



Using neural networks to detect financial fraud: an applied study on a sample of Iraqi banks listed on the Iraq Stock Exchange

Ameer Haider Malik Jaafar ¹, Dr. Janan Abdul Abbas Baqer ²

^{1,2} Al-Furat Al-Awsat Technical University (Technical College of Management/ Kufa , Accounting Techniques Department , 54003, Iraq)

¹ ameer.malik.cku@student.atu.edu.iq

² jenan.aldulamy@atu.edu.iq

*Corresponding Contact: ameer.malik.cku@student.atu.edu.iq

Abstract. *The research aims to employ neural networks in external auditing to predict financial fraud in the research sample banks using the Benesch model indicators. This is due to the challenges facing the auditing process, most notably the increased risk due to the test audit (sample method) and reliance on traditional data analysis procedures, which creates substantial risks that are not detected by the auditor. This is due to the shortcomings of the planning and prior risk assessment process, which increases the likelihood of undetected risks. To test the research hypothesis (that neural networks do not contribute to predicting fraud in financial statements), the researcher relied on the applied approach in the practical aspect, where he used the Benesch M-score measure as one of the analytical tools in external auditing to detect financial fraud in the research sample banks. In addition, he used neural networks based on fraud indicators to analyze the financial statements to predict banks that practice fraud. To achieve the research objectives, the researcher relied in the practical aspect on a sample of (10) Iraqi banks listed on the Iraq Stock Exchange for the period (2021-2022). The researcher concluded that neural networks contribute to predicting financial fraud, as the network accurately distinguished between banks engaging in financial fraud, demonstrating the neural network's ability to recognize unusual patterns. The researcher recommended that audit firms adopt neural networks as an enhanced tool for external auditing in detecting fraud in financial statements.*

Keywords: Financial fraud, neural networks, external audit, Beneish model.

1. INTRODUCTION

The tremendous developments in the field of artificial intelligence and the increasing workload have necessitated the application of technologies that contribute to addressing the challenges facing audit firms in providing audit services to clients and keeping pace with rapid modern developments. One of the most significant challenges facing auditors is the risk of detection, represented by unintended errors and intentional distortions (financial fraud). Fraud is one of the factors that undermine confidence in financial data and is considered a complex problem with a

significant impact on users of this data, as they rely primarily on it for decision-making. Reducing or eliminating fraud requires a more thorough and accurate audit. Given the shortcomings of some measures used to mitigate financial fraud, auditors are required to develop their skills in newer and faster technologies. Artificial intelligence (neural networks) technologies are among the most prominent and distinguished, offering numerous advantages that contribute to enhancing auditors' work, such as analyzing big data, expanding the scope of work, and directing auditors' attention to items of high relative importance, thus strengthening their judgment. The research aims to demonstrate how neural networks can be used in external audits to predict fraud in the financial statements of the banks in the research sample, using the indicators of the Benesch model. To achieve the research objective, the researcher used SPSS to build an MLP neural network. This network is characterized by its multiple layers, thus providing accurate results close to the actual calculated results. To achieve this, a sample of 10 active Iraqi banks listed on the Iraq Stock Exchange was selected, with periodic financial data available for the years (2021-2022). These banks are: Bank of Baghdad, Iraqi Investment Bank, Middle East Bank for Investment and Finance, United Investment Bank, National Bank of Iraq, Iraqi Credit Bank, Gulf Commercial Bank, Babylon Bank, Mosul Bank, and Sumer Commercial Bank. Two years were selected to find the values of the Benish model indicators for 2022, as each indicator is based on data for the current and previous years. After finding fraud indicators represented by financial ratios, the researcher used the neural network, and the network's results achieved a high degree of accuracy compared to the actual results.

2. MATERIALS AND METHODS

2.1. *theoretical materials*

2.1.1 *The problem of the study*

The auditing profession faces numerous obstacles. Recent years have witnessed tremendous developments in the business world across economic units. The volume of financial transactions has increased and operations have become more complex. This has presented the auditing profession with significant challenges in auditing these units. Prominent among these challenges is the increased risk resulting from test auditing (sampling method) or its reliance on traditional data analysis procedures. This creates substantial risks that go undetected by the auditor. This is due to insufficient planning and prior risk assessment, which increases the likelihood of detection risk. This is the auditor's failure to detect material misstatements or financial fraud in the financial statements, leading to misleading financial statements that undermine their credibility and reliability. In light of these challenges, the need has emerged to adopt technologies that help auditors handle and analyze massive amounts of data more accurately and effectively. One of the most prominent of these technologies is neural networks, which can be employed to enhance auditors' capabilities in analyzing financial statements, detecting unusual patterns, and identifying indicators that may indicate the possibility of manipulation or fraud.

2.1.2 *Objectives of the study*

1. Learn about neural networks and their importance in external auditing as an analytical tool to reduce fraud risks..



2. Study of how neural networks can be used to predict fraud in banks' financial statements. Research sample..

2.1.3 The importance of the study

The importance of the research lies in providing an applied framework that supports audit firms in Iraq in adopting modern and advanced techniques or tools in data analysis to reduce detection risks, thus enhancing the auditor's understanding of the audited entity's environment. Neural network-based auditing contributes to providing accurate and distinct information in predicting banks that practice fraud in financial statements, which reduces risks and material distortions. Furthermore, the importance of the research lies in the relative importance of the volume of transactions, operations, and the huge capital contained in banks. In addition, the shareholders of these banks desire more accurate results, which requires auditors when auditing this sector in particular to use advanced analytical tools to reduce audit costs and examine high-risk accounts more closely to arrive at more comprehensive results.

2.1.4 Study hypothesis

Based on the research problem, the following hypothesis can be formulated:

1. **main hypothesis:** Neural networks do not contribute to predicting fraud in financial statements.

2.1.5 study Methodology:

To achieve the objectives of this study, the descriptive approach was adopted to review the theoretical aspect of the study problem, test the validity of its hypotheses, understand and organize the phenomenon under study, and form a comprehensive picture of it. As for the applied aspect, the researcher relied on analyzing the financial statements of Iraqi banks using fraud indicators according to the Benenish model, in addition to employing neural network technology to detect financial fraud in the banks that comprise the study sample..

2.1.6 study References:

To cover the theoretical aspect, the researcher relied on theses and dissertations published on the Internet, especially on the official website of the digital library of the al-Abbas's (p) Holy Shrine, in addition to making use of the central library of the Federal Board of Financial Supervision in Baghdad, as it provided the researcher with many modern scientific sources of theses and books, especially on external auditing and artificial intelligence. As for the practical aspect, the researcher relied on the official website of the Iraq Stock Exchange to obtain the financial statements of the Iraqi banks listed on it..

2.1.7 study Limitations:

The researcher faced several problems while completing the research, the most important of which are:



1. The limited time required to complete the message.
2. The data is not available in an easy format, as it was obtained from the Iraq Stock Exchange in print and not in Excel tables that can be easily extracted.

2.1.8 Previous studies

1- Study [1]

Study Details	Details	Seq.
[Al-Masoudi,2023]	Researcher and Year	-1
The impact of artificial intelligence on audit quality and its impact on investor decisions	Study Title	
Master's thesis at the University of Karbala	Type of study	
A questionnaire was designed as a data collection tool. 155 questionnaires were distributed to a sample consisting of accountants, auditors, certified public accountants, accountants, and financial managers working in accounting and auditing offices, as well as Iraqi companies listed on the Iraq Stock Exchange. A total of 135 valid questionnaires were retrieved for analysis, and their results were used for statistical analysis.	Study sample	
This research aims to demonstrate the impact of artificial intelligence in its various dimensions, which include: systems technology, machine learning technology, continuous audit technology, natural language processing technology, and robotic process automation technology, on the quality of external auditing and investor decisions.	Study Objective	
The results showed a statistically significant impact of the use of artificial intelligence technologies, including machine learning expert systems, continuous auditing for natural language processing, and robotic process automation. This impact is reflected across all dimensions, demonstrating the importance of artificial intelligence applications in improving the quality of external auditing. There is also a positive impact of using these technologies in improving investor decisions by improving the quality of external auditors..	Key Findings	
Both the research and the thesis address an important aspect, which is artificial intelligence and its impact on the external audit process.	Similarities	



<p>The current research is distinguished in the applied framework, as the previous research used the questionnaire method to collect information, but the current research is distinguished in its reliance on the Benesch M-score model and its eight indicators (fraud indicators). It also used neural networks to predict financial fraud and consider it an analytical tool that contributes to enhancing external auditing processes.</p>	<p>Difference</p>
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2- Study: [2]

Study Details	Details	Seq.
[Al-Qarawi,2022]	Researcher and Year	-2
The role of the external auditor in reducing accounting fraud	Study Title	
Research published in the International Journal of Humanities and Social Sciences	Type of study	
The study community is represented by the workers in the branches of the three government banks in the province of Najaf, which are: (Rafidain Bank - Rashid Bank - Trade Bank of Iraq (TBI), while the study sample is represented by the managers of departments and divisions and heads of the IT department) and everyone who has the authority to answer the questions and their number was (120)	Study sample	
Identifying weaknesses and finding appropriate solutions plays a major role in reducing errors, fraud, and accounting manipulation in financial statements.	Study Objective	
The weakness of the external auditor in evaluating the internal control system according to international auditing standards, which leads to shortcomings in the business aspects of government units.	Key Findings	
Both studies focused on the theoretical framework of external auditing and its mechanisms for detecting fraud in financial statements.	Similarities	
The previous study used a questionnaire in its practical aspect. In the current study, the researcher used a methodology different from traditional fraud detection methods in its practical aspect, employing neural networks as a tool to assist auditors in predicting financial fraud. The study also relied on a sample of ten Iraqi banks, whose financial statements were studied, and fraud was identified based on account amounts, using fraud indicators according to the Benesch M-score model.	Difference	



2.2. METHODS

2.2.1 Financial statement fraud

Financial fraud is generally defined by the Association of Certified Fraud Examiners (ACFE) as: “Illegal transactions involving breach of trust and deception, which do not end with payments, securing personal interests, or even losing services” [3] .

Financial statement fraud is defined as intentional errors committed by management in the books and records to manipulate the financial position or performance of an economic entity. The danger of this type of fraud lies in the fact that it occurs even when good internal control systems are in place. Management may bypass internal control procedures, making it difficult to detect, despite its significant impact on the integrity and fairness of financial statements [4].

This type of fraud can be committed by management through a number of methods, including the following [5]:

- A- Inconsistency in the selection of accounting rules, policies, and procedures adopted by management to present a positive picture of the financial position of the economic entity.
- B- Management's manipulation of accounting estimates. This manipulation can be attributed to the estimation of the useful life of these assets, given their connection to valuation and forecasting, with the aim of influencing the financial statements to suit management's desires.
- C- Management's making false accounting entries related to third parties, such as selling an entity's asset and leasing it back for a price higher or lower than the asset's actual value, to manipulate the balance sheet, income statement, and financial position.
- D- Management's making false accounting entries to create a false image and impression.

Management commits fraud in the financial statements with the intent of achieving one of the following objectives [6]:

- 1- Inflating profits: Management works to inflate profits to deceive shareholders about the success of their management and policies, thus securing their re-election; increasing their bonuses in proportion to profits; and distributing dividends to increase the share price. Encouraging new investors to increase capital and subscribe for new shares.
- 2- Reducing profits: Management may understate profits to create secret reserves to manipulate stock prices and lower them so they can buy them at reduced prices, as well as to evade taxes.
- 3- Misrepresenting financial statements: Management manipulates financial statement items and presents them in a false manner to mislead creditors (banks and institutions) in order to obtain a loan and benefit from selling shares to investors.

2.2.2 Using Neural Networks in Fraud Detection

Neural networks are a computer model similar to and inspired by the human nervous system. They are characterized by their ability to learn and train using a group of interconnected central processing units (CPUs), which are grouped together to form artificial neurons, very similar to brain cells, interconnected through a weight matrix that forms artificial synapses [7].

Artificial neural networks serve as powerful analytical tools for extracting valuable information from large data sets. Each neuron in an artificial neural network corresponds to a specific feature or



aspect of the data being analyzed, reflecting how different departments within an organization handle different tasks. Information flows through these neurons, and as they interact, the network distinguishes unusual patterns in the data and excels at tasks such as forecasting and fraud detection. It can adapt and improve its performance over time through a process of "training," making it more flexible to solve complex business challenges[8].

Neural networks are characterized by their ability to learn how to perform tasks through training, organizing data, and storing large amounts of information. They can process large amounts of data in parallel, achieve good results despite weak data structures, and exhibit intelligent behavior [9] .

In addition, neural networks are used in the auditing process during the planning process to recognize patterns, data, and visualization methods to identify risk factors. All this information is collected to identify fraud and risk factors. The term audit planning refers to the stage of delving into information and expanding the database, in which the auditor can estimate the associated risk and control risk. Through analytical procedures, the auditor can enhance his understanding of the unit's activity. The auditor must also take into account the effects resulting from the complexity of the electronic accounting information systems environment and the complexity of the internal control structure, which results in an increase in audit risk and, consequently, an increase in the level of doubt for the auditor. It is worth noting that the approach of relative importance and the approach of audit risk remain appropriate for planning audit work, and there is an intertwined relationship between these two approaches. The higher the relative importance level, the lower the risks [10].

2.2.3 Fraud indicators according to the Beneish model

The Beneish model is based on specific indicators for companies exposed to financial statement manipulation. In total, these indicators include eight (8) financial variables. These indicators include the Days Sales Receivable Index (DSRI), Gross Profit Margin Index (GMI), Asset Quality Index (AQI), Sales Growth Index (SGI), Depreciation Index (DEPI), Sales and General Management Index (SGAI), Leverage Index (LVGI), Total Receivables and Total Assets (TATA) [11].

Indicators reflecting financial statement manipulation can be explained according to the Beneish M-score model as follows[12]:

1-Sales Growth Index: If this index's value is greater than one, it reflects sales growth for the current year compared to the previous year. Although sales growth in and of itself does not represent an indicator of earnings manipulation, sales growth does represent a greater likelihood of fraud.

2-Customer Index: This index measures the ratio of sales recorded in customer accounts and is compared to this ratio for the previous year. If this ratio exceeds one, it indicates that the unit is exposed to fraud.

3- Profit Margin Index: This index measures the ratio of the profit margin for the previous year to the profit margin for the current year. When this ratio exceeds one, it indicates that the unit is exposed to earnings manipulation.



4- Asset Quality Index: This index measures the quality of the unit's assets and is calculated by the ratio of non-current assets (except for equipment and machinery) to total assets. If this index value is greater than one, it indicates the potential for increased intangible assets to manipulate earnings. Therefore, a higher value of this index reflects poor asset quality and a higher likelihood of earnings manipulation.

5- Depreciation Index: If this index exceeds one, it may indicate an overestimation of the productive life of machinery and equipment, which contributes to increased unit income. If this index exceeds one, it indicates the potential for assets to be depreciated at a slow rate in order to increase profits

6- Selling and Administrative Expenses Index: This ratio measures the ratio of selling, administrative, and general expenses to sales. A disproportionate increase in sales represents a negative signal regarding the company's future results. If this index falls below one, it indicates the potential for earnings manipulation through deferred expenses.

7- Total Accruals to Total Assets Ratio: This index measures sales generation on a cash basis, i.e., it measures the quality of the company's cash flows. The higher the accruals to total assets ratio, the greater the opportunity for manipulation. As a result, the higher this ratio is, the more likely it is to be an indicator of earnings manipulation.

8- Financial Leverage Ratio: This ratio measures the ratio of total debt to total assets. When the financial leverage ratio exceeds one, it indicates that the unit is exposed to financial statement manipulation.

After calculating the above indicators, the M-Score is found through the following equation:

$$\text{M-Score} = -4.840 + (0.08924 \times \text{DSRI}) + (0.528 \times \text{GMI}) + (0.404 \times \text{AQI}) + (0.892 \times \text{SGI}) + (0.115 \times \text{DEPI}) + (-0.172 \times \text{SGAI}) + (4.679 \times \text{TATA}) + (-0.327 \times \text{LEVI})$$

If the M-Score is greater than 2.22, the unit likely manipulated its earnings.

If the M-Score is less than 2.22, the unit likely did not manipulate its earnings.

3. Applied study

3.1 Overview of the research sample

Research Sample: The research sample was selected from a group of Iraqi private banks listed on the Iraq Stock Exchange for the year 2022. 10 banks were selected and their financial statements (income statement, balance sheet, cash flow statement) were analyzed for the period 2021-2022, as the indicators require data for the base year and a previous year. The selected banks are: (Bank of Baghdad, Iraqi Investment Bank, Middle East Bank for Investment and Finance, United Investment Bank, National Bank of Iraq, Iraqi Credit Bank, Gulf Commercial Bank, Babylon Bank, Mosul Bank, Sumer Commercial Bank)

3.2 Analysis of financial fraud indicators for Iraqi banks listed on the Iraq Stock Exchange. The researcher calculated the eight Beneish indicators as follows:

1. Sales Receivables Index (DSRI) = (Net Receivables for the Base Year / Revenues for the Base Year) / (Net Receivables for the Prior Year / Revenues for the Prior Year)

2. Gross Margin Index (GMI) = (Profit Margin_{1-t} / Revenue_{1-t}) /



(Profit Margin t / Revenue t) **3. Asset Quality Index (AQI)** = $(1 - \text{Current Assets } t + \text{Property and Equipment } t + \text{Investments } t) / (\text{Current Assets } 1 - t + \text{Property } 1 - t + \text{Plant } 1 - t + \text{Equipment } 1 - t + \text{Investments } 1 - t)$

4. Sales Growth Index (SGI) = $\text{Base Year Revenue} / \text{Prior Year Revenue}$

5. Depreciation Index (DEPI) = $(\text{Depreciation } t - 1 / (\text{Property and Equipment } t - 1 + \text{Depreciation } t - 1)) / (\text{Depreciation } t / (\text{Property and Equipment } t + \text{depreciation } t))$

6- Selling and Administrative Expenses Index (SGAI) = $(\text{Selling and Administrative Expenses } t / \text{Revenue } t) / (\text{Selling and Administrative Expenses } t / \text{Revenue } t)$

7- Leverage Index (LVGI) = $(\text{Current Liabilities } t + \text{Long-Term Liabilities } t / \text{Total Assets } t) / (\text{Current Liabilities } t + \text{Long-Term Liabilities } t / \text{Total Assets } t)$

8- Total Assets Receivables Ratio (TATA) = $(\text{Income } t - \text{Cash Flow } t / \text{Total Assets } t)$

3.3 Data analysis of the research sample banks and discussion of the results

This section aims to present the main results derived from the analysis of financial ratios to detect financial fraud in the research sample banks. Then, it uses neural networks to predict which banks are likely to be engaging in financial fraud to achieve the research objectives. The following is a presentation of the research sample banks.

Table (1): Results of applying the Beneish M-score model to the research sample banks

Bank name	DSRI	GMI	AQI	SGI	DEPI	SGAI	LEVI	TATA	M-Score	Fraud/NO Fraud
Bank of Baghdad	0.59	0.95	0.77	1.35	0.98	0.88	1.00	-0.01	-2.70*	No Fraud
Iraqi Investment Bank	1.08	0.33	0.82	1.35	2.75	0.80	1.04	0.14	-1.63	Fraud
Middle East Bank for Investment and Finance	1.18	1.04	1.00	1.12	1.06	0.89	1.14	-0.10	-2.66	No Fraud
United Investment Bank	0.86	1.56	1.16	0.56	1.57	1.16	0.97	-0.001	-2.60	No Fraud
National Bank of Iraq	0.84	1.22	3.96	1.30	1.01	1.54	0.74	-0.01	-1.08	Fraud
Iraqi Credit Bank	0.10	-1.78	0.14	4.15	1.00	0.23	0.69	0.17	-1.26	Fraud
Gulf Commercial Bank	0.74	1.09	1.04	1.02	1.26	0.89	1.04	-0.07	-2.28	No Fraud



Babylon Bank	1.07	-1.04	1.01	0.94	3.22	0.58	0.98	0.002	-3.21	No Fraud
Mosul Bank	0.77	1.08	0.99	1.53	1.42	1.05	0.91	0.003	-2.10	Fraud
Sumer Commercial Bank	0.71	2.99	1.47	1.20	1.84	1.25	0.66	0.005	-1.14	Fraud

Source: Prepared by the researcher based on the financial statements published in the Iraq Stock Exchange <http://www.isx-iq.net/isxportal/portal/homePage.html>

$$* \text{ M-Score} = -4.840 + (0.08924 \times 0.59) + (0.528 \times 0.95) + (0.404 \times 0.77) + (0.892 \times 1.35) + (0.115 \times 0.98) + (-0.172 \times 0.88) + (4.679 \times -0.01) + (-0.327 \times 1.00) = -2.70$$

The results in Table No. (1) indicate that there are (5) banks in which the M-score value was abnormal, which indicates the possibility of unintended errors or deliberate distortions, which requires the auditor to expand the sample size for banks in which the M-score value was abnormal and to prepare an audit program that is compatible with the size of the risks to reduce the fundamental risks to a minimum, taking into account the values of the indicators included in the model (DSRI, GMI, AQI, SGI, DEPI, SGAI, LEVI, TATA), as these indicators are warning signs for specific items in the financial statements. For example, at the Iraqi Investment Bank, the values of the indicators were normal, with the exception of the depreciation index (DEPI) and the revenue growth index (SGI), as the depreciation index reached (2.75), which requires the auditor to verify and examine more comprehensively the depreciation rates and methods of calculating them. As for the revenue growth index, it reached (1.35), which requires the auditor to expand the sample size during the revenue audit for the year 2022 to verify Reasons for the abnormal rise in the revenue growth index. As for the other (4) banks (National Bank of Iraq, Iraqi Credit Bank, Mosul Bank, Sumer Commercial Bank), the auditor is required to expand the sample size during its audit, taking into consideration the evaluation of the (8) indicators of the Beneish M-score model.

3.4 Applying the neural network model to identify banks engaging in financial fraud

Neural networks are an artificial intelligence technique characterized by their ability to absorb large amounts of data and analyze them intelligently and with high accuracy. The researcher relied on neural network technology to predict financial fraud in the research sample banks based on fraud indicators for the purpose of verifying or rejecting the hypothesis (artificial intelligence using neural networks does not contribute to predicting fraud in financial statements). The researcher employed neural network technology to verify the research hypothesis. The researcher built the neural network using SPSS to create a database. The network was trained using several commands to predict financial fraud in the research sample banks. The following are the three most important components of the neural network:

1- Input layer: To build the network, (8) inputs were used, which represent the financial ratios of the Benesh model, namely (sales growth index, customer index, asset quality index, depreciation



index, selling and administrative expenses index, financial leverage index, and total receivables-to-total assets index). For each input, a node was identified, as the input layer consists of (8) nodes. There are also weights. The inputs serve as links connecting the inputs to the dependent variable to be predicted. The weight of each input varies according to its importance in explaining the phenomenon.

2- Hidden Layer: This layer acts as a processing layer between the inputs and outputs. It analyzes and classifies the inputs by assigning weights to each using several functions, including the aggregate function, which uses the inputs and their weights to calculate the sum, and then the active function, which creates the outputs.

3- Output Layer: Financial ratios (fraud indicators) (sales growth index, customer index, asset quality index, depreciation index, selling and administrative expenses index, financial leverage index, total receivables to total assets index) were used to train on these ratios and then predict the M-score to identify banks that engage in financial fraud, **The figure shows the components of the neural network:**

Network Information			
Input Layer	Covariates	1	DSRI
		2	GMI
		3	AQI
		4	SGI
		5	DEPI
		6	SGAI
		7	LVGI
		8	TATA
		Number of Units ^a	
	Rescaling Method for Covariates		Standardized
Hidden Layer(s)	Number of Hidden Layers		1
	Number of Units in Hidden Layer 1 ^a		3
	Activation Function		Hyperbolic tangent
Output Layer	Dependent Variables	1	M-Score
	Number of Units		1
	Rescaling Method for Scale Dependents		Standardized
	Activation Function		Identity
	Error Function		Sum of Squares

a. Excluding the bias unit

FIGURE (1): COMPONENTS OF THE NEURAL NETWORK

SOURCE: PREPARED BY THE RESEARCHER BASED ON SPSS .

Figure (1) shows that the network consists of three components (inputs - hidden layer - output layer) and the activation function (Activation Function) was used in the hidden layer, a hyperbolic tangent function, symbolized by (Tan h), and it takes the following non-linear function:

$$f(ai) = \text{Tan h}(a) = \frac{z}{1 + e^{-zai}}$$

In the output layer, I used the Identity function, which takes the following linear function:

$$f(a) = y = a$$

THE FIGURE SHOWS THE STRUCTURAL STRUCTURE OF THE NEURAL NETWORK:

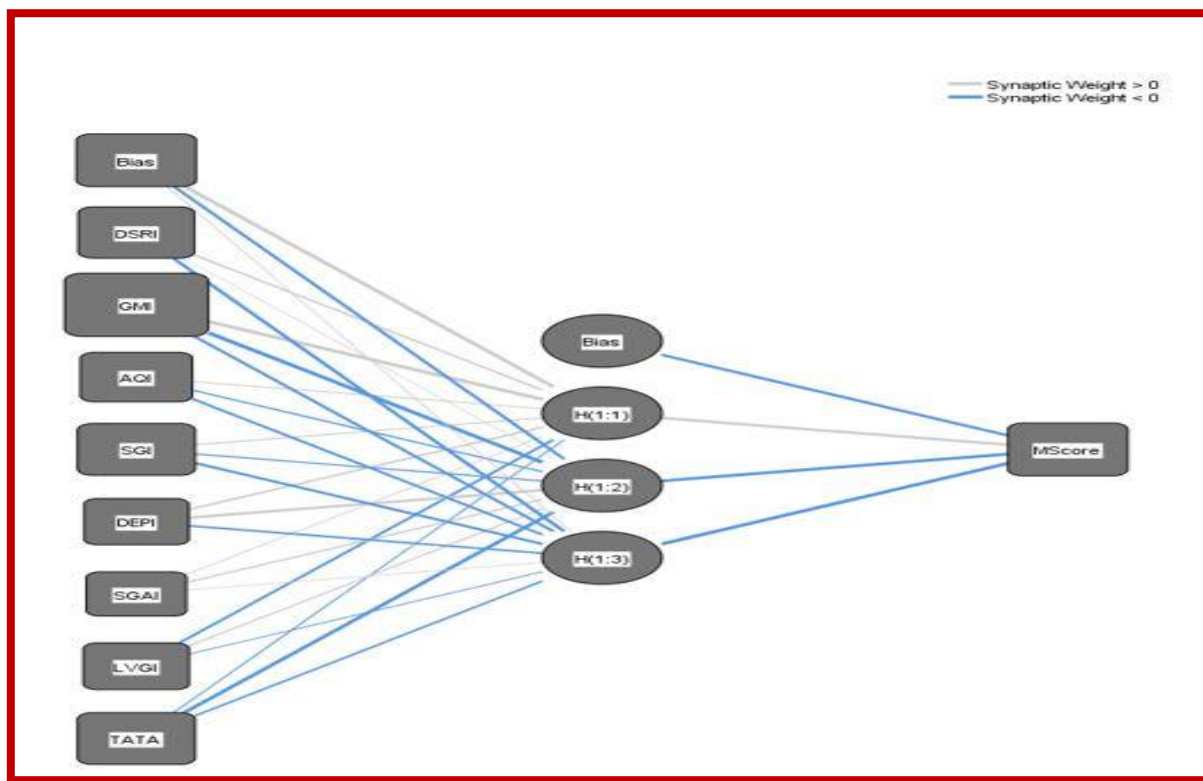


FIGURE (2): MLPS NEURAL NETWORK ARCHITECTURE

SOURCE: PREPARED BY THE RESEARCHER BASED ON SPSS

Figure (5) shows an artificial neural network model consisting of three main layers: the input layer, one hidden layer, and the output layer. The input layer contains eight variables (inputs): TATA, LVGI, SGAI, DEPI, SGI, AQI, GMI, and DSRI. These variables represent financial indicators used



as inputs for analyzing company performance or detecting financial manipulation. These inputs are passed to the hidden layer, which contains three main nodes (H (1:1), H (1:2), and H (1:3)), in addition to a bias node (Bias). These nodes are processed using activation functions to transform the inputs into analyzable values. Signals from the hidden layer are then sent to the output layer, which contains only one variable: the M-Score, which represents the model's final score, such as the degree of likelihood of financial manipulation. The blue lines represent the weights between the layers, which determine the impact of each input on the outcome. These weights are adjusted during the training process to achieve the best possible accuracy.

4. RESULTS AND DISCUSSION

To identify banks that may have manipulated their financial statements, the results obtained through the application of the neural network will be presented in the following table:

Table (2) Results of the application of the neural network and comparison of the actual results of the banks in the research sample.

Bank name	M-Score	M-Score net	Fraud/NO Fraud	Erorr
Bank of Baghdad	-2.695018661981643	-2.624385779248165	No Fraud	0.00176
Iraqi Investment Bank	-1.632419147400605	-1.089366315776638	Fraud	0.01357
Middle East Bank for Investment and Finance	-2.660635202007431	-2.678575135491694	No Fraud	0.00044
United Investment Bank	-2.596935984396565	-2.547219657497049	No Fraud	0.00124
National Bank of Iraq	-1.081095838620532	-1.042035716484875	Fraud	0.00097
Iraqi Credit Bank	-1.263417031517760	-1.288978484705049	Fraud	0.00063
Gulf Commercial Bank	-2.282019345952554	-2.242478255954297	No Fraud	0.00098
Babylon Bank	-3.205475826045357	-3.270726832479285	No Fraud	0.00163
Mosul Bank	-2.096257412574322	-1.971975434383581	Fraud	0.00310
Sumer Commercial Bank	-1.138472919578008	-1.208510090190210	Fraud	0.00175

Source: Prepared by the researcher based on SPSS and Excel.

The results in Table (2) showed the most important results that were reached using the neural network technique on a sample of Iraqi banks consisting of (10) banks, as the value of the Beneish M-Score indicator was used as a tool to determine whether the financial statements indicate the presence of financial fraud or not. The column “M-Score net” shows the results of the neural network prediction, while the column “M-Score” represents the actual results of the model. The



error between the two models was calculated to determine the accuracy of the neural network in simulating or improving the performance of the Beneish model. The results showed that the error rate is small in all sample members, which indicates the accuracy of the neural network's prediction. In the Bank of Baghdad, the actual M-Score value reached (-2.695018661981643), while the M-Score net in the neural network reached (-2.624385779248165), and the error rate was (0.00176) very small. In the Bank of Sumer, the actual value reached (-1.138472919578008), and the value resulting from the neural network (-1.208510090190210), and the error rate (-0.00175). As a final result, the results obtained through the application of the Beneish model were determined for (5) banks, namely (Iraqi Investment Bank, National Bank of Iraq, Iraqi Credit Bank, Mosul Bank, Sumer Bank).

It is likely that Its financial statements contain unintentional errors or deliberate distortions. These same results were reached using a neural network. The above results demonstrate that the neural network produces accurate results when trained on the actual results obtained by applying the Beneish model. Therefore, the null hypothesis (**artificial intelligence using neural networks does not contribute to predicting fraud in financial statements**) can be rejected. The alternative hypothesis (**artificial intelligence using neural networks contributes to predicting fraud in financial statements**) can be accepted.

5. Conclusions and Recommendations

5.1 Conclusions

- 1- Financial statement fraud is one of the most dangerous types of fraud due to its difficulty in detection. The fraudster manipulates accounting principles but uses them for personal gain, in addition to concealing his actions with fictitious documents and collusion among employees. This type of fraud also has a detrimental impact on the economic performance of the entity, potentially exposing it to bankruptcy.
- 2- External auditing contributes to detecting distorted financial statements using financial ratio analysis (the Beneish model), as this model provides indicators that reveal material misstatements in the financial statements.
- 3- There were no significant differences between the average results actually obtained to identify fraudulent banks and the results predicted using neural networks. The network accurately identified banks engaging in financial fraud, indicating the neural network's ability to distinguish unusual patterns.
- 4- Neural networks are an effective analytical tool for improving the external audit process through their ability to analyze large amounts of data quickly and accurately.
- 5- External auditing based on neural networks helps reduce audit risks, as the network provides an understanding of the audited entity's environment, enhancing the auditor's personal judgment.
- 6- Neural networks are an effective analytical tool through their ability to analyze large amounts of data quickly and with high accuracy, which helps auditors in financial analysis to understand the environment of the unit being audited.



5.2 Recommendations

- 1- Audit firms in Iraq should adopt artificial intelligence (neural networks) as an enhanced tool in performing audit procedures, particularly in the audit planning process and fraud risk assessment. This enhances users' confidence in the audit results of audit firms.
- 2- The necessity for auditors to rely on neural networks in analyzing financial ratios (the Beneish model) during the audit planning process, as this model provides indicators of fraud in the financial statements.
- 3- The Iraqi Financial and Accounting Standards Board should update its audit manuals and adopt an audit manual specifically for technology and artificial intelligence, ensuring information security and procedural integrity. This is a key requirement for the Iraqi environment, and audit firms should be directed to adopt technology in their auditing tasks.
- 4 Attention should be given to training and qualification of external auditors by holding practical training courses in the field of artificial intelligence (neural networks) to develop and enhance the skills of staff.
- 5- The need to enhance cooperation between universities and professional bodies to exchange knowledge and develop software based on artificial intelligence.
- 6- Focus on modern auditing curricula, particularly those related to data analysis and risk assessment using artificial intelligence and its technologies.

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