Stock Price Forecasting Of E-Commerce Company Using Feedforward Backpropagation Neural Network

by Doddy Heka Ardana

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ABSTRACT

Stock price forecasting is widely known and has become a special issue in financial and scholarly research. This stock price movement trends to be non-linear and non-stationary which was influenced by many factors. The stock price forecasting involves a lot of processes because in it there is a lot of noise and the conditions are always changing. In recent years, the development of e-commerce has increased rapidly. E-commerce companies have been entered to the stock or trading market where one of them is Kioson Komersial Indonesia company with the KIOS stock code. In this study, stock price predictions investigated by using Matlab version R2018b software using the Feedforward Backpropagation Neural Network method. The results of the study proved that using artificial neural networks can predict the price of a stock whose price is very close to the actual price with a very small mean square error (MSE) value and high correlation coefficient parameter.

Keywords : Stock price, Forecasting, E-commerce, Feedforward backpropagation neural network, Prediction

1. INTRODUCTION

In economic development, the stock trading market has an important function of the economy of a country. The stock trading market runs two functions at once, namely as a function of the economy and financial functions. Through this market, companies can obtain long-term funds, both in the form of their capital (equity) and loan capital (bonds) or the company can sell its shares or stock in the trading market. Where the offer or sale of the stock company is intended to hold an expansion in its operating activities and to increase production capacity which must be supported by professional management and requires capital, both for investment in fixed assets and for working capital.

In Indonesia, various companies have joined the trading market to get additional funds. Indonesia Stock Exchange (IDX) in Jakarta as the coordination institution of the trading market in Indonesia mention many companies was recorded as an emiten or participant. Companies of manufacture, construction, bank, mining, plantations, finance, insurance even e-commerce company have been a participant or emiten in the trading market.

In recent year, the development of information technology brings up many new business opportunities where buying and selling transactions are carried out electronically. Indonesia as one of the largest population in the world become the largest growth in the number of internet users in the world too. Internet developments have a significant influence in all aspects of life such as trade transactions. In connection with the development of information technology, this allows everyone to be far easier and faster in terms of trade with people from all corners of the world. The benefits of the internet currently are as promotional media and as online trade transactions of goods and services so that all parts of the world are familiar with these goods and services. This is commonly known as electronic commerce or commonly called e-commerce. E-commerce is a company or website that provides space for buying and selling transactions of a product or service online or direct selling by utilizing internet facilities.

One of e-commerce company which become an emiten in Indonesia Stock Exchange is Kioson Komersial Indonesia company with KIOS code. Company of Kioson Komersial Indonesia (Kioson) as a startup in the Online-to-Offline (O2O) is one of the e-commerce sectors, officially offered an initial public offering (IPO) on the Indonesia Stock Exchange (IDX) in middle of 2017. The raised funds from the stock of around Rp 45 billion with estimating of growth of Kiosan partners are 400% by the end of 2017. The number of Kioson partners has reached 19 thousand spread in 384 cities in Indonesia [1].

Stock price forecasting has been respected as one of the most challenging of time series forecasting [2]. Forecasting the stock market is an indispensable private area, the longer period of the value for the upper stock of investment among companies having the stocks [3]. This stock price movement trends to be non-linear and non-stationary which influenced by many factors. The stock price forecasting involves a lot of processes because in it there is a lot of noise and the conditions are always changing [4]. Financial conditions are strongly influenced by many factors, including political news, company policies, economic conditions, investor expectations, investor psychological conditions, etc [5]. The parties are involved in the stock market will be greatly helped

by an accurate forecast of the stock price. From forecasting of the stock price, the investment risks can be anticipated by investors and arbitrators can expect to get the maximum profit from stock trading [6].

Every day, the pattern of stock price activities is always experiencing an increase or decrease where this condition depends on the number of trading market players who transact on that day. This is also influenced by the economic conditions in Indonesia. So that the right stock price prediction method is needed. Many market participants, particularly regulation ones, spend a part of time and cash to gather and analyze significant data sometime recently making an investment choice. On the other hand, the researches can be estimated to check market efficiency. Moreover, they concoct, apply or alter different models to progress the prescient control. Finding a good strategy to more precisely estimate the stock cost will be a until the end of time theme in both the academic field and the financial industry [7]. There are two techniques used in stock price prediction namely fundamental analysis and technical analysis. In addition to these two techniques, using artificial intelligence systems can also help predict stock prices. The famous artificial intelligence system is the artificial neural network (ANN). ANNs have been smeared by the researcher for many model forecasting which involves finance, exact, health, climate and engineering area [8]. Many studies have been used artificial intelligence models to predict stock prices during the last decade. One of the studies was by [9] who had used ANN to forecast The Istanbul Stock Exchange (ISE) market index values. Five models of the artificial neural network was used by [7] to predict the price of three individual stocks: Bank of China, Vanke A and Kweichou Moutai. The models are BPNN, RBFNN, GRNN, SVM, LS-SVMR. According to [10] ANN was used to predict of stock price and described the theory behind ANN and our neural network model and its salient features. Forecasting the daily NASDAQ stock exchange rate was investigated by [11]. Combination of two models, using Hybrid ARIMA - Neural Network Models for stock index return forecasting and trading strategy was studied too. the study found that ARIMABP hybrid model outperforms in forecasting stock index returns both in terms of forecasting accuracy and in generating trading returns [4].

The research of ANN was used in predicting stock price had been done widely but there has been no specific research for prediction of e-commerce emiten stock market values. This paper aim is to use ANN to forecast of e-commerce stock market values particularly the prices of KIOS stock price.

2. LITERATURE REVIEW

2.1 Stock Market and Stock Exchange

The stock market alludes to the collection of markets and trades where normal exercises of buying, offering, and issuance of offers of publicly-held companies take put. Such financial exercises are conducted through institutionalized formal trades or over-the-counter (OTC) marketplaces which work beneath a characterized set of controls. There can be different stock exchanging settings in a nation or a locale which permit exchanges in stocks and other shapes of securities [12].

A stock exchange may be a put where individuals purchase and sell stocks and offers. The stock exchange is additionally the exchanging movement that goes on there and the exchanging organization itself. An exchange is an institution, organization, or affiliation which has a market where stocks, bonds, choices, prospects, and commodities are exchanged. Buyers and dealers come together to exchange amid particular hours on trade days. Trades force rules and directions on the firms and brokers that are included with them [13]. Stock exchange essentially serve as (1) essential markets where enterprises, governments, regions, and other joined bodies can raise capital by channelling reserve funds of the speculators into profitable wanders; and (2) auxiliary markets where financial specialists can offer their securities to other speculators for cash, hence decreasing the risk of investment and keeping up liquidity within the framework [14].

2.2 E-commerce

Electronic commerce or e-commerce is very interesting because it has been able to answer the demands of today's modern human lifestyles that are given technology to make e-commerce an effective and efficient trade alternative, both in terms of time, effort and cost. On the other hand, e-commerce does not only make it easier for the buyer and the seller. In Indonesia, e-commerce growth is very rapid. There are Tokopedia, Bukalapak, Traveloka, Lazada, Shopee, Blibli, Salora, Elevenia, Kios, Go-Jek, Bhineka, Tiket.com, etc. Even four of e-commerce companies have been a Unicorn company that are Tokopedia, Go-Jek, Bukapalak, and Traveloka. Unicorn is a term that is very familiar in the world of startup or startup companies. The term unicorn is used to describe private companies that have valuations of more than US $ 1 billion [15].

Kioson Komersial Indonesia company (KIOS) as an e-commerce company in Indonesia is a technology company that provides software and hardware platforms to assist Micro, Small and Medium Enterprises (MSMEs) in Indonesia through a partnership system called Kioson Cash Point (KCP), wherein conducting recruitment activities business partners and/or collection of transaction results from the Company's business partners (KCP) in collaboration with third parties, called Kioson Corporate Correspondence (KCC).

Kioson was established on June 29, 2015, and started commercial operations in August 2015 [16]. Company of Kioson Komersial Indonesia (Kioson) as a startup in the Online-to-Offline (O2O) is one of the e-commerce sectors, officially offered an initial public offering (IPO) on the Indonesia Stock Exchange (IDX) in middle of 2017. The raised funds from the stock of around Rp 45 billion with

estimating of growth of Kiosan partners are 400% by the end of 2017. The number of Kioson partners has reached 19 thousand spread in 384 cities in Indonesia [1].

2.3 Feedforward Backpropagation Neural Network

Artificial neural network (ANN) is an information processing system that has characteristics similar to biological neural networks [17]. This means that artificial neural networks are one of the information processing systems designed by imitating the workings of the human brain in solving a problem by doing the learning process through changes in the weight of the synapses. ANN is a method that can find a non-linear relationship between the load and various economic factors and other factors that can make adjustments to the changes that occur. ANN can be applied well is the field of forecasting. To estimate what will happen, we need forecasting techniques to determine the planning and decision-making process. Backpropagation is an algorithm in ANN. Backpropagation is mostly used in many layer networks or it can be called multi-layer in the hope that it can minimize errors in the results of the calculation techniques performed by the network. There are three main steps, namely entering data into the input network (feedforward), doing calculations and backpropagation of errors (backpropagation) and doing weight and bias (adjustment) updates. After finding a network pattern that is the values of weights and biases, the network can be used to determine the output of any testing. FFBNN is comprised of various computational components portrayed as neurons. These are sorted out in three layers: the input layer which contains the information unit that gets data from external and will be identified with the system, at least hidden layer of calculation neurons where the information is prepared and an output layer of calculation neurons where the outcomes for given sources of info are created.

The back-propagation consists of two passes: a forward propagation and backward propagation. In the forward, the information design connected to the input layer and its impact is spread layer by layer through the system. The movement at a neuron is registered as the weighted total of the output of the neurons of the past layer. The output of the neuron was processed from a non-linear actuation work. From the input layer to hidden layer, activation capacity will be utilized is the logsig. This activation function is ceaselessly differentiable, symmetric and limited in the range of 0 and 1. The scientific function of the calculated sigmoid capacity was given by

$$y = f(x) = \frac{1 - e^{-x}}{1 + e^{-x}} \tag{1}$$

Or activation capacity is utilized with tansig. This activation function is ceaselessly differentiable, symmetric and limited in the range of 1 and -1. The scientific function of the calculated sigmoid capacity was given by

$$y = f(x) = \frac{1 - e^{-x}}{1 + e^{-x}} \tag{2}$$

The purelin will be used when hidden layer to output layer processes. The equation was given by

$$f(x) = x \tag{3}$$

3. RESEARCH MODEL

The model in this study was based on the feedforward backpropagation neural network model with each architecture which contains the input layer, hidden layer, and output layer. The training and testing data set collected during 5th October 2017 to 28th June 2019 were selected to evaluate the performance of the neural network model for predicting KIOS stock price. In this study, the data used consist of two sets: 300 of data are used for model calibration (training) in the case of ANN, and 252 of data are used for model validation (testing). The input and target values of each feature are normalized by using the unit interval [0,1]. Following [18], the general scale down procedure is given by

$$X' = \frac{X - X_{min}}{X_{max} - X_{min}}(BA - BB) + (BB) \tag{4}$$

Here X and X´ represent the value to be scaled down and its normalized value respectively. X_{max} and X_{min} are the maximum and minimum observed values of each feature on inputs and BA is top values (1) and BB is bottom values (0). In this study, we used multilayer architecture scenario with four inputs (open price, low price, high price, and the close price one day before), hidden layer, and one output to get the best result. For model performance criteria, statistical criteria are adopted here to help select the desired optimal network model. The selection procedure is based on the following statistics: coefficient of correlation (r) and mean square error (MSE). In this study, analysis processing used MATLAB software version R2018b.

4. RESULT AND DISCUSSION

In this paper, feed forward backpropagation neural network (FFBNN) with 4-5-1 and 4-10-5-1 architecture was used for analysis. Open price, low price, high price, and the close price one day before or close price-1 as input to ANN models. The length of the data used for calibration are 300 data and for validation are 252 data. The framework model was presented in Figure 1. The model structures with least mean square error (MSE) and higher correlation coefficient (R) is considered as the best result.
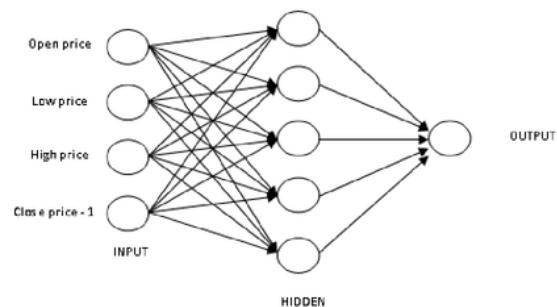
Figure 1: The framework model

The stock price of KIOS as one of an e-commerce company which has been an emiten in Indonesia Stock Exchange was fluctuating. From initial public offering (IPO) in October 2017, the prices growth increase rapidly but at the beginning of January 2019 the prices of KIOS stock started a decrease. The fluctuating stock price of KIOS presented in Figure 2.

Figure 2: The stock price fluctuating

Based on historical data of KIOS stock price, forecasting process can be analyzed using Feedforward Backpropagation Neural Network (FFBNN). Two models FBBNN architecture was used to forecast the stock price that is 4-5-1 (single hidden layer with 5 neurons) and 4-10-5-1 (double hidden layer with 10 neurons in the first hidden layer and 5 neurons in second hidden layer). From analyzed with MATLAB software version R2018b the result showed in Figure 3 until Figure 8 and Table 1.
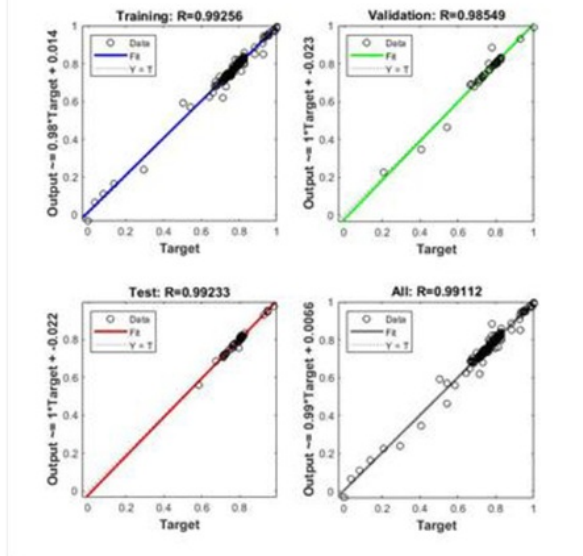

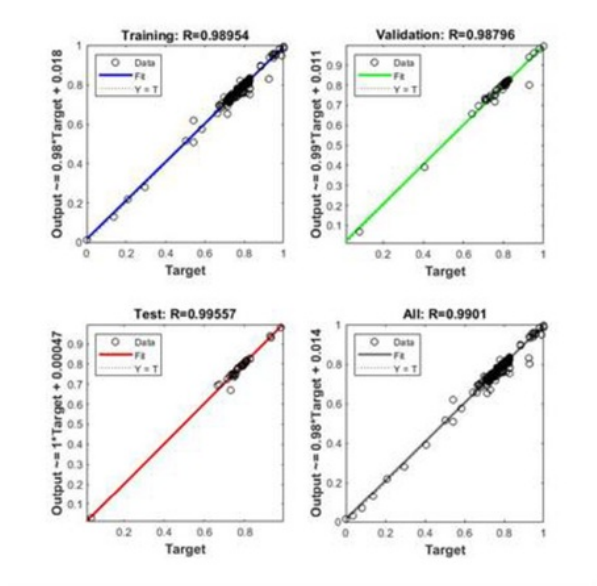**Figure 3:** The correlation coefficient value of 4-5-1 architecture

Figure 4: The correlation coefficient value of 4-10-5-1 architecture

From the result of correlation coeficient value, both of model presented there is a very strong relationship between the input variable and targets to be achieved. Model FFBNN with 4-5-1 architecture shows the R-value of the training process is 0,99256 and testing process is 0,99233 while the model with 4-10-5-1 give value for training correlation coefficient is 98,954% and testing process is 99,557%. Based on both the correlation coefficient value it was found that the model 4-5-1 gave the best result because for forecast process will use the last weight during the training process from network architecture.
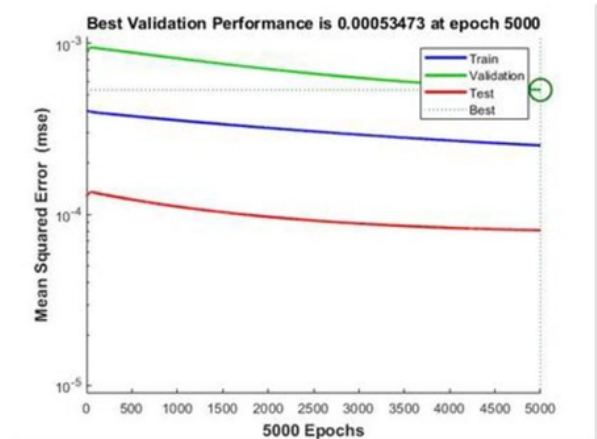

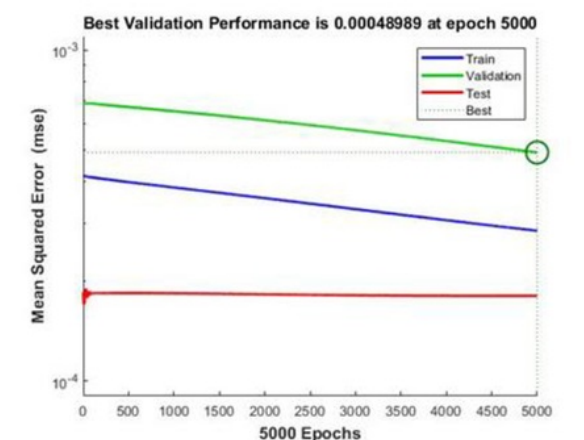**Figure 5:** MSE value of 4-5-1 architecture

Figure 6: MSE value of 4-10-5-1 architecture

Based on Mean Square Error (MSE) value obtained almost the same value there are 0,00053473 in epoch 5000 for 4-5-1 FFBNN model and 0,0048989 in the same epoch. That shows both of these models provide excellent results so this FFBNN model can be used as a tool for forecast of stock price.

In Figure 7 shows the comparison between the observed value of KIOS stock price with the predicted value of stock price. The figure shows the predicted model has a similar pattern with observed value. That means FFBNN model can be used in the forecast stock price.

Figure 7: Comparison of Observed and Predicted Stock Price

The best architecture which obtained from the training process will be used as a stock price predicting model. That is the FFBNN with 4-5-1 architecture will be used. In this paper, stock price predicting for next one week will be analyzed with training pattern of FFBNN 4-5-1 architecture. The result of KIOS stock price predicting presented in Table 1.

Table 1: Estimated "KIOS" Stock Price for Next 1 Week

Date	Last Day Close Price	Estimated Stock Price
01-Jul-19	720	705.62
02-Jul-19	705.62	691.52
03-Jul-19	691.52	677.71
04-Jul-19	677.71	664.17
05-Jul-19	664.17	650.91

Based on Table 1, the stock price of KIOS continues to decline with 1,99% average for one week. After getting the pattern of stock prices using the FFBNN model, investor or trader can suggest this model as a decision-making tool in trading shares.

5. CONCLUSION

This study reports an empirical work which investigates the usefulness of feedforward backpropagation neural network models in forecasting and trading the KIOS stock price in Indonesia Stock Exchange. The nonlinear FFBNN model are used to capture different forms of relationship in the time series data. The performance of the FFBNN models with 4-5-1 architecture with open price, low price, high price, and last day stock price for input parameter were measured statistically analyzed that are MSE and correlation coefficient. The prediction performance of the model 4-5-1 is 0,00053473 for mean square error value and 99,23% for training correlation coefficient and testing process is 0,99233.

Thus we can see that Feedforward Backpropagation Neural Networks are an effective tool for stock market prediction and can be used on real-world datasets like the KIOS stock price dataset.

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