25 (+4.55%)
TNL	6,200	21.20	+0.90 (+4.43%)
UTP	2,843,000	12.00	+0.50 (+4.35%)

Figure 5c. Trading information of top-ten trading gainer

Source: www.set.or.th on April 27, 2018.

Top Losers

หลักทรัพย์	ปริมาณ AOM (หุ้น)	ล่าสุด	เปลี่ยนแปลง (%)
U	168,239,700	0.02	-0.01 (-33.33%)
HTC	1,336,800	22.20	-2.30 (-9.39%)
ASAP	6,849,500	8.50	-0.80 (-8.60%)
KCE	7,445,800	67.50	-5.25 (-7.22%)
GSTEL	13,974,200	0.13	-0.01 (-7.14%)
S & J	5,100	24.10	-1.65 (-6.41%)
DIGI	13,877,800	0.61	-0.04 (-6.15%)
SIS <XD>	552,600	8.45	-0.55 (-6.11%)
BAT-3K	100	217.00	-13.00 (-5.65%)
BH	6,608,500	195.00	-11.00 (-5.34%)

Figure 5d. Trading information of top-ten trading looser

Source: www.set.or.th on April 27, 2018.

The forecasting process trail is selected from the depicted stocks from SET 50. SET 50 is a set of stocks categorized by Stock Exchange of Thailand (SET) with specific conditions, including invulnerable stocks with a consistent trading. For example, the electricity business as Global Power Synergy Public Company Limited (GPSC) is listed on SET 50 and is selected to run the forecasting price.

The experiment is done into five categories: open price, close price, low price, high price and average price. The period of displaying the data is identified and reported during the period of 12-26 April 2018 and covered nine days trading. The actual high trading data is

reported as Table 1a. The trading data is demonstrated as high price and trial of three parameters of each technique as shown in Figure 6a, 6b and 6c. The comparison between the actual trading price and the forecasting value is computed from MA with parameter n=5, 6 and 7. WMA, the parameter n = 5, 6, and 7 and fraction weighted equally. EMA, the parameter exponential smoothing is α = 0.2, α = 0.3, α = 0.4.

The actual high price and the forecast price $F_{(t+1)}$ among the three techniques, including MSE, are reported in Table 1b (note: the data is reported in 2 digits for the trading price and 3 digits for MSE). Automatically, MSE of each trial will be reported with the forecasting value and reported to the end of the column; for instance, MSE of moving average parameter n = 5 is 2.908; weighted moving average parameter n = 5 is 3.492, and exponential smoothing parameter α = 0.3 is 1.622.

Table 1a: Actual high trading price during 12-26 April 2018 of GPSC

Date	12 April	17 April	18 April	19 April	20 April	23 April	24 April	25 April	26 April
Actual price	76.5	75.75	74.5	76.75	77.25	76.5	74.75	74.75	75.25

Table 1b: Comparison of high forecast price, actual price and MSE among three techniques with three parameter of GPSC

| Date / Price	12/4	17/4	18/4	19/4	20/4	23/4	24/4	25/4	26/4	F(t+1)	MSE
Actual trading price	76.5	75.75	74.5	76.75	77.25	76.5	74.75	74.75	75.25	-	-
Forecast MA (n = 5)	73.15	73.75	74.45	74.80	75.50	76.15	76.15	75.95	76.00	75.7	2.908
Forecast MA (n = 6)	73.42	73.71	74.08	74.46	75.13	75.79	76.21	75.92	75.75	75.88	3.095
Forecast MA (n = 7)	73.75	73.86	74.00	74.14	74.79	75.43	75.90	76.00	75.75	75.68	3.170
Forecast WMA (n = 5)	73.02	73.10	73.83	74.52	75.27	75.98	75.87	75.93	76.43	76.08	3.492
Forecast WMA (n = 6)	73.51	73.21	73.38	74.01	74.69	75.42	76.05	75.88	75.88	76.27	3.867
Forecast WMA (n = 7)	74.02	73.60	74.41	73.57	74.21	74.88	75.54	76.04	75.85	75.83	4.001
Forecast EMA (α = 0.2)	74.48	74.88	75.06	74.95	75.31	75.70	75.86	75.64	75.46	75.42	1.652
Forecast EMA (α = 0.3)	74.42	75.04	75.26	75.03	75.55	76.06	76.19	75.76	75.46	75.39	1.621
Forecast EMA (α = 0.4)	74.36	75.27	75.43	75.06	75.74	76.34	76.41	75.74	75.35	75.31	1.628
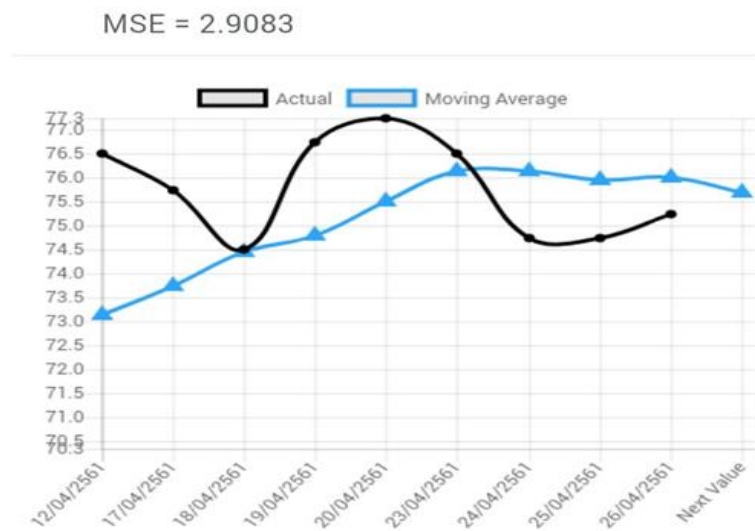
Figure 6a: The feature of forecast price by moving average of GPSC with parameter n = 5
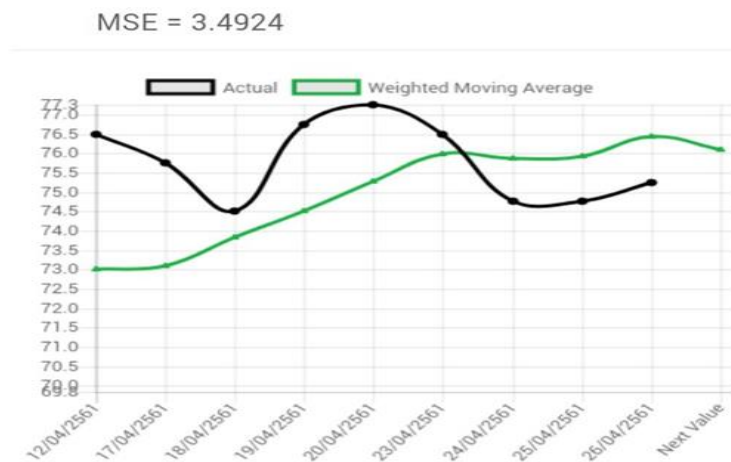

Figure 6b: The feature of forecast price by weighted moving average of GPSC with parameter n = 5
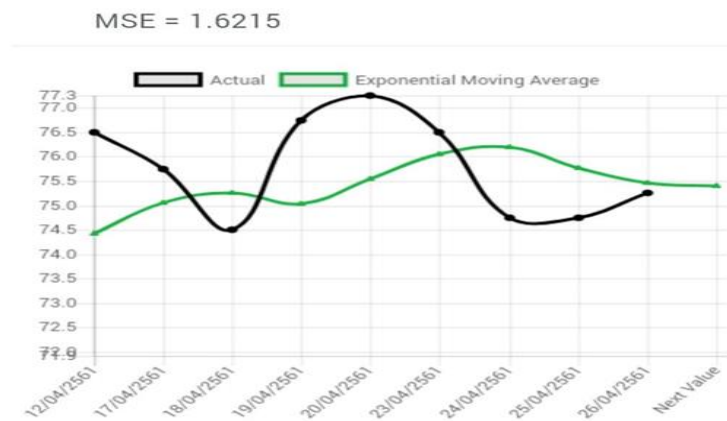
MSE = 1.6215

Figure 6c: The feature of forecast price by Exponential average of GPSC with parameter α = 0.3

In order to validate the accuracy of forecast, it can be traced by speed sheet calculation if mean square has errors (as described in table 2); as an example test MSE of GPSC with moving average (MA) parameter n = 5, it is found the same value from the forecasting system.

Table2: Demonstrate MSE validation: MSE calculation of high price forecasting by moving average (MA) parameter n = 5 of GPSC

Date	Actual Trading (Y_t)	Forecast (F_t)	Forecast Error (Y_t-F_t)	Squared Forecast Error (T_t-F_t)^2
4/4	73.50	-	-	-
5/4	72.25	-	-	-
9/4	72.75	-	-	-
10/4	73.25	-	-	-
11/4	74.00	-	-	-
12/4	76.50	73.15	3.35	11.2225
17/4	75.75	73.75	2.00	4.0000
18/4	74.50	74.45	0.05	0.0025
19/4	76.75	74.80	1.95	3.8025
20/4	77.25	75.50	1.75	3.0625
23/4	76.50	76.15	0.35	0.1225
24/4	74.75	76.15	-1.40	1.9600
25/4	74.75	75.95	-1.20	1.4400
26/4	75.25	76.00	-0.75	0.5625
Forecast	-	75.70	-	**Total 26.175**

$$MSE = \frac{26.175}{9} = 2.908$$

The high, low, open, close and average prices at the same period of GPSC 12 – 26 April 2018 are processed to produce the forecasting price and reported in Table 3. Table 3 reports the comparison MSE among the three techniques in the forecasting results of GPSC. To illustrate as the example of one parameters of each technique, High price: MA (n = 5) is 2.908; WMA (n = 5) is 3.492; EMA (α = 0.2) is 1.652. Low price: MA (n = 5) is 2.326; WMA (n = 5) is 3.439 and EMA (α = 0.2) is 1.429. Open price: MA (n = 5) is 2.633; WMA (n = 5) 3.349 and EMA (α = 0.2) is 1.403. Close price: MA (n = 5) is 2.576; WMA (n = 5) is 3.111 and EMA (α = 0.2) is 1.606. Average price: MA (n = 5) is 2.427; WMA (n = 5) is 3.313 and EMA (α = 0.4) is 0.996. Observed from the experiment outcome of each technique, the exponential smoothing is produced with the lowest MSE. Hence, it is suitable to be used for GPSC price forecasting. However, after the observation to the trading environment, it is found that it has the factor effects to the trading during this period. Furthermore, it affects the violating of a trading price which can be caused by the potential of business. It could also be taken into account for consideration in a long run.

Table 3: Comparison of MSE among three techniques of different parameters for GPSC

MSE	High	Low	Open	Close	Average
MA 5	2.908	2.326	2.633	2.576	2.427
MA 6	3.905	2.995	2.896	2.814	2.875
MA 7	3.170	3.369	3.002	2.871	2.999
WMA 5	3.492	3.439	3.349	3.111	3.313
WMA 6	3.867	4.548	3.836	3.553	4.022
WMA 7	4.001	5.122	4.001	3.653	4.247
EMA 0.2	1.652	1.429	1.403	1.606	1.289
EMA 0.3	1.621	1.609	1.386	1.609	1.098
EMA 0.4	1.627	0.878	1.394	1.652	0.996

The experiment is made for the trial with different types of business, including property and construction business such as Land and House Public Company Limited; it is depicted for running. The report is demonstrated in Table 4a,4b and the graphs of each technique with three parameters of each technique are in Figure 7a, 7b, 7c. The trial is also made for the five prices: high, low, open, close and average with parameter n=5, 6 and 7 for moving average, parameter n =5, 6, and 7 for weighted moving average and parameter α =

0.2, 0.3 and 0.4 for exponential moving average (EMA). Then the example result is reported with the high trading price in Table 4.

Table 4a: Actual high trading price during 12-26 April 2018 of LH

Date	12/4	17/4	18/4	19/4	20/4	23/4	24/4	25/4	26/4
Actual trading price	11.20	11.30	11.00	11.10	11.00	11.00	11.00	10.90	11.00

Table 4b: Comparison of forecast price, actual price and MSE among three techniques with three parameter of LH

| Date / Price	12/4	17/4	18/4	19/4	20/4	23/4	24/4	25/4	26/4	F(t+1)	MSE
Actual trading price	11.20	11.30	11.00	11.10	11.00	11.00	11.00	10.90	11.00	-	-
Forecast MA (n = 5)	11.00	11.08	11.18	11.20	11.18	11.12	11.08	11.02	11.00	10.98	0.022
Forecast MA (n = 6)	10.95	11.03	11.12	11.15	11.18	11.15	11.10	11.07	11.00	11.00	0.271
Forecast MA (n = 7)	10.93	10.99	11.07	11.10	11.14	11.16	11.13	11.09	11.04	11.00	0.031
Forecast WMA (n = 5)	10.91	11.00	11.13	11.23	11.22	11.16	11.12	11.03	11.03	10.99	0.035
Forecast WMA (n = 6)	10.85	10.94	11.03	11.13	11.21	11.20	11.14	11.11	11.02	11.02	0.045
Forecast WMA (n = 7)	10.83	10.88	10.98	11.05	11.14	11.20	11.18	11.13	11.09	11.01	0.051
Forecast EMA (α = 0.2)	10.96	11.01	11.07	11.06	11.06	11.05	11.04	11.03	11.01	11.07	0.019
Forecast EMA (α = 0.3)	11.01	11.06	11.14	11.10	11.10	11.07	11.05	11.03	10.99	11.00	0.016
Forecast EMA (α = 0.4)	11.05	11.11	11.19	11.11	11.11	11.06	11.04	11.02	10.97	10.98	0.014
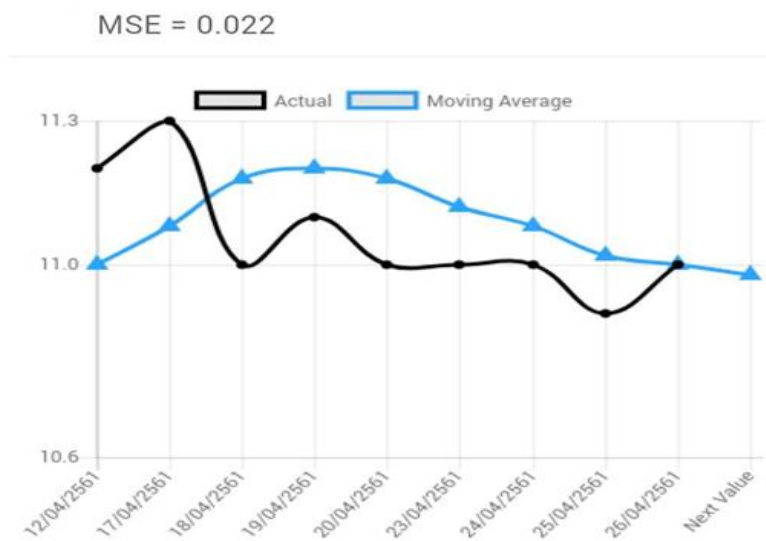
Figure 7a: The feature of forecast price by moving average of LH with parameter n = 5
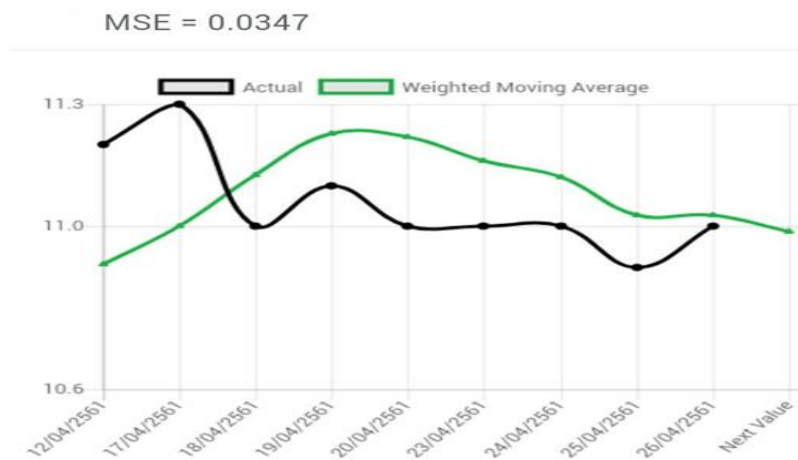

Figure 7b: The feature of forecast price by weighted moving average of LH with parameter n = 5

Figure 7c: The feature of forecast price by Exponential average of LH with parameter $\alpha = 0.4$

Table 5 reports the comparison of MSE among the three techniques in the forecasting results of LH in the same period of 12 – 26 April 2018. The trial was made by using three different parameters of each technique. Moving average (MA) parameter n = 5, 6 and 7. Weighted Moving Average (WMA) parameter n = 5, 6 and 7. Exponential Moving Average (EMA) parameter $\alpha = 0.2$, $\alpha = 0.3$, and $\alpha = 0.4$. The MSE of high value: MA (n = 5) is 0.022; WMA (n = 5) is 0.0347; EMA ($\alpha = 0.4$) is 0.0141. Low price: MA (n = 5) is 0.0167; WMA (n = 5) is 0.0229; EMA ($\alpha = 0.4$) is 0.0129. Open price: MA (n = 5) is 0.0318; WMA (n = 5) is 0.0442; EMA ($\alpha = 0.4$) is 0.0219. Close price: MA (n = 5) is 0.0288, WMA (n = 5) 0.0397 and EMA ($\alpha = 0.4$) is 0.0232. Average price: MA (n = 5) is 0.0153; WMA (n = 5) is 0.0251 and EMA ($\alpha = 0.4$) is 0.0089.

Table 5: Comparison of MSE among three techniques of different parameters for LH

MSE	High	Low	Open	Close	Average
MA (n = 5)	0.022	0.0167	0.0318	0.0288	0.0153
MA (n = 6)	0.0271	0.0185	0.0384	0.0332	0.0190
MA (n = 7)	0.0306	0.0206	0.0455	0.0327	0.0216
WMA (n = 5)	0.0347	0.0229	0.0442	0.0397	0.0251
WMA (n = 6)	0.0446	0.0270	0.0549	0.0487	0.0321
WMA (n = 7)	0.0505	0.0311	0.0652	0.0478	0.0367
EMA ($\alpha = 0.2$)	0.0191	0.0164	0.0318	0.0260	0.0138
EMA ($\alpha = 0.3$)	0.0162	0.0141	0.0259	0.0242	0.0109
EMA ($\alpha = 0.4$)	0.0141	0.0129	0.0219	0.0232	0.0089

The report of LH can be notified that the exponential smoothing method with parameter α = 0.4 contributes the minimum of mean square error. Hence, it is a preferable technique and fits to this stock type.

Conclusion

This stock price forecasting system is proposed to support the investors who intend to invest in Thailand stock market or Stock Exchange of Thailand (SET). This system employs a smoothing method to forecast the stock price by implementing the whole three techniques to forecast the stock price, F(t+1): moving average, weighted moving average and exponential moving. The system provides the predicted stock price in five categories of trading values: open price, close price, highest trading price, lowest trading and real-time trading price.

This system provides flexibility for investors to select the parameter and constant value to be used for calculating the forecast value of each technique. Due to the different nature of investor's preference to trade each stock, different data pattern in time series will be produced; hence, it is important to select a suitable technique for each stock type which would help investor measure the forecast error and calculate the forecast value.

Furthermore, this system provides many benefits to investors. It provides reports in both descriptive and diagnostic patterns which could be used by investors in considering whether the stocks are worth investing or not. The descriptive pattern reports allow investors to study the current situation in the stock market and select the appropriate method for each stock type. The graphical reports on the other hand, could be used to diagnose patterns of stock data to predict stock prices. Another advantage this system provides is it provides investors with trading data inconsecutively displayed as desired to support decisions on whether to hold or sell stocks in their portfolio.

Discussion and Recommendation

The use of the following three smoothing techniques is also recommended to forecast pattern of stock data. The appropriateness of each technique depends on the different patterns of data observation in time series. The moving average technique is appropriate for data time series that appear stable over time, with stable price trading and consistent trading such as the stock in SETHD group. The weighted moving average technique is suitable for time series data with high variability such as a new stock which enters the market in which the trading

price fluctuates or case in which the period of time is near the closing date for dividend payment or. The exponential smoothing technique is applicable for data time series that contains substantial random variability. This technique is recommended for stocks that are sensitive to environmental factors such as news or under speculation sign that affects investor's decision.

Information from the stock market produces different patterns due to factors like investor's preference and economic news. Since it is a challenge to gain profit from trading stock during the trading time of the day, the system presented in this paper gives investors flexibility to select the parameter and method to compute forecast value easily using web-based trading application. Technically, the computation process is volatile when using the system and the auxiliary infrastructure of the system has low cost such as 1 gigahertz processor, ram 1 gigabyte of 32 bits or 2 gigabyte for 64 bits and only 16 gigabyte of HDD. Thus, this system can be used by any investor who can access www.set.or.th through the Internet.

In addition to these three techniques of smoothing method implemented through this system, another techniques called trend projections and Generalize Autoregressive Conditional Heteroskedasticity (GARCH) could be considered for further study. These techniques can be used to review the historical data and project the slope to the line in order to forecast the medium and long-range mathematical equation in the future. This complement is possible by using the historical data supported by the Stock Exchange of Thailand (SET). The data from SET are accurate and reliable since they are collected, compiled and available to the public.

The process of automatically storing the data to the local hard disk could be considered for further study because the current public data are available only three months backward. If this process could be added to the system, the overview of the market volatility would be useful to any forecasters to predict the stock indexes as part of the economic growth as a whole.

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