The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

# PREDICTING THE PERFORMANCE OF SHARIA BANK IN INDONESIA USING ARTIFICIAL NEURAL NETWORKS

**GARIN PRATIWI SOLIHATI [1]*, HERRY SUHARDIYANTO [2], DEDI BUDIMAN HAKIM [3] and TONY IRAWAN [4]**

[1] Universitas Mercu Buana Jakarta, Indonesia.
[2, 3, 4] Institut Pertanian Bogor (IPB), Indonesia.
Email: [1]garin@mercubuana.ac.id (*Corresponding Author), [2]herrysuhardiyanto@apps.ipb.ac.id, [3]dbhakim@apps.ipb.ac.id, [4]tonyirawan82@gmail.com

**Abstract**

This research provides an analysis of Islamic banking health using the Artificial Neural Network (ANN) approach, incorporating various theories such as Signalling Theory, Sharia Enterprise Theory (SET), Stewardship Theory, and Stakeholder Theory. Internal data of Islamic banks were evaluated with a focus on variables such as Return on Assets (ROA), Return on Equity (ROE), Financing to Deposit Ratio (FDR), Operating Expenses to Operating Income Ratio (BOPO), Net Interest Margin (NIM), Capital Adequacy Ratio (CAR), and Non-Performing Financing (NPF). The analysis results indicate that factors like Good Corporate Governance (GCG), Islamic Corporate Social Responsibility (ICSR), Zakat, and Sharia Compliance play crucial roles in influencing Islamic banking health. Policy recommendations include revising the selection of input variables, enhancing Sharia Governance, and re-evaluating the relevance of Sharia Supervisory Board (DPS) meetings. The implications of these findings provide guidance to improve the effectiveness of Islamic banking policies by considering additional variables. The research suggests that optimizing the model by incorporating additional variables such as Loan to Deposit Ratio (LDR) can enhance the accuracy of Islamic banking health evaluations through the ANN approach. Policy recommendations and research findings serve as a foundation for Islamic financial institutions to enhance their performance and operational sustainability.

**Keywords:** ICSR, GCG, Zakat, Syariah Governance, Syariah Compliance, ANN.

## BACKGROUND

Based on World Population Review data, the number of Muslim residents in Indonesia in 2020 reached 229 million people or 87.2% of the total population of 273.5 million people. As a country with the largest Muslim population in the world, Indonesia is a country that is seen by some parties as a potential market share in developing products with Muslim labels.

One of the businesses that began to develop in Indonesia in the early 1990s was sharia commercial banks with the start of operations of Bank Muamalat Indonesia on May 1 1992. By definition, based on Law number 10 of 1998 concerning Banking, it is known that banks are referred to as business entities that collect funds from the community in the form of savings and channeling them to the community in the form of credit and/or other forms in order to improve the community's standard of living. In Law No. 21 of 2008, Sharia Banking is everything that concerns Sharia Banks and Sharia Business Units, including institutions, business activities, as well as methods and processes in carrying out their business activities, while Sharia Commercial Banks are Sharia Banks whose activities providing services in payment traffic. The activities of sharia commercial banks are, collecting funds, disbursing

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

financing, carrying out credit card/payment business, buying, selling, guaranteeing risks, receiving payments, safekeeping, other general activities as well as social activities.

Performance assessment from non-financial aspects, namely corporate social responsibility (Islamic Corporate Social Responsibility) and corporate governance (Sharia Governance). According to Khursid et al. (2014) Islamic Corporate Social Responsibility is a concept of corporate social responsibility that has dimensions of Islamic economics, Islamic law, Islamic ethics and Islamic philanthropy based on Islamic values found in the Al-Quran and hadith. Companies that have good environmental performance (Corporate Social Responsibility) will be responded positively by investors through share price fluctuations which increase from period to period and vice versa if the company has poor environmental performance (Corporate Social Responsibility) then doubts will arise from investors. towards the company and responded negatively with fluctuations in the company's share prices in the market which were decreasing from year to year (Almilia and Wijayanto 2007). Research on Islamic corporate social responsibility was previously researched by Sidik and Reskino and Arifin and Wardani (2016). Corporate social responsibility does not have a significant influence on company performance. Research by Arifin and Wardani (2016) also states that ICSR has an effect on company performance as measured by ROE.

The level of financial performance of a bank can influence public trust in the bank because the public will tend to choose banks that have credibility and high levels of profits to entrust their funds to. The emergence of issues regarding weaknesses in corporate governance in the Islamic banking industry has attracted the attention of Islamic economics and finance experts in revealing important issues related to weaknesses in corporate governance (good corporate governance). Apart from good corporate governance, sharia banking also applies sharia governance or what is better known as sharia governance. Issues such as the level of compliance of Islamic banks and good corporate governance can affect the financial performance of Islamic banks. This is due to the increasing awareness of the Muslim community regarding sharia rules. Therefore, apart from using conventional measurements, the financial performance of Islamic banks must also be implemented in terms of sharia objectives.

The IFSB explains that the definition of Sharia Governance is a set of institutional and organizational regulations by which sharia financial institutions can ensure that there is an independent view on sharia compliance through the process of issuing relevant sharia fatwas, disseminating fatwa information and internal reviews of sharia compliance. Sharia Governance in this research is indicated by the number of Sharia Supervisory Board Meetings. Based on Bank Indonesia Regulation no. 11/33/PBI/2009 article 49 concerning the implementation of Good Corporate Governance for Sharia Commercial Banks and Sharia Business Units, Sharia Supervisory Board meetings must be held at least once a month and decision making at Sharia Supervisory Board meetings is carried out based on deliberation and consensus. Fauzi (2016) stated that the more frequently the Sharia Supervisory Board meetings are held, the better the monitoring of sharia banks will be, thus it can improve company performance because the company continues to operate in accordance with sharia principles. Research on Sharia Governance has also been studied by Sunarwan (2016) who shows that the influence of

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

Corporate Governance in terms of Sharia Supervisory Board meetings has a significant effect on the performance of sharia banking. These results contradict research conducted by Kartika (2014) and Fauzi (2016) which shows that the Sharia Supervisory Board is a variable that has no real effect on banking performance.

Sharia compliance is part of implementing risk management and creating a culture of compliance in managing sharia banking risks. Sharia compliance also has international standards prepared and determined by Islamic. Financial Services Board (IFSB) where sharia compliance is part of institutional governance (corporate governance). To fulfill Sharia Bank compliance with sharia principles, the Islamic Disclosure Index (IDI) is recommended, which is developed based on three Islamic disclosure indicators, namely sharia compliance, corporate governance and social/environmental disclosure. The Islamicity discloser index and the Islamicity performance index are two factors that can increase the performance level of Islamic banks. The Islamicity discloser index consists of corporate governance, social and sharia compliance. The Islamicity performance index consists of zakat performance, profit sharing, equitable distribution, Islamic investment, Islamic income, directors employee welfare.

This research also added the calculation of the zakat performance ratio and Islamic investment ratio because these values have the opportunity to have a greater influence on financial performance in Islamic banks based on stewardship theory and Sharia Enterprise Theory. The purpose of the Islamic income ratio is to measure income that comes from halal income. Principles in Islam prohibit transactions containing usury and require halal trade. The profit sharing ratio shows how far Islamic banking has achieved existence by obtaining profit sharing from providing financing to customers. Profit sharing financing is the core of sharia bank financing, because profit sharing is the most important component in sharia banking. The Islamic investment ratio is used to see the percentage of Islamic investment made by the bank of the total investment. The zakat performance ratio is a ratio that measures how much zakat is distributed by the bank compared to Net Income.

Good corporate governance is one factor that is also considered capable of influencing banking health. In carrying out the business strategies that have been planned by the company to improve performance, it is very important for the company to have good governance. Corporate governance is a system that regulates and controls a company in carrying out its business in order to increase success and accountability based on statutory regulations and ethical values.

Based on this situation, the problem formulation in this research can be detailed as follows:

1. Are Good Corporate Governance (GCG), Islamic Corporate Social Responsibility (ICSR), Zakat, Sharia Governance (SG), Sharia Compliance (SC) strongly correlated with the health of Islamic commercial banks?
2. Can the health performance of Islamic banking in Indonesia be modeled using artificial neural networks?
3. Can artificial neural network models be used as a basis for considering improving the health of Islamic banking in Indonesia?

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

## LITERATURE REVIEW

### Signaling Theory

Signaling theory can be defined as a form of information that influences the decisions of investors and business people regarding the financial condition of a bank in the past, current or future periods. This information includes information, notes and financial descriptions, as well as their impact on the economy. Signals or information are crucial for investors in making decisions, with the accuracy and timeliness of information being the key in analyzing financial behavior in the capital market.

Signal theory has explained the reasons behind companies' desire to provide financial report information to external parties. This motivation arises because of concerns about information asymmetry between companies and outside parties, especially investors and creditors. Lack of information to external parties can cause a low assessment of the company. Therefore, companies try to reduce information asymmetry by providing signals to outside parties, which is explained by signaling theory. In the context of Islamic bank financial reports, signal theory is important to explain to external parties as a form of accountability for the performance of Islamic banks.

The use of signal theory in this research can be explained by its relationship to the availability of information, especially those related to Islamic bank financial reports. This financial report plays an important role as a guide for investors in the decision-making process. Therefore, Islamic banks are expected to provide accurate and precise information about their financial condition. Signal theory is closely related to the three main variables in this research, namely CAR (Capital Adequacy Ratio), NPF (Non-Performing Financing), and FDR (Financing to Deposit Ratio). Signaling theory is relevant because the information conveyed through Islamic bank financial reports is expected to make it easier for users of financial reports, including the public, to analyze the bank's financial performance by considering the fundamental variables CAR, NPF and FDR. The high value of the capital adequacy ratio (CAR) in the financial statements shows the ability of Islamic banks to manage their financial management well, creating a positive view from outside parties. On the other hand, the high value of the NPF ratio (financing risk) indicates that the financial management of Islamic banks is not yet efficient, creating negative views from outside parties. The high value of the FDR ratio indicates that a sharia bank can maintain its level of liquidity with the effectiveness of the financing it disburses, reflecting the bank's ability to channel its funds to debtors and pay back to depositors.

### *Sharia Enterprise Theory (SET)*

Corporate Social Responsibility (CSR) in Islam includes several main concepts, including zakat, justice, benefit, responsibility, and falah. These concepts form Sharia Enterprise Theory (SET), as explained by Zakiy (2015). SET is used as a framework for understanding corporate stakeholders from an Islamic perspective, emphasizing that corporate stakeholders involve not only humans, but also the natural environment and God.

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

SET emphasizes that humans have a moral responsibility to Allah for all their activities in the world, in accordance with the principles of justice and benefit. Company stakeholders in Islam involve not only humans, but also spiritual and natural aspects, as explained by Triyuwono (2007) in research by Sidik and Reskino (2016). Allah is considered the highest stakeholder in SET, and humans have a moral responsibility towards Him as the main goal of life, in accordance with the views of Novarela and Sari (2015).

Thus, it can be concluded that Sharia Enterprise Theory (SET) supports the implementation of Islamic Corporate Social Responsibility in accordance with the principles of Islamic law. This theory also supports the obligation to pay zakat by sharia banking, which is the responsibility of Muslims. Meutia (2010) emphasized that SET is the most relevant theory for describing corporate social responsibility, especially Islamic banks, because SET focuses on Allah as the main source of trust. Resources owned by stakeholders are considered a trust from Allah, who demands responsibility for their use in accordance with the provisions set by the Almighty Trustee.

***Artificial Intelligence Theory***

Artificial intelligence (AI) refers to computing programs that have the ability to enable machines to perform tasks similar to human intelligence, including decision making, problem solving, and prediction (Russell and Norving 2016). Another term for artificial intelligence is external intelligence (Gaudron 2019). Artificial intelligence operates using algorithms, with machine learning and deep learning being the two most commonly used techniques for processing data in the context of artificial intelligence.

Algorithms, in a simple sense, refer to sequentially arranged computational steps (Knuth et al. 1998). These algorithms serve as "recipes" for artificial intelligence programs that produce predictions and outputs (Gillespie 2013). Machine learning is a subset of artificial intelligence. To make machines intelligent, machine learning algorithms first learn from data provided by humans as input (Goldberg and Holland 1998).

The process of machine training (training) involves providing data and responses repeatedly, so that the machine can develop general patterns (models) of human intelligence functioning. Deep learning is a field that originates from machine learning. Compared with machine learning, deep learning works more autonomously (Cun et al. 2015). Independent in this context refers to the ability of deep learning algorithms to train machines with much larger data and nested hierarchical layers. In this way, machines can recognize general patterns in data without relying on humans to provide input. The concept of artificial intelligence involves the use of algorithms, machine learning, and deep learning to enable machines to perform intelligent tasks automatically. Artificial intelligence (AI) can be grouped into two dimensions, as described by Bishop et al. (2000). This relatively simple type of artificial intelligence, with a low level of machine involvement, can be found in applications such as image-to-text conversion. In this system, the human role is needed to provide input in the form of images into the system, which is specific because it is specifically designed to convert images into writing. On the other hand, artificial intelligence that is still simple but adaptive can be

ISSN 1533-9211

DOI: 10.5281/zenodo.10605039

illustrated with the example of a travel route guide. With its adaptive nature, artificial intelligence in street signs is able to adjust routes based on factors such as congestion conditions.

This type of artificial intelligence with a high level of machine involvement is found in applications such as transaction fraud detection systems and autonomous vehicles without drivers. These two systems, respectively, have specific and adaptive properties.

It is worth noting that, regardless of the type of application, AI has a major challenge, namely bias. This challenge arises because there is always a "black box" in the data processing process by AI, as stated by Citron and Pasquale (2014) and Russell and Norvig (2016).

**Artificial Neural Networks**

A brief history of the development of artificial neural networks (ANN) stems from research on biological neural networks, which allows researchers to create mathematical models of neurons to simulate the behavior of neural networks. Attempts to understand how the brain works began with Ramon Cajal (1911), who introduced the concept of neurons as the basic structure of the human brain. In the early 1940s, these efforts developed further with the introduction of the first abstract model of the neuron by McCulloch and Pitts (1943). Neural network learning theory was introduced by Hebb (1949). Other researchers, such as Minsky (1954) and Rosenblatt (1958), continued to develop it in the following two decades.

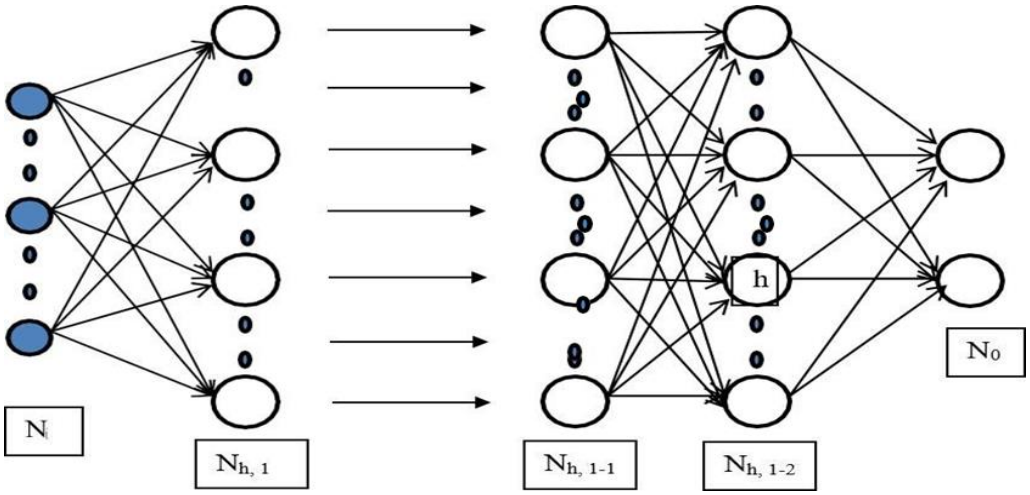



**Figure 2.2: ANN with hidden layer**

Neural networks are an artificial representation of the human brain which always tries to stimulate the learning process in the human brain (Kusumadewi 2003). The term artificial is used here because neural networks are implemented using computer programs that are capable of completing a number of calculation processes during the learning process. ANN is basically composed of several layer layers, namely input layer, hidden layer and output layer. Nodes or units connected from the input layer to the hidden layer or from one layer to another layer are connected by synapses which are represented by weighting values obtained in the learning

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

process. One of the ANN learning methods is backpropagation. The backpropagation algorithm uses error to change the weighting value in the backward direction. To get an output error, the forward propagation stage must be carried out first

**Banking Theory**

Banks, according to Law Number 10 of 1998 concerning Amendments to Law Number 7 of 1992 concerning Banking, are defined as business entities that collect funds from the public in the form of savings and allocate them to the public in the form of credit and other forms with the aim of increasing people's standard of living. This definition reflects the main function of banks as collectors and distributors of funds.

Rindjin (2000) states that the definition of a bank can vary according to bank development. These definitions can be grouped into three main groups, namely those that emphasize the function of banks as recipients of deposits, those that emphasize the function of banks as institutions that provide credit, and finally a combination that involves the creation of new purchasing power.

Banks, as financial institutions, involve three main activities, namely providing credit, providing services in payment traffic, and participating in money circulation traffic. Financial institutions themselves include all bodies that, through their financial activities, attract and distribute money to society.

**Capital**

Bank capital is funds invested by the owner in the context of establishing a business entity which is intended to finance the bank's business activities in addition to complying with regulations set by the monetary authority (Taswan 2010).

(Kasmir 2008) explains that CAR is a ratio that shows the extent to which all bank assets that contain risk (credit, investments, securities, claims on other banks) are financed from the bank's own capital funds, both from sources outside the bank, such as public funds. , loans (debt), and others. The higher the CAR, the better the bank's ability to bear the risk of any risky credit/productive assets.

Capital Adequacy Ratio according to (Dendawijaya 2000) is a ratio that shows the extent to which all bank assets that contain risk (credit, investments, securities, claims on other banks) are financed from the bank's own capital funds in addition to obtaining funds from other sources. outside the bank, such as funds from the public, loans, etc.

**Islamic Corporate Social Responsibility (ICSR)**

Conceptually, disclosure is an integral part of financial reporting. Technically, disclosure is the final step in the accounting process, namely the presentation of information in the form of a complete set of financial statements. Disclosure is information provided by the company to interested parties regarding the condition of the company

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

According to research by Andriyanto and Metalia (2011), information disclosure in company financial reports is divided into two, namely mandatory disclosure and voluntary disclosure. Mandatory disclosure is disclosure that is required by applicable regulations, in this case the regulations set by the authorized institution. Meanwhile, voluntary disclosure is disclosure that exceeds what is required.

**Zakat**

Zakat literally means blessing, clean, good and increasing (Munawir 1997). Zakat in terms of language (lughatan) has several meanings, namely blessing (ak-barakatu), growth and development (al-nama'), purity (al-taharatu), and order (al-sayau). Meanwhile, the meaning of zakat in terms of terms (shar'iyah) is that zakat is part of property with certain conditions, which Allah SWT requires the owner to hand over to those who are entitled to receive it, with certain conditions (Nawawi 2013). Meanwhile, in Law No. 38/1999 concerning Management of zakat, it is stated that zakat is property that must be set aside by a Muslim or an entity owned by a Muslim in accordance with religious provisions to be given to those entitled to receive it. Based on this understanding, zakat is not the same as voluntary donations/contributions/shadaqah.

**Sharia Compliance**

Sharia banks are banks that carry out their business activities based on sharia principles (Yaya 2014). Fulfillment of sharia values (sharia compliance) is one of the fundamental aspects that differentiates Islamic banking from conventional (Maradita 2014). Compliance risks are coordinated with work units in risk management. The compliance function carries out preventive supervisory duties and is an important element in the management and operations of sharia banks, capital markets, sharia insurance, sharia pawnshops and non-bank sharia financial institutions (sharia financial services cooperatives). This is done to ensure that the policies, provisions, systems and procedures carried out by Islamic banking are in accordance with the provisions and regulations of Bank Indonesia, the Government, Bapepam-LK, MUI Fatwa, as well as legal provisions that have been stipulated in the IFSB international standards, AAOIFI, Sharia Supervisory Board (SSB) (Sukardi 2012). In this study, three indicators were used to measure sharia compliance according to Hameed et al. (2004) in (Falikhatun 2012), namely, Islamic Income Ratio (IsIR), Profit Sharing Ratio (PSR), and Islamic Investment Ratio (IIR).

**Sharia Governance**

Corporate governance is basically a system that includes input, process and output and a set of regulations that regulate relationships between stakeholders, especially in the narrow sense of the relationship between shareholders, the board of commissioners and the board of directors in order to achieve company goals. Corporate governance is intended to regulate these relationships and prevent deviations in implementing company strategy and to ensure that if errors occur they can be corrected immediately (Faozan 2013).

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

**Previous Research**

Gontar 2019), Volgograd State Technical University, Volgograd, Russia, in research entitled "Artificial Neural Network Model for Systems of Economic Security of Banks". To prove theoretically and practically the need to research and develop additional mechanisms, increase the level of economic security of the financial sector using the Artificial Neural Network (ANN) method. Based on the ANN approach to the analysis of economic phenomena, companies can build self-training expert systems, modeling decision-making situations.

Estiko and Wahyuddin 2019), Department of Economics, Hanyang University, Seoul, South Korea 2Master of Information Systems, Indonesian Computer University, Bandung in research entitled "Analysis of Indonesia's Inflation Using ARIMA and Artificial Neural Network". To research whether there are any interesting trends in Indonesian inflation and to compare/predict the performance of the autoregressive integrated moving average (ARIMA) model made by artificial neural networks (JST/ANN) in the case of Indonesian inflation. The results find that the short-term delayed (backward) inflation variable has a lower effect on inflation compared to more recent series. The research also found that the ANN model outperformed the ARIMA model in estimating inflation for each series by analyzing the Root Mean Squared Error (RMSE).

Prashanth and Ahmed 2020, School of ECE, REVA University,Bengaluru- 560064, India, in research entitled "Artificial Neural Network based Modeling and Simulation to Identify new candidates for hosting Skyrmions", to research Input: Chiral Ideal Crystal Output: Chiral New Crystal, using Probalistic Classification, Artificial Neural Nerworks (ANN), Statistical Techniques, research results show This research has adopted experimental research which offers a flexible method to achieve the goal, Acceptable prediction results are achieved by the ANN model.

Haider and Nahif 2018, in research entitled Inflation forecasting in Pakistan using Artificial Neural Networks which examines Inflation Estimates (compare the forecast performance of the ANN model with conventional univariate time series forecasting models such as AR(1) and ARIMA), using Arficial Neural Nerworks (ANN), RMSE (root mean square Errors), ARIMA, results show that the RMSE of the ANN based estimates is much less than the RMSE of the estimates based on the AR(1) and ARIMA models. At least with this criterion, estimates based on ANN are more precise.

Oyewale et al. 2019, Agunloye Oluokun Kasali2, Kgosi Phazamile M.3, Michael Vincent Abiodun4, Eriobu Nkiru Obioma5, Abdulazeez Ismail Adeyinka, 2019, Department of Statistics, Federal Polytechnic, Ede, Osun State Nigeria Department of Statistics, University of Botswana, Gaborone, Botswana 3Department of Mathematics, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria 4Department of Statistics, Federal Polytechnic, Bida, Niger State, Nigeria Department of Statistics, Faculty of Physical Science, Nnamdi Azikiwe University, Awka, Anambra State, in a study entitled “Forecasting Inflation Rates Using Artificial Neural Networks”, which examines inflation forecasting, using Artificial Neural Nerworks (ANN), Neural networks (Standard Backpropagation (SBP) .

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

## Hypothesis

Based on theoretical research, there are strong indications that Good Corporate Governance (GCG), Islamic Corporate Social Responsibility (ICSR), Zakat, Sharia Governance (SG), and Sharia Compliance (SC) have a significant correlation with the health of Islamic commercial banks. Simultaneously, all of these variables make a significant contribution to the bank's health condition. Therefore, emphasis is placed on selecting an artificial neural network model, which not only evaluates the partial correlation between each parameter and the output variable, but also takes into account the interactions between the parameters that influence each other. An artificial neural network model that is able to provide accurate and responsive predictions of the current condition of bank health has the potential to become a basis for consideration for improving the health of sharia banking in Indonesia. By utilizing the prediction results from the model, Islamic banking institutions can identify key factors that influence bank health and implement appropriate actions to improve health.

## Variable Operationalization.

Health Level Assessment is carried out by calculating the ROA, ROE, NIM, CAR, BOPO, FDR, NPF variables and then entering them into the health level assessment system for commercial banks, in accordance with Bank Indonesia Regulation No. 13/1/PBI/2011, and SE No. 13/24 DPNP dated 25 October 2011. These variables are:

### 1. Finance to Deposit Ratio

FDR is a term in sharia banking. Meanwhile, the Financing Deposit Ratio (FDR) states how far the bank's ability is to repay withdrawals made by depositors by relying on credit provided as a source of liquidity.

### 2. Good Corporate Governance (GCG)

Based on SE BI No. 15/15/DPNP 2013, banks are required to carry out self-assessments regarding GCG implementation. The GCG composite score helps researchers see the state of GCG of each bank. GCG self-assessment has been established, which includes eleven assessment factors

### 3. Return on Assets (ROA)

Return on Assets (ROA) measures the comparison between net profit after deducting interest and tax expenses (Earning After Taxes / EAT) resulting from the company's main activities with the total assets (assets) owned by the company to carry out the company's activities as a whole and expressed as a percentage.

### 4. Operating Costs to Operating Income Ratio (BOPO)

Operating Costs Operating Income (BOPO) is a ratio that describes banking efficiency in carrying out its activities. Operational costs are interest costs given to customers, while operating income is interest earned from customers. The smaller the BOPO value means the more efficient the banking is in operating.

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

### 5. Capital Adequancy Ratio (CAR)

Capital Adequacy Ratio according to (Dendawijaya 2000) is a ratio that shows the extent to which all bank assets that contain risk (credit, investments, securities, claims on other banks) are financed from the bank's own capital funds in addition to obtaining funds from other sources. outside the bank, such as funds from the public, loans, etc.

### 6. Zakat

The company's zakat calculation is based on the financial report (balance sheet) by subtracting liabilities for current assets, or all assets (excluding facilities and infrastructure) plus profits, minus debt payments and other obligations, then paying 2.5 percent as zakat. Meanwhile, another opinion states that it is only profits that must be paid zakat.

### 7. Sharia Governance

Shariah Governance (SG) in this study was measured by scoring three categories, namely

a. Number of DPS members. If the number of DPS members in a sharia bank meets the provisions of Bank Indonesia Regulations, namely a minimum of 2 members, then it is given a value of 1. And vice versa, if it does not comply, it is given a value of 0;

b. Educational qualifications of DPS members. If a DPS member has doctoral status then it is given a value of 1 and otherwise it is given a value of 0;

c. Frequency of DPS meetings. If the average attendance of DPS members at a DPS meeting is more than 50% then it is given a score of 1 and otherwise a score of 0 is given.

### 8. Sharia Compliance

#### a. Islamic Income Ratio (IsIR)

The Islamic Income Ratio is used to assess the percentage of Islamic income from all total income received by sharia banks, both halal and non-halal income.

#### b. Profit Sharing Ratio (PSR)

Profit Sharing Ratio is used to see how Islamic banks use profit sharing activities in their activities with total financing. The ratio for calculating profit sharing from financing carried out by Islamic banks includes mudharabah and musyarakah.

#### c. Islamic Investment Ratio (IIR)

The Islamic Investment Ratio is used to see the percentage of Islamic investment made by the bank of the total investment.

### 9. Islamic Corporate Social Responsibility

The Islamic Corporate Social Responsibility concept was developed from conventional Corporate Social Responsibility. social responsibility that has Islamic values contained in the Al-Qur'an and hadith

ISSN 1533-9211

DOI: 10.5281/zenodo.10605039

**Data analysis technique**

Data analysis techniques are designs for analyzing data that has been collected from sources, whether observations in the field or from other sources that can be concluded and informed to parties. Activities in data analysis are grouping data based on variables and tabulating data based on all variables, presenting data from the variables studied, as well as carrying out calculations to answer the problem formulation and carrying out calculations to test the hypotheses that have been proposed.

a. The data analysis technique in this research uses Artificial Neural Networks (ANN).

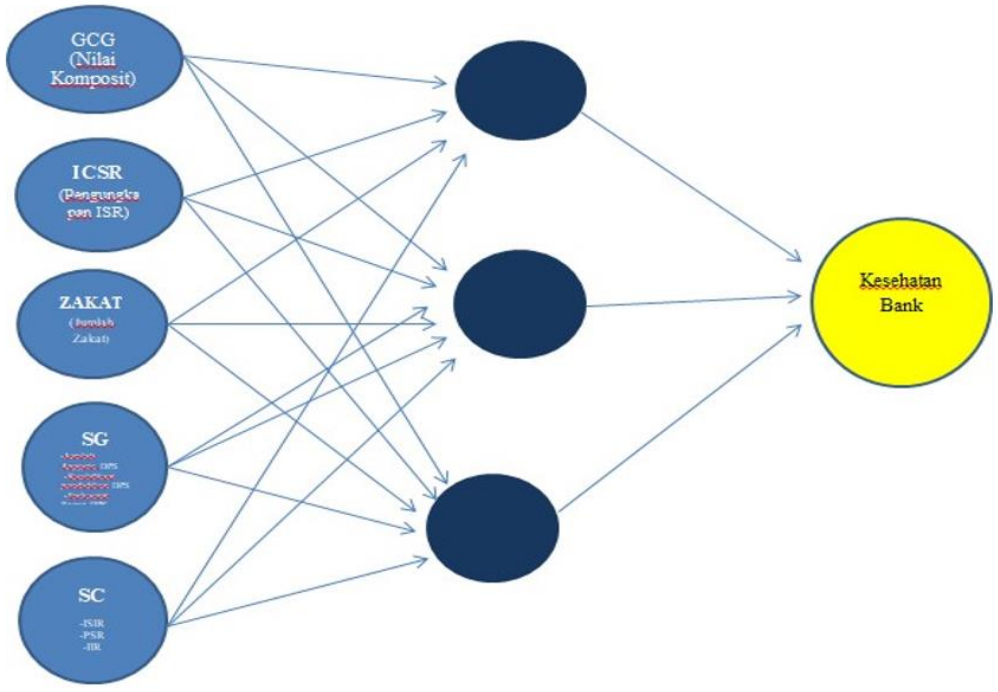
Artificial Neural Networks (ANN) are used to determine the simultaneous influence of GCG, ICSR, Zakat, SG and SC on the health of the Bank as depicted in the backpropagation algorithm. This algorithm was developed by (Rumelhart et al. 1986). In this research, we use a Single Layer Perceptron, input, output and hidden layers in neural networks, namely:

Ní = GCG,ICSR, Zakat, SG,SC.

Nh, 1= Bank Health N0= Performance

Backpropagation algorithm, in this research which illustrates

input, output and hidden layers can be seen in the image as follows:



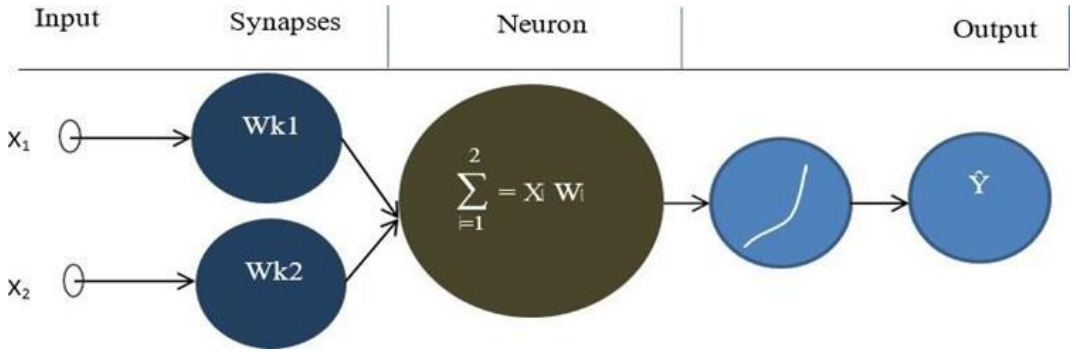

**Backpropagation algorithm GCG, ICSR, Zakat, SG and SC on bank health**

Based on the GCG, ICSR, Zakat, SG and SC Backpropagation algorithms for the health of the Bank above, a learning process is carried out by carrying out a feed forward process by sending

ISSN 1533-9211

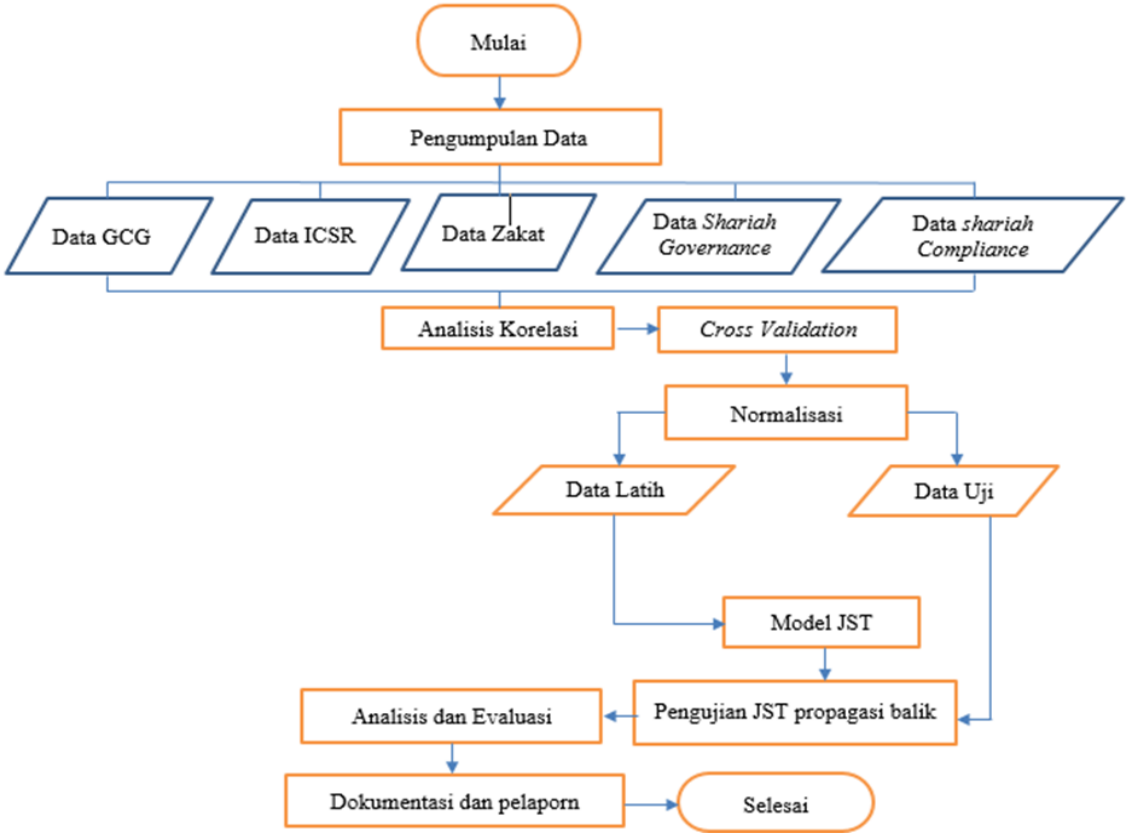
DOI: 10.5281/zenodo.10605039

a 'forward' signal. Depicted through the Perceptron, namely an NN network consisting of input, synapses, neurons and output. Calculations are carried out in each perceptron, the results depend on the number of inputs and outputs and calculating the final result depends on the activation function used. The process carried out in the feed forward process in this research is described in the following Perceptron:




**Perceptron GCG, ICSR, Zakat, SG and SC on the health of Bank**

## RESULTS AND DISCUSSION




**Struktur JST *backpropagation***

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

Steps in developing an ANN Model with the Backpropagation Algorithm

1. Data set preprocessing: At this stage there are several processes, namely
   - Data cleaning,
   - Normalization of data sets
   - Data set sharing.
2. Development of the ANN Model
   - The development of this ANN model was carried out at Google Colaboratory using the Python programming language.
   - The ANN architecture in this research uses 18 input layer nodes and 7 output layer nodes.
   - The stains on the input layer are X data, namely GCG, ICSR, Zakat, SG, SC. Meanwhile, the stains on the output layer are Y data, namely bank health, ROA, ROE, FDR, BOPO, NIM, NPF, CAR
3. Determining the Best Model Parameter Values
   - Carrying out the Training and Testing Process
   - Looking for the best parameter values, namely: Random State, Learning Rate Initial, Momentum, Stains in hidden layer sizes,and Maximum Iteration
4. Evaluation of ANN Model Prediction Data
   - Evaluation is carried out by comparing the model prediction results with the measurement results.
   - This evaluation process is carried out using several assessment criteria, namely the coefficient of determination (R2) and Root Mean Square Error (RMSE)
   - R-squared (R2) or coefficient of determination, is a measure that tells how well a statistical model (such as a regression model) can explain or predict the data we have
   - R2=0 means the model does not explain any variation at all.
   - R2=1 means the model explains all the variation in the data.
   - RMSE gives an idea of how accurate the model is in making predictions. The smaller the RMSE value, the better the model is at fitting the data and predicting values that are close to the true value.

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

**Table parameter input output**

| Variabel | | | | Min | Maks | Rata-rata |
|---|---|---|---|---|---|---|
| Input | Internal | GCG | 1 | 1 | 4 | 1.817 |
| | | | 2 | 1 | 3 | 1.892 |
| | | | 3 | 1 | 3 | 1.942 |
| | | | 4 | 1 | 3 | 1.858 |
| | | | 5 | 1 | 3 | 1.925 |
| | | | 6 | 1 | 3 | 1.942 |
| | | | 7 | 1 | 3 | 1.967 |
| | | | 8 | 1 | 3 | 2.008 |
| | | | 9 | 1 | 3 | 1.758 |
| | | | 10 | 1 | 3 | 1.850 |
| | | | 11 | 1 | 3 | 1.967 |
| | | ICSR | | 0.124 | 0.854 | 0.584 |
| | | Zakat | | 0 | 7.704E+10 | 7342407099 |
| | | SG | Jumlah Anggota | 0 | 1 | 0.525 |
| | | | Kualifikasi Pendidikan | 0 | 1 | 0.917 |
| | | SC | Isir | 0.765 | 1.000 | 0.990 |
| | | | PSR | 0 | 0.961 | 0.342 |
| | | | EDR | -0.049 | 1.909 | 0.426 |
| | Eksternal | Inflasi | | 2.036 | 11.1 | 4.636 |
| | | SWBI | | 2824 | 17145 | 9693.13 |
| | | Kurs | | 8991 | 14481 | 12189.825 |
| | | GDP | | 5.10229E+11 | 1.1191E+12 | 9.2808E+11 |
| Output | Kesehatan bank | ROA | | -20.13 | 13.58 | 1.112 |
| | | ROE | | -94.01 | 64.84 | 7.000 |
| | | FDR | | 1.105 | 289.2 | 90.962 |
| | | BOPO | | 8.709 | 217.4 | 92.609 |
| | | NIM | | -0.86 | 15.49 | 6.238 |
| | | CAR | | 3.84 | 76.4 | 21.540 |
| | | NPF | | 0 | 8 | 2.486 |

## Building an ANN model

The construction of the ANN model with the backpropagation algorithm was carried out using the scikit-learn library. uses a neural network model algorithm with the MLPRegressor class, taking into account several parameters.

| Parameter | Nilai |
|---|---|
| Hidden Layer Sizes | 1-20 |
| Activation Function | Logistic |
| Solver | Stochastic Gradient Descent |
| Random State | 0-20 |
| Learning Rate | Constant |
| Learning Rate Initial | 0,1-0,9 |
| Momentum | 0,1-0,9 |
| Maximum Iteration | 100-10000 |
| Tolerance | 1,00e-09 |
| N Iteration No Change | 10 |

ISSN 1533-9211

DOI: 10.5281/zenodo.10605039

**Table of results for the Best Model Parameter Values based on several input variable scenarios**

| Skenario | Input Variabel | Struktur Neural Network | *Random State* | *Learning Rate Initial* | *Momentum* | *Maximum Iteration* | R2 |
|---|---|---|---|---|---|---|---|
| e | Internal | 18 10 7 | 9 | 0,3 | 0.8 | 1010 | 0.13428 |
| 2 | Ekternal | 4 4 7 | 1 | 0.1 | 0.7 | 1090 | 0.06002 |
| 3 | Internal dan Eksternal | 22 10 7 | 10 | 0.6 | 0.2 | 940 | 0.15479 |

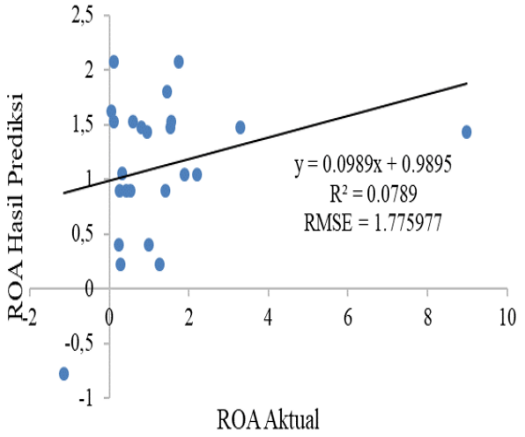
This table is the result of the best parameter values after carrying out the stage of determining the best parameter values. The table also displays the coefficient of determination values for the 3 scenarios carried out.

**Evaluation of ANN Model Prediction Data Results**

The evaluation process is aimed at finding out the best ANN model performance on datasets that have never been used in the training process. This can be seen in the following table and graph.

**Table of Predicted and Actual Results of Equation Y, R2 and RMSE Internal Parameters**

| No | Parameter | Persamaan (Y) | R2 | RMSE |
|---|---|---|---|---|
| 1 | ROA | 0.1662x + 0.9017 | 0.4091 | 3.2229 |
| 2 | ROE | 0.1478 x + 5.0077 | 0.4173 | 11.87117 |
| 3 | FDR | 0.0474x + 85.451 | 0.0094 | 14.26684 |
| 4 | BOPO | 0.2175x + 71.377 | 0.1872 | 15.06434 |
| 5 | NIM | 0.268x + 4.5061 | 0.4299 | 2.189153 |
| 6 | CAR | 0.1765x + 17.611 | 0.0639 | 11.43631 |
| 7 | NPF | 0.2808x + 1.8905 | 0.3464 | 1.524638 |



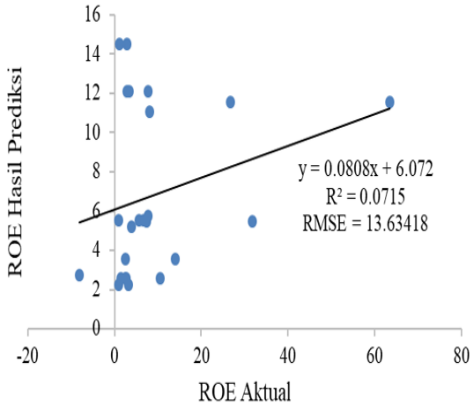
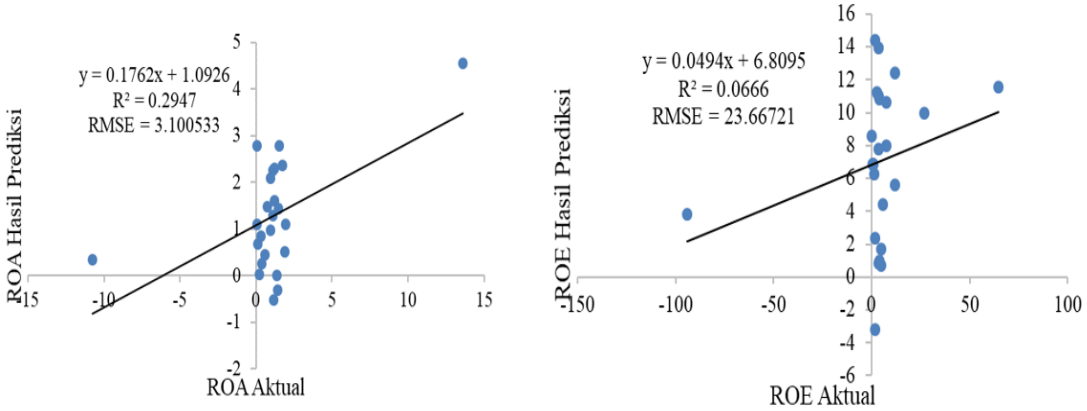




Table of Predicted and Actual Results for Y, R2 and RMSE Internal and External Parameters

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

| No | Parameter | Persamaan Y | R2 | RMSE |
|---|---|---|---|---|
| 1 | ROA | 0.1762x + 1.0926 | 0.2947 | 3.100533 |
| 2 | ROE | 0.0494x + 6.8095 | 0.0666 | 23.66721 |
| 3 | FDR | 0.1211x + 81.78 | 0.0988 | 23.37461 |
| 4 | BOPO | 0.1208 x + 80.836 | 0.1706 | 29.78531 |
| 5 | NIM | 0.1851x + 4.8949 | 0.2523 | 2.625737 |
| 6 | CAR | 0.1122x + 19.58 | 0.2449 | 14,79583 |
| 7 | NPF | 0.2468x + 1.8046 | 0.2081 | 1.344026 |




## DISCUSSION

### 1. Input Internal Variables

The output variables NIM, ROA, ROE, and NPF are the order of output variables that are most influenced by internal input variables based on the ANN model

The output variables CAR, BOPO, and FDR are the sequence of output variables that are least influenced by internal input variables based on the ANN model

### 2. External Variable Input

The NPF and FDR output variables are the sequence of output variables that are most influenced by external input variables based on the ANN model

The output variables ROA, ROE, CAR and BOPO are the sequence of output variables that are least influenced by external input variables based on the ANN model

### 3. Input External and internal Variables

The output variables ROA, NIM CAR and NPF are the sequence of output variables that are most influenced by internal and external input variables based on the ANN model

The output variables BOPO, FDR and ROE are the order of output variables that are least influenced by internal and external input variables based on the ANN model

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

From the output results it can be said that the correlations between variables are not too strong, but there are still good output prediction values such as NIM. ROA, ROE from input uses internal variables.

The results of external output variables are poor and do not produce good output predictions, as seen from the R2 value, because these input variables do not have a direct influence on sharia banking management

## Suggestion

1. Reducing the number of input variables, because some input variables may make the model worse because they have no influence
2. Conduct an evaluation by creating an ANN model from each output variable with different model parameters and comparing the results of each output

### References

1) Alam T. 2019. Forecasting exports and imports through artificial neural network and autoregressive integrated moving average. *Decision Science Letters. 8*(3):249–260. https://doi.org/10.5267/j.dsl.2019.2.001

2) Anggraini D, Mariana. 2023. Pengaruh Islamic Corporate Governance (ICG),Islamic Corporate Social Responsibility (ICSR), dan intellectual capital (IC) terhadap kinerja perbankan syariah di Indonesia. *AKUNESA : JurnalAkuntansi Unesa*. *11*(2): 118–127.

3) Awalia R, Krisntanti FT. 2023. Prediksi financial distress menggunakan artificial neural network (ANN) pada perusahaan perbankan yang terdaftar di Bursa Efek Indonesia (BEI) periode 2017-2021. *Jurnal Kajian Pendidikan EkonomiDan Ilmu Ekonomi*. *7*(2).

4) Chuku C, Oduor J, Simpasa A. 2017. *Intelligent forecasting of economic growth for African economies: Artificial neural networks versus time series and structural econometric models*. 159(4): 1–28.

5) Dirman, A. (2020). Financial distress: The Impacts of Profitability, Liquidity, Leverage, Firm Size, and Free Cash Flow. International Journal of Business, Economics, and Law, 22(1), 17–25.

6) Ghozilah U, Khasanah EK. 2020. Manajemen wakaf produktif dalam pemberdayaan ekonomi di KSPPS BMT Bina Umat Sejahtera Lasem Rembang. *Islamic Management and Empowerment Journal*. *2*(2): 151–168. https://doi.org/10.18326/imej.v2i2.151-168

7) Golnaraghi S, Zangenehmadar Z, Moselhi O, Alkass S, Vosoughi AR. 2019.Application of Artificial Neural Network(s) in predicting formwork labour productivity. *Advances in Civil Engineering*. 2019: 1–11. https://doi.org/10.1155/2019/5972620

8) Herbrich R, Keilbach M, Bollmann-Sdorra P, Obermayer K. 2018. Neural networks in economics : background , applications and new developments. *Advances inComputationalEconomics.11*(8):169–196. http://www.herbrich.me/papers/herkeilgraebollober99.pdf

9) Indrayani, Risna. 2018. Pengaruh islamic corporate social responsibility (icsr) dan sharia governance. *Jurnal Akuntansi, Keuangan Dan Perpajakan Indonesia*, *6*(1): 68–80.

10) Jahn M. 2018. Artificial neural network regression models: Predicting GDP Growth. In *HWWI Research Paper*. 185(185).http://hdl.handle.net/10419/182108

11) Khofifah AN, Patuh PM. 2022. Pengaruh islamic corporate social responsibility (ICSR), zakat dan islamic corporate governance (ICG) terhadap kinerja keuangan. *Jurnal Ilmu Dan Riset Akuntansi*. *11*(4): 1–22.

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10605039

12) Mais RG, Munir, Nuryasa N. 2023. Pengaruh islamic corporate social responsibilitydan sharia governance terhadap kinerja keuangan perusahaan. *Equilibrium: Jurnal Ekonomi-Manajemen-Akuntansi*.19(1): 42–49. https://doi.org/10.30742/equilibrium.v19i1.2792

13) Mayliza R, Yusnelly A. 2021. Pengaruh good corporate governance terhadap islamic social responsibility pada bank umum syariah di Indonesia. *Jurnal Tabarru': Islamic Banking and Finance*. *4*(2): 369–379. https://doi.org/10.25299/jtb.2021.vol4(2).7616

14) Moghaddam AH, Moghaddam MH, Esfandyari M. 2016. Stock market indexprediction using artificial neural network. *Journal of Economics, Finance and Administrative Science. 21*(41): 89–93.https://doi.org/10.1016/j.jefas.2016.07.002

15) Nabillah S, Oktaviana UK. 2022. Pengaruh zakat, islamic corporate social responsibility dan good corporate governance terhadap kinerja keuangan Bank Umum Syariah (Periode 2011-2015). *Jurnal Masharif Al-Syariah: Jurnal Ekonomi Dan Perbankan Syariah*. *7*(30): 577–588.

16) Notolegowo HK, Pujiyono A. 2016. Aplikasi model artificial neural network pada analisis determinan profitabilitas Bank Syariah (Studi empiris pada banksyariah di Indonesia periode 2006.Q1 - 2016.Q1). *Seminar Nasional TerapanRiset Inovatif*. 1*:* 459–467.

17) Rahma DA. 2021. *Analisis determinan financial distress bank umum syariah di Indonesia menggunakan artificial neural network*.

18) Thoqih MM, Sakti RK. 2020. *Analisis Pengaruh ROA, FDR, BOPO Terhadap Financial Distress (Studi Kasus pada Bank Muamalat Indonesia periode2001-2019)*.

19) Umiyati, Maisyarah L, Kamal M. 2020. Islamic Corporate Governance and ShariaCompliance on Financial Performance Sharia Bank in Indonesia. *Al- IQTISHAD: Jurnal Ilmu Ekonomi Syariah (Journal of Islamic Economics). 12*(1): 33–50. https://doi.org/https://doi.org/10.15408/aiq.v12i1.15053