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Predicting stock closing prices using artificial neural networks for a sample of banks listed in the Iraqi Stock Exchange

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Abstract : *The research aims to construct a predictive model based on the artificial neural network to predict the stock closing price for rationalizing investment decisions. Stock prices are highly volatile, which makes it difficult to predict using traditional methods. Therefore, an applied study has been conducted for two Iraq Stock exchange-listed banks, which are Al-Mansour bank (BMNS) and Investment bank (BIBI), on the basis of daily indices for the period from (2/1/2019) to (28/2/2019). MLP neural network was used in this study to model stock prices using SPSS v26 software. The model was evaluated using a set of metrics, which are MSE, RMSE, MAPE, MAE, and R2. The results proved neural networks' accuracy in predicting stock prices, and thus their dependability in making investment decisions. The researcher recommended conducting more studies in the future.*

Keywords - *ANN, ISX, Backpropagation, MLP, Prediction, BMNS, BIBI.*

1. INTRODUCTION

Financial Markets are considered as nerve drives the economy in any country through what they provide of physical means and spatial framework for trading securities by variety of financial instruments, which the important of them is the stocks, that considered as shares to holders in projects or companies, So, in order to make financial decisions related buying or selling shares, for that, investors had to pay attention to the process of stocks forecasting for the making effective financial decisions which would mitigate the expected losses by disposing of stocks whose price is expected to fall, on the other hand, achieving capital gains by buying the stocks whose its price is expected to high, So, the forecasting process of closing prices became one of the important financial management duties in order to predict the future. The stock price forecasting methods have varied, ranging the simple and complex depending on the used tools and required cost, where the financial affairs researchers used methods depend upon financial ratio, personal estimates as well as the traditional statistical methods, Recently, forecasting methods have been developed to keep abreast of modern technical developments and the changes happened in the new financial environment, Considering the weakness witnessed by traditional methods in modelling financial data, The use of artificial neural networks has begun as new technique simulating biological cells of human brain in modelling financial data depending on training and learning mechanics, hence the ability constructing predictive models can reduce the predictive values errors. The research is structured into three sections, the first section: methodology of the research where includes (importance, problem, hypothesis, aims) of the research, While the second section was about theoretical framework of the research including the basic conception of the stock exchange and artificial neural network, As the third section was the applied research of how to forecasting stock price using ANN.

2. METHODOLOGY

2.1 Importance of the research

Making decisions about buying or selling stocks is so important because of its consequences as well as the risk surrounding financial markets, which makes the prices are fluctuating, hence the importance of forecasting stock prices for rationalizing the investment decisions and reducing the risk, for that, the research provides applied study to construct a predictive model using ANN, because its effective role in predicting the prices trend in the future.

2.2 Problems of the research

The research problem is concerned with the extent to which artificial neural networks can predict stock prices on which to base stock investment decisions. Therefore, the research problem can be summarized up in the following questions:

A. How accurate are artificial neural networks in predicting stock prices?
B. Can neural networks predict future price values by modeling historical data?
C. Is it possible to rely on the results of artificial neural networks in making decisions to invest in stocks?

2.3 Hypotheses of the research

The hypotheses of the research can be summarized by follow:

A. The artificial neural network is able to model stock historical data for predicting stock prices.
B. Reliability of artificial neural network outcomes in stock investment making decisions.

2.4 Objectives of the research

The objectives of the research can be summarized by follow:

A. Take advantage of artificial intelligence techniques in constructing effective predictive models.
B. Focus on flexible alternatives for the prediction to solve traditional methods problems
C. Help rationalize stock investment decisions by providing effective models that are dependable.

2.5 Sample of the research

The sample of research is a daily indices of two banks listed on Iraqi stock exchange (ISX) which are Al-Mansour Bank (BMNS), and Investment Bank (BIBI), for the period form (2/1/2019) to (28/2/2019).

2.6 Methods of the research

The research used Multi-Layer Perceptron neural network using SPSS v26 software.

3. THEORETICAL FRAMEWORK

3.1 Stock exchange

The stock exchange is a term refers to that workplace where trading, buying and selling stock occurring, where these activities are conducted according to a set of regulations and laws, which are regulated by the securities commission (http://www.investopedia.com/terms/s/stockmarket.asp), Noting the stock exchange might have physician location or be online, where the investors trading their securities from anywhere.

3.1.1 Classifications of stock exchange

A. Regular stock exchange

This term refers to the trading process conducted in regulated place, where all processes are regulated and monitored by management of the market, like the stock exchange of New York and Tokyo.

B. Irregular stock exchange

Also called "Over-the counter" (OTC), unlike regular stock exchange, this market has no physics place to investors meet, where all trading processes are done by wide network of brokers through negotiation, the most important characteristic of this type is well-organized, less formal, less trading cost, and all participants is as market maker (https://www.imf.org/external/pubs/ft/fandd/basics/markets.htm).

3.1.2 Types of the stocks

There are several types of stocks in the stock exchanges, which differ from each other according to their characters, but the most common types are as follows:

A. Ordinary Stock

It also called "Common Stock", this kind of stock represents an ownership in the company, where the shareholders have some right such as voting, receiving dividends, records auditing, as well as can be obtained capital returns when the stock prices rise (Frederic S. Mishkin; Stanley G. Eakins 2018: p234).

B. Preferred Stock

It also called "Premium Stock", this type is different from "common stock", where the preferred shareholders receive fixed revenues, so that the prices of these stocks are fairly stable, the preferred shareholders can get their dividends before the common shareholders but they can't vote or records auditing (Frederic S. Mishkin; Stanley G. Eakins 2018: p235).

3.2 Prediction concept

In general, the prediction term refers to estimating a result or specific behavior in the future depending on historical data, where sometimes called "Forecasting", it gives the same meaning. (Hussein Bayoudh, 2016; p11)

Financial prediction is one of the basic concept, where the experts define it as a process to estimate the performance or result of business in the future, like estimating sales, stock prices and so on (https://www.toolshero.com/financial-management/financial-forecasting/).

Financial prediction is generally classified into two types, Quantitative and Qualitative prediction, where both contain subtypes, and as follows:

3.2.1 Quantitative prediction

The quantitative prediction technique is based on historical data to identify a specific pattern of trend of data, where is active with large data, and accurate more than qualitative prediction, the subtypes it contains, Pro-forma financial statements, Time series analysis, Cause-effect method.

3.2.2 Qualitative prediction

It also called "Speculation", the technique of this type is based on experience and intuition, the brain of human have more flexibility to deal with problems the computers can't do, One of this approach drawbacks is biases of the decision-makers, but it is accepted to prediction with having no data (https://www.coursehero.com/file/91664205).

3.2.3 Predicting using artificial network

The ANN combine the features of the two previous types, where depend on historical data and use some of human brain technique, as we will be discussed later.

3.2.4 Error Prediction Concept

Simply, the prediction error term refers to expected values deviation from the actual, where the predicting models usually don't provide accuracy 100%. (Mehdi Khashei, Seyed Reza Hejazi, Mehdi Bijari, OPCIT, P 782)

There are many measures to calculate the prediction error can depend on, below some of them with their equations.

A. Mean Squared error (MSE)

This measure calculates the mean of squared error of the model, its equation in below

$$MSE = \frac{\sum_{i=1}^{N}(y - \hat{y})^2}{N} \quad (1)$$

B. Root Mean Squared error (RMSE)

This measure calculates the root mean of squared error of the model, it is used to reduce the big value of error calculated by MSE, its equation in below

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(y - \hat{y})^2}{N}} \quad (2)$$

Where: N is number of observations, y is actual values, $\hat{y}$ is predicted values

C. Mean Absolute Error (MAE)

This measure calculates the absolute value of the error mean dividing by number of observations, it can be used as an alternative measure of RMSE, its equation in below

$$MAE = \frac{\sum_{i=1}^{N}|(y - \hat{y})^2|}{N} \quad (3)$$

D. Mean Absolute Percentage Error (MAPE)

This measure calculates the absolute value of the error mean as percentage of the actual values, its equation in below

$$MAPE = \frac{\sum_{i=1}^{N} \left| \frac{(y - \hat{y})^2}{y} \right|}{N} \quad (4)$$

Where: N is number of observations, y is actual values, ŷ is predicted values

3.3 Artificial Neural Network (ANN)

Artificial Neural Network is a system or technique to process the data simulating the biological nervous system in human in its mechanism, neural network consists of some neurons that is linked each other by synapses called "weights", Basically the artificial neural network contains three layers, which are "Input ", "Hidden" and "Output" layers, later will be discussed in details (Charu C. Aggarwal, 2018: p1).

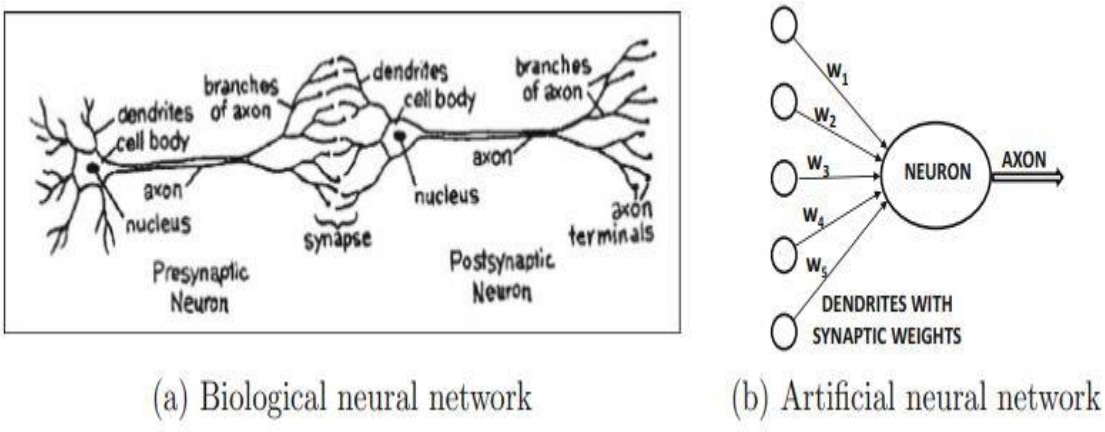

Fig 1: biological and Artificial neurons (Charu. Aggarwal, 2018: p1).

3.3.1 Differences between ANN and BNN

There are several differences between artificial neural networks (ANN) and biological neural networks (BNN), which can be summarized as follows in table (1):

Table (1): Comparison between ANN & BNN (https://www.geeksforgeeks.org/difference-between-ann-and-bnn)

No	ANN	BNN
1	In comparison to a biological neural network, processing speed is faster.	They take a long time to process information.
2	Storage allocation to a new process is strictly irreplaceable because the old location is reserved for the previous process.	Storage allocation to a new process is simple because it is added simply by adjusting the interconnection strengths.
3	Processes run in a sequential mode.	The process is capable of performing massive parallel operations.
4	If information in the memory becomes corrupted, it cannot be recovered.	Information is distributed throughout the network into sub-nodes and can be recovered even if it becomes corrupted.
5	A control unit continuously monitors the activities.	There is no control unit to monitor the data flowing into the network.

3.3.1 Mechanism of ANN

The process starts injecting network by data through the input neurons which multiple data by weight synapses and passing the signals to the processing unit, which contains mostly two parts, the first collect the inputted signals

into one, and the second that usually called "activation function", where convert data to specific pattern depend on activation function used, after that the outcomes have passed to the output layer where processing also by activation function to have obtained final outcomes.

3.3.2 Learning Types

Generally, in artificial neural network, there are two common techniques to learn the network, these techniques are algorithms built in order to simulate the technique of biological neurons, below discussing these types in details (https://www.ibm.com/cloud/blog/supervised-vs-unsupervised-learning).

A. Supervised learning

At this type, the network is supplied with the labeled dataset, where the network can measure the differences between observed and actual dataset, then it learns over time until reaching the required accuracy.

B. Unsupervised learning

At this type, the network is not supplied with target dataset, where be used special algorithms to analyze the data and detect hidden patterns without need to supervising.

3.3.3 Classification of ANN

There are main two classes of neural networks, one contains two layers which is called “Single Layer Perceptron”, the other is called “Multi-Layers Perceptron” which contains at least three layers, in follow explanning in more details.

A. Single Layer Perceptron (SLP)

The SLP is considered the first proposed model in artificial neural network, it consists two layers, input layer which injected by data, and the outputs, where the computation is performed simply by summing the multiplied data by weights, the outcome values are summation product, where this model have no hidden layers and the activation function is linear.

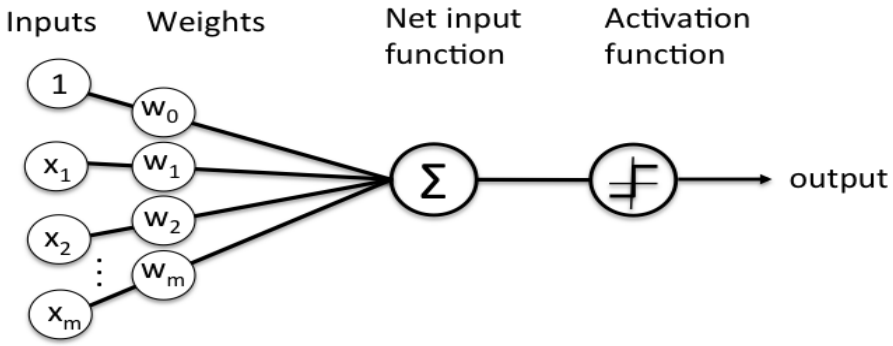

Fig 2: SLP network architecture (https://github.com/ZahidHasan/Perceptron).

B. Multi-Layer Perceptron (MLP)

MLP architecture is more complex than SLP. In his model, the network has at least one hidden layer, which is between input and output layers. The number of hidden layers depend on the complexity of the problem, where MLP basically has been created to solve the problems are not linearly separable, this network is being trained with backpropagation algorithm (S. Abirami, P. Chitra, 2020).

Since the MLP is used to solve nonlinear problems, So its formula is represented as below:

$$a_k^2 = f^2\left(\sum_{j=1}^{s1} w_{jlk}^2 f\left(\sum_{i=1}^{R} w_{ij}^1 p_i + b_j^1\right) + b_k^2\right), k = 1 \text{ to } s^2 \quad (5)$$

Where: S^1 is hidden neuron, S^2 is output neurons, R is input neurons, W_{jlk} are weights between input layer and hidden layer, W_{ij} are weights between hidden layer and output layer, f is activation function, b is bias value.

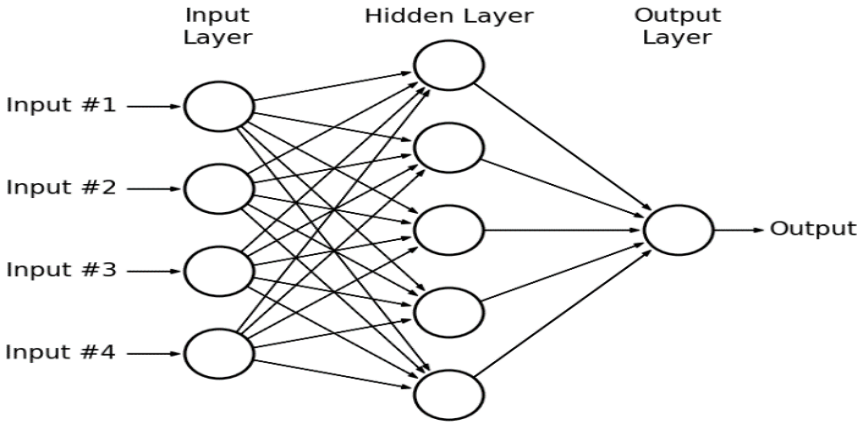

Fig 3: MLP network architecture (https://www.researchgate.net/ publication/303875065).

C. Other types of ANN

There are many types of artificial neural networks, which differ in architecture, functions and purpose, in this research will use MLP, below list of other types of ANN networks.

1) Radial basis function Neural Network
2) Kohonen Self Organizing Neural Network
3) Recurrent Neural Network (RNN)
4) Convolutional Neural Network
5) Modular Neural Network (https://analyticsindiamag.com/).

3.3.4 Activation Function

It is also called "Transfer Function". Simply it is a function that make the values into specific rang depending on the used function, an important reason to need activation function is to avoid the huge values that could result, Basically there is two classes of activation functions, first is linear activation functions that used to solve the linear problem in learning process, the second one is the non-linear activation functions that used to solve the complex problems, the error occurs when the activation function returns a value is not match the threshold (Edgar N. Sanchez, 2020: p65).

In follow explaining in detail, some of the common activation function:

A. Step / Identity

It is linear function, where the activation is proportional to the inputs

$$f(x) = \begin{cases} 0, & x < 0 \\ 1, & x \geq 0 \end{cases} \quad (6)$$

B. Sigmoid / logistic

This function result outputs in the range of (0, 1), its formula in follow:

$$f(x) = \frac{1}{1 + e^{-x}} \quad (7)$$

C. Tanh Function (Hyperbolic Tangent)

This function result outputs in the range of (-1, 1), its formula in follow:

$$f(x) = \frac{(e^{x} - e^{-x})}{(e^{x} + e^{-x})} \quad (8)$$

Where: e is exponential

3.3.5 Backpropagation algorithm

Adjusting weights is the most important procedure in ANN training for get best performance.

Backpropagation algorithm is a form of gradient descent. Gradient descent is a machine learning technique to reduce the errors. In feed-forward, the weights are initialized randomly, then the errors resulting are calculated. After that, backpropagation runs to adjust the weight in which should entire training set is traversed, this process is repeated gradually to each epoch until one of the stopping rules is met, the stopping rules are usually related to the learning time, global error, or the number of epochs (Torkil Aamodt, 2015: p20).

3.3.5.1 Gradient descent algorithm

Simply, the gradient descent is an optimizing iterative algorithm, it is being used for training the network. More precisely used to adjust the weights after the training set is passed and got errors. The goal of this algorithm is to find the local minimum of a function by calculate the partial derivative of the error with respect to the derivative of network weights all that multiplied by the learning rate (Suellen Teixeira and others, 2020: p 618), as following equations.

Backpropagation runs backward to calculate the value of gradient descent for minimizing the value of error, On the basis of which the weights are updated. Therefore, the chain rule used to calculate the derivatives is as follows:

$$\frac{\theta E}{\theta W} = \frac{\theta E}{\theta y} * \frac{\theta y}{\theta s} * \frac{\theta si}{\theta wi} \quad (9)$$

Where: θE is error derivative, θW is weight derivative, θy is output derivative, θs is hidden derivative.

Then, The updating weight is calculated as following equation.

$$W_{new} = W_{old} - \eta * \left(\frac{\theta E}{\theta W}\right) \quad (10)$$

Where: η is learning rate of gradient descent, W is weight.

3.3.6 Prediction using ANNs

Artificial neural networks can predict time series, including stock prices, by detecting and identifying distinct patterns in the time series and using lags to predict future values. In contrast to traditional prediction methods, neural networks are distinguished by the fact that they do not require time series preprocessing, such as missing data or the time series stability problem, because the neural network can deal with all types of time series through its learning ability.

4. THE APPLIED RESEARCH

4.1 Preparation of the research data

As stated in the methodology of the research, the dataset of the research is daily Indicators that are provided by the Iraq stock exchange, in details the dataset is (Opening price, Closing price, Last closing price, Maximum price, Minimum price, Present rate, Last rate, Transactions, Traded stocks, Traded value), The period of research is from (2/1/2019) to (28/2/2019), where the daily observations of Al-Mansour bank were (40), while the daily observations of Investment bank were (32) due to lack of trading some days.

The main goal of the research is to construct ANN model to forecast the closing prices of the Banks, that is mean the close price will be the dependent variable, and the others are covariates variables.

Following, Table 2 and Table 3 show some descriptive statistics of the variables used in the research.

Table 2: Al-Mansour bank descriptive statistics prepared by researcher

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Open Price	40	.130	.630	.760	.70825	.025509	.001
Max Price	40	.130	.630	.760	.71450	.024594	.001
Min Price	40	.100	.630	.730	.70325	.022348	.000
Present Rate	40	.120	.630	.750	.70825	.022290	.000
Past Rate	40	.120	.630	.750	.70550	.024905	.001
Past Close	40	.130	.630	.760	.70725	.025418	.001
Change Percentage	40	12.160	-2.780-	9.380	.47200	2.714574	7.369
Transaction Number	40	73	2	75	20.78	17.108	292.692
Traded Stocks	40	118322000	825000	119147000	35920429.85	27672686.35	7.658E+14
Traded Values	40	88160330	594000	88754330	25514494.88	20001557.56	4.001E+14
Close Price	40	.130	.630	.760	.71025	.023037	.001
Valid N (listwise)	40						

Table 3: Investment bank descriptive statistics prepared by researcher.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Open Price	32	.070	.210	.280	.26438	.018128	.000
Max Price	32	.080	.210	.290	.26531	.018662	.000
Min Price	32	.080	.200	.280	.26313	.020703	.000
Present Rate	32	.070	.210	.280	.26375	.018965	.000
Past Rate	32	.060	.220	.280	.26594	.016434	.000
Past Close	32	.070	.210	.280	.26625	.016801	.000
Change Percentage	32	12.550	-8.700-	3.850	-.86594-	2.418268	5.848
Transaction Number	32	17	1	18	6.84	5.623	31.620
Traded Stocks	32	91019676	97941	91117617	15309779.34	22389437.45	5.013E+14
Traded Values	32	19215577	27423	19243000	3743944.16	5062284.816	2.563E+13
Close Price	32	.07	.21	.28	.2641	.01932	.000
Valid N (listwise)	32						

4.2 ANN Architecture

The Multi-layer perceptron network is used in this research, It is one of the most famous of ANN, IBM SPSS software is used to do that, where the network will contain three layers, single input layer that has neurons compatible with covariates (Independent variables), the hidden layers will be initialized automatically to get best performance to process the data, concerning the output layer is single to obtain the predictive values of closing price.

The first procedure taken is to normalize the data set, the action is necessary to enhance training network, because the disparate data make gradient descent algorithm converge faster in adjusting errors, and to get rid of saturation problem with activation function, So, will use Normalized, Standardized and Adjusted Normalized methods in this research.

Concerning the activation function, will use hyperbolic tangent and identity in hidden and outputs layers.

Regarding the training methods, will be relying on Batch type with gradient descent algorithm, Batch is convenient to small data.

4.3 Results

The results will be discussed for the two banks, respectively, the research rely on IBM SPSS v26 to construct the neural network.

4.3.1 Mansuor Bank

Several attempts were made to reach to best predictive MLP model, (40) observations have been input in the network of Al-Mansour Bank, which represent the dataset provided by ISX, In hidden layer Hyperbolic tangent function with gradient descent are used for training, and concerning rescaling the Normalized and Adjusted normalized methods are used for normalizing data, regarding output layer the Identity function is used, Standardized rescaling data is used for normalizing data, Sum square (SSE) is used to measure the errors in training and testing phases, Table 4 shows information of the network.

Table 4: ANN information, prepared by researcher using spss

	Input layer	Hidden layer	Output layer
Sample	40	40	40
Activation function	none	Hyperbolic tangent	Identity
Training algorithm	none	Gradient descent	none
Training type	none	Batch	none
Error measure	none	Sum square of Error (SSE)	Sum square of Error (SSE)
Rescaling method	Normalized, Adjusted normalized	none	Standardized

Following in Table 5 the models obtained by MLP network to choose the best model, that give lowest error value.

Table 5: Al-Mansour bank predictive models: prepared by researcher using spss

Models	Hidden Layers	Hidden Neurons	R^2	MSE	RMSE	MAPE
MLP 1	1	3	0.98902	0.00001	0.00253	0.00271
MLP 2	1	2	0.98877	0.00001	0.00275	0.00260
MLP 3	1	1	0.98885	0.00001	0.00265	0.00239
MLP 4	1	1	0.99297	0.00001	0.00246	0.00235
MLP 5	1	4	0.92953	0.00005	0.00692	0.00790
MLP 6	1	1	0.92575	0.00005	0.00685	0.00698
MLP 7	1	4	0.97883	0.00001	0.00363	0.00370
MLP 8	1	1	0.95290	0.00003	0.00533	0.00585
MLP 9	1	1	0.99253	0.00000	0.00222	0.00240

MLP 10	**1**	**3**	**0.99453**	**0.00000**	**0.00193**	**0.00216**

As it is shown in Table 4, the network consisted single input, hidden and output layers, through changing the neurons in hidden layer architecture, obtained 10 MLP models, For evaluating between models, MSE, RMSE, MAPE measures have been used, and it illustrated by Table 4 that (MLP 10) model is the best, it contained (3) neurons in hidden layer, where has lowest values of errors measures, MSE(0.0000), RMSE(0.00193) and MAPE(0.00216) where the lower the results indicates the efficiency of the model, as well as the R^2 value is (0.99453) confirms the correlation between the actual and predicted values, where the closer the results is to (1) indicates the strength of correlation.

At this model, used (7) covariate variables that are (Open price, Max price, Min price, Present rate, Past rate, Past close price, Change Percentage), As it turns out through training and testing that they give the best results, in follow the summary of the model.

Table 6: MLP 10 model summary, prepared by researcher using spss

Model Summary		
Training	Sum squares of error	0.107
	Relative error	0.007
Testing	Sum squares of error	0.050
	Relative error	0.007

Table 5 shows that the SSE is (0.107) in training phase, and is (0.05) in testing phase, Relative Error was (0.007) in both, where indicates the performance efficiency of model.

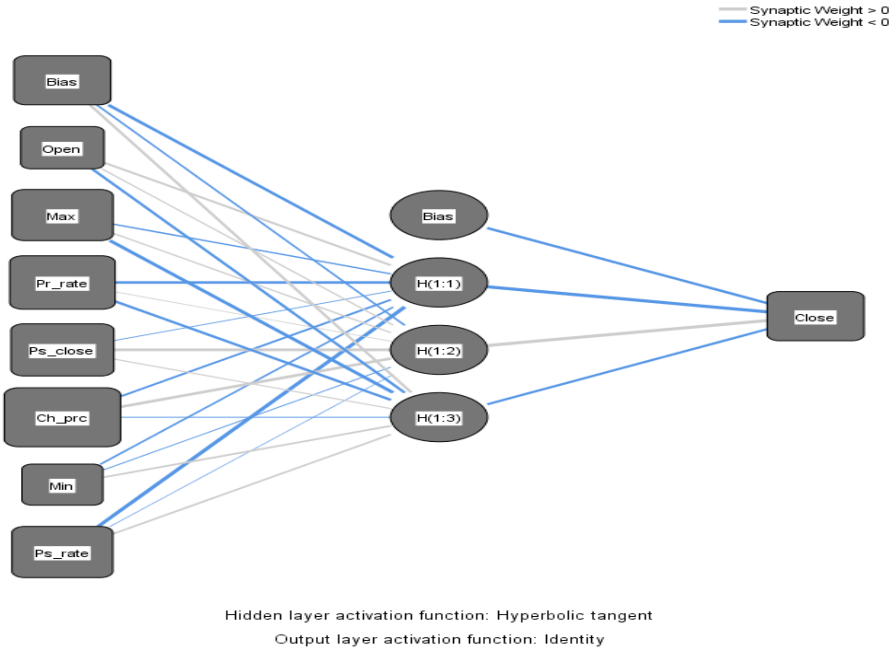

Fig 4: Diagram of MLP 10 network, prepared by researcher using spss

The Fig 5 shows how the network is connected by neural synapses (weights), where the blue lines indicates to negative value, and the gray indicates to positive value.

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Fig 5: scatterplot of MLP 10 model. Prepared by researcher using spss

Fig 6 shows how close are the predicted values to the actual values, where the square of the correlation R^2 as mentioned is (0.99), while regression equation is **Y = 0.002 + 0.97X**

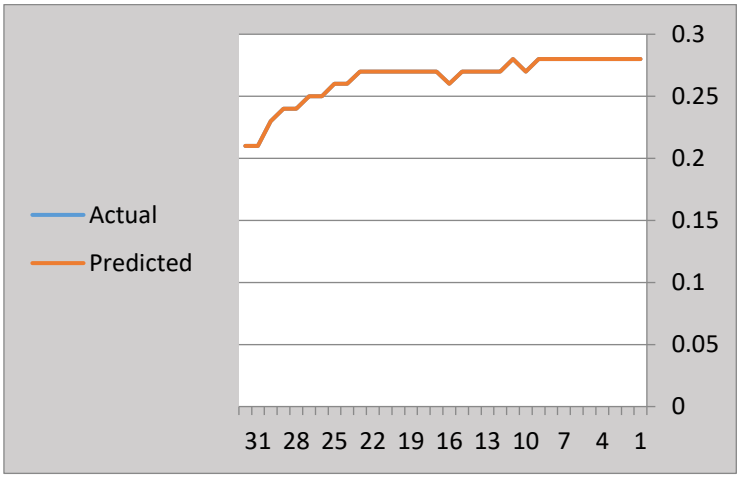

Fig 6: Linear chart of actual and predicted closing price, prepared by researcher using excel.

Fig 7 shows how well the actual values match the predicted values, where the red line represents the predicted values and the blue line represents the actual values, this confirms our reached findings.

Table 7: Importance independent variables. Prepared by researcher using spss

Independent variables importance		
	Importance	**Normalized Importance**
Open Price	0.039	14.70%
Max Price	0.159	60.50%
Present Rate	0.188	71.90%
Past Close	0.171	65.40%
Change Percentage	0.262	100%
Min Price	0.023	8.90%

Past Rate	0.158	60.30%

Table 7 shows the relative importance of independent variables used in model, where Change Percentage was highest important of this network by 100%, while the Min price was the lowest importance by 8.9%.

4.3.2 Investment Bank

Several attempts were made to reach to best predictive MLP model, (32) observations have been input in the network of Investment Bank, which represent the dataset provided by ISX, In hidden layer Hyperbolic tangent function with gradient descent are used for training, and concerning rescaling the Normalized and Adjusted normalized methods are used for normalizing data, regarding output layer the Identity function is used, Standardized rescaling data is used for normalizing data, Sum square (SSE) is used to measure the errors in training and testing phases, Table 8 shows information of the network.

Table 8: ANN information, prepared by researcher using spss

	Input layer	Hidden layer	Output layer
Sample	32	32	32
Activation function	none	Hyperbolic tangent	Identity
Training algorithm	none	Gradient descent	none
Training type	none	Batch	none
Error measure	none	Sum square of Error (SSE)	Sum square of Error (SSE)
Rescaling method	Normalized	none	Standardized

Following in Table 9 the models obtained by MLP network to choose the best model, that give lowest error value.

Table 9: Investment bank predictive models: prepared by researcher using spss

Models	Hidden Layers	Hidden Neurons	R^2	MSE	RMSE	MAPE
MLP 1	1	4	0.94838	0.00003	0.00500	0.00973
MLP 2	1	1	0.95675	0.00003	0.00500	0.00595
MLP 3	1	2	0.98272	0.00001	0.00250	0.00285
MLP 4	1	2	0.99099	0.00001	0.00250	0.00298
MLP 5	1	3	0.98073	0.00001	0.00306	0.00382
MLP 6	**1**	**1**	**0.99999**	**0.00000**	**0.00000**	**0.00000**

As it is shown in Table 8, the network consisted single input, hidden and output layers, through changing the neurons in hidden layer architecture, obtained 6 MLP models, For evaluating between models, MSE, RMSE, MAPE measures have been used, It illustrated by Table 8 that (MLP 6) model is the best, it contained (1) neurons in hidden layer, where has lowest values of errors measures, MSE(0.0000), RMSE(0.0000) and MAPE(0.0000)

where the zero results indicates the efficiency of this model, as well as the R^2 value is (0.999) confirms matching the predicted values with the actual, where the R^2 value means the correlation is perfect.

At this model, used (7) covariate variables that are (Open price, Max price, Min price, Present rate, Past rate, Past close price, Change Percentage), As it turns out through training and testing that they give the best results, in follow the summary of the model.

Table 10: MLP 6 model summary, prepared by researcher using spss

Model Summary		
Training	Sum squares of error	0.010
	Relative error	0.001
Testing	Sum squares of error	0.007
	Relative error	0.001

Table 10 shows that the SSE is (0.010) in training phase, and is (0.007) in testing phase, Relative Error was (0.001) in both, where indicates the performance efficiency of model.

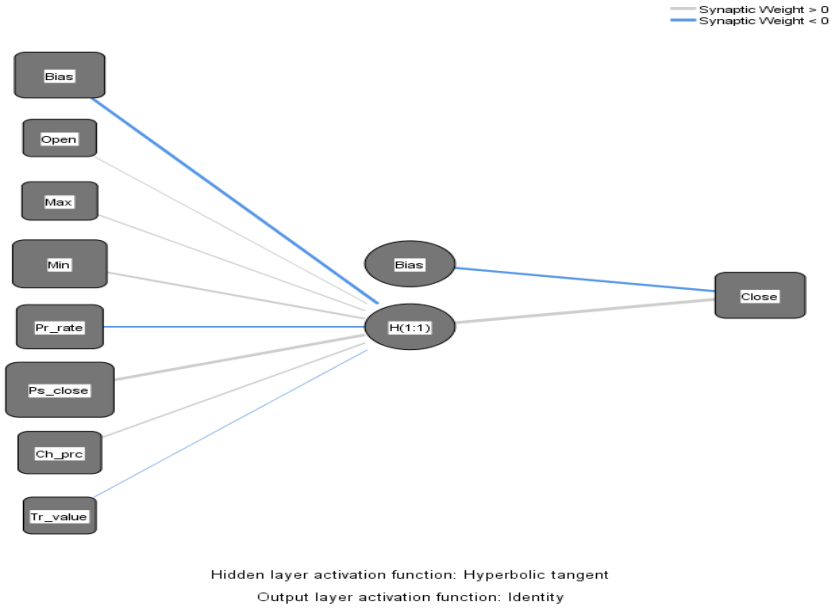

Fig 7: Diagram of MLP 6 network, prepared by researcher using spss

The Fig 8 shows how the network is connected by neural synapses (weights), where the blue lines indicates to negative value, and the gray indicates to positive value.

Fig 8: scatterplot of MLP 6 model. Prepared by researcher using spss

Fig 9 shows how close are the predicted values to the actual values, where the square of the correlation R^2 as mentioned is (0.999), while regression equation is **Y = 0.00143 + 0.99X.**

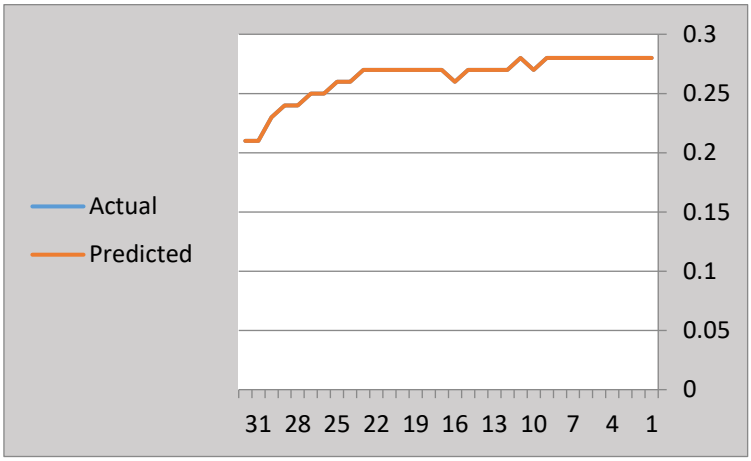

Fig 9: Linear chart of actual and predicted closing price, prepared by researcher using excel.

Fig 10 shows how well the actual values match the predicted values, where the red line represents the predicted values and the blue line represents the actual values, this confirms our reached findings.

Table 11: Importance independent variables. Prepared by researcher using spss

Independent variables importance		
	Importance	**Normalized Importance**
Open Price	0.013	3.10%
Max Price	0.038	9.20%
Min Price	0.249	61.10%
Present Rate	0.163	40.10%
Past Close	0.407	100.00%
Change Percentage	0.127	31.10%

Traded Value	0.004	0.90%

Table 11 shows the relative importance of independent variables used in model, where Past close was highest important of this network by 100%, while the Traded value was the lowest importance by 0.90%.

5. DISCUSSION

Given the importance of the research mentioned in the methodology about the ability of the neural network to help in making decisions, In this research, we examined the mentioned problems about possibility of artificial neural networks in modelling the past data to forecast the close prices, and how reliable results is it.
Considering the hypotheses mentioned in the methodology of the research and based on the results were reached, the researcher found the artificial neural network can provide accurate results being reliable in making decisions through modelling the historical data.

6. CONCLUSION

In light of the problem of the research and what has been discussed in the hypothesis, and through the applied aspect which was conducted, can conclude the following:

A. The empirical study proved the efficiency of the Artificial neural network in modelling historical data to forecast the future closing price.
B. The artificial neural networks have fewer requirements comparing the other techniques and are flexible in use, and it can deal with nonlinear problems.
C. MLP network proved that is suitable for forecasting the stock closing price, that evident by the findings obtained from the tiny error measures, as well as the rate of correlation between the actual and the predicted values.
D. Given the findings obtained, this technique can be relied in making decisions along with other techniques.
E. It can not be proved that this technique is the best ever predictor, hence the researcher recommends conducting more studies in the future.

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