International Journal of Zakat Vol. 9(Special) 2024 page 56-70

Zakat, Economic Growth, and Poverty Alleviation: An Artificial Neural Networks Analysis

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ABSTRACT

This research investigates the multifaceted relationship between zakat, economic growth (GDP), and poverty alleviation in Indonesia using Artificial Neural Networks (ANN). Our findings reveal that zakat has more prominent impact on poverty alleviation than on GDP. In particular, we identify a positive correlation between zakat distribution and GDP in Indonesia, indicating that higher zakat distribution contributes significantly to economic growth. It further reveals a negative correlation between zakat distribution and poverty, consistent with most earlier studies, suggesting that zakat significantly contributes to poverty alleviation in Indonesia. Our findings practically imply the potential economic significance of zakat in human development and solving poverty issues. Our research contributes to the novelty of Islamic philanthropic research with the power of advanced AI algorithms, offering insights that can inform policy decisions.

Keywords: *Zakat, GDP, Poverty, Artificial Intelligence, Artificial Neural Network (ANN).*

INTRODUCTION

The relationship between philanthropy and economic growth has long been a subject of scholarly interest and policy consideration. One particular form of charitable giving, zakat, a mandatory almsgiving in Islam, has been a scholarly topic due to its potential impact on economic development.

Zakat is one of the five pillars of Islamic faith that is central to the Islamic finance and social welfare systems. It involves the redistribution of wealth from the affluent to the less fortunate, with the aim of reducing poverty, promoting social justice, and fostering economic well-being within Muslim communities. While the ethical and humanitarian aspects of zakat have been widely discussed, its potential economic impact, especially on GDP, has remained a subject of academic debate.

This research delves into the complex interplay between zakat contributions to Gross Domestic Product (GDP) and poverty alleviation in a country, employing an innovative approach enhanced by Artificial Intelligence (AI) techniques, specifically Genetic Algorithms. Traditional economic models have attempted to quantify the effects of charitable giving on economic growth, but they often encounter challenges in capturing the intricate dynamics and externalities involved. This is where the power of AI, particularly Genetic Algorithms, comes into play. Genetic Algorithms offer a unique advantage in analyzing complex, nonlinear relationships within economic systems by mimicking the process of natural selection and evolution to optimize solutions. By harnessing the capabilities of AI, we aim to provide a more nuanced and data-driven understanding of how zakat contributions can impact GDP and alleviate poverty in a country.

In this study, the theoretical foundations of zakat and its potential mechanisms for impacting GDP and poverty are explored. This work introduces the concept of Artificial Neural Network (ANN) and its application to unravel the intricate of economic interactions and

dependencies that link zakat to GDP and poverty.

LITERATURE REVIEW

Zakat

Zakat is one of the most important pillars of Islam. It not only contains an element of vertical obedience to Allah (*hablum minallah*) but also embodies a horizontal social concern (*hablum minannas*). According to Harahap et al. (2022), etymologically, zakat carries the meanings of growth (*an-namaa*), purification (*ath-thaharatu*), and blessings (*al-barakatu*). In terminological, zakat means giving a portion of one's wealth that Allah *Ta'ala* has obligated to be given to specific groups (*mustahik)* under certain conditions and guidelines.

Sundari (2018) also explains that zakat originates from the word "*zakka*", which means "pure", "blessed", "grown", and "praiseworthy". She further adds that the word "*tazkiyah*", which means purification, is the root of zakat. Therefore, zakat means purifying oneself and one's possessions. Thus, zakat is a concept of worship taught by the Islamic religion and provides various benefits to both the giver of zakat (*muzakki*) and the zakat recipient (*mustahik*). Anik & Prastiwi, (2019) state that zakat has significant wisdom and benefits for the giver (*muzakki*), the recipients (*mustahik*), the wealth spent on zakat, and society, which are as follows:

a) *First*, zakat for the giver (*muzakki*) serves as evidence of faith in Allah *Ta'ala* by expressing gratitude for His blessings, fostering noble character by cultivating a high level of compassion, eliminating qualities of greed and avarice, creating peace in one's life, and developing and purifying one's wealth (Quran 9:103, Quran 30:39, Quran 14:7).
b) *Second*, zakat for the recipients (*mustahik*) functions to assist, support, and improve their lives so that they can meet their basic needs, worship Allah *Ta'ala*, avoid the dangers of disbelief, and eliminate feelings of envy, jealousy, and resentment that may arise when they see wealthy individuals living prosperously.
c) *Third*, zakat serves as a unifying pillar among the wealthy who enjoy their lives and the mujahidin who dedicate their time to strive in the path of Allah. The latter may not have sufficient time to pursue their own interests and provide for their families (Quran 2:273).
d) *Fourth*, zakat serves as a source of funds for the development of facilities and infrastructure that the Muslim community should possess, such as educational, healthcare, and socio-economic facilities, as well as the enhancement of human resources.
e) *Fifth*, zakat promotes ethical business practices because it is not accepted from wealth acquired through illegitimate means (al-Hadith). Muslims are also encouraged to be prosperous givers of zakat. Zakat is expected to encourage communities to produce goods that will contribute to the economic growth of the nation.
f) *Sixth*, from the perspective of community welfare development, zakat is one of the tools for income redistribution. Hence, it promotes economic growth.

Economic Growth

Long-term per capita output growth is considered economic growth. If the quantity of goods and services in an economy increases, then that economy is considered to be experiencing economic growth. Gross Domestic Product (GDP) reflects this increase in output (Anik and

Prastiwi, 2019) and it represents the total value of all goods and services produced within the borders of a country in a specific period, usually within one year.

As an important indicator, GDP is used for several purposes (Ichsan & Kurniawan, 2023), including:

i. *Measuring Economic Growth*: GDP indicates whether a country's economy is experiencing growth or contraction. Positive GDP growth signifies an increase in economic production, while negative growth indicates a decrease.
ii. *International Comparisons*: GDP allows for comparisons of the economic size between countries. It can be used to determine how one country's economic production measures up against another in terms of size.
iii. *Economic Well-being Assessment*: Although it does not directly measure well-being, GDP is often used as an indicator to gauge the level of economic well-being in a country. However, it should be noted that GDP does not account for fair income distribution, so it does not comprehensively reflect economic inequality.
iv. *Economic Policy*: Governments and policymakers use GDP data to plan economic policies, including fiscal and monetary policies, to influence economic growth and stability.
v. *Business Cycle Monitoring*: GDP data aids in monitoring business cycles, which are the phases of growth and contraction in the economy. This can help businesses and investors make informed decisions.

Relationship of Zakat on Economic Growth

How zakat at a 2.5% can impact on economic growth? In Table 1, previous studies on this critical query are presented. Ashfahany et al., (2023) explored the impact of zakat on economic growth with a sample of three countries, i.e., Indonesia, Malaysia, and Singapore, from 2003 to 2020 using panel data regression. They found that zakat distribution and population growth have a positive and significant influence on economic growth.

Al-Salih (2020) identified the role of zakat in building social and economic sustainability in Saudi Arabia. The results indicated that zakat is considered one of the most important systems in terms of economic sustainability and social welfare because its main objectives are to develop balanced socio-economic growth and to purify one's soul and wealth.

Suprayitno (2020) found similar results, discovering the influence of zakat distribution on macroeconomics in five provinces in Indonesia via ECM analysis. The study concluded that zakat allocated for consumptive aid has been able to provide a significant multiplier effect. Moreover, if it is given for productive purposes such as business capital or revolving funds, it can generate a greater multiplier effect in boosting the economy.

Similarly, Roisyatin & Jamaludin, (2020) investigated the extent of zakat's influence on Indonesia's economic growth, especially during the period 2007-2018. Their results showed a positive relationship, where every 1% increase in zakat fund receipts led to a 0.591% change in GDP. This is because zakat distributed affects the income of the recipients, thus increasing the national income (GDP), ultimately contributing to Indonesia's economic growth. Furthermore, zakat was found to influence GDP by 32.9%, with the remaining 67.1% influenced by other

factors not covered in the study. This suggests that zakat's impact is relatively weak, primarily because the real GDP analyzed in the study represents overall economic growth or each sector's growth from year to year, while the zakat figures used are limited to household consumption expenditure.

Table 1. Previous Study

Refference	Method	Effect
El Ashfahany, et.al (2023)	Panel Data Regression Model	Positive
Ali Salih (2020)	Qualitative	Zakat considered important system
Rosyiatun & Jamaludin (2020)	Qualitative (Sampling)	Positive
Suprayitno (2020)	ECM	Positive
Anik & Pratiwi (2019)	Qualitative (Literature Study)	Positive
Khasandy & Badrudin (2019)	SEM PLS	Unsignificant

Taken together, zakat does have an impact on a country's economic growth. However, in certain cases, zakat may not affect a country's economic growth due to unequal distribution and less professional management, resulting in its impact being limited to specific regions rather than contributing nationally. From this analysis, we can formulate the following hypothesis framework:

H_0 : The distribution of zakat does not have an impact on economic growth.

H_1 : The distribution of zakat has an impact on economic growth.

Poverty Alleviation

Poverty is defined as a situation in which someone lacks enough money or goods to sustain their livelihood and is also associated with unemployment. It is a state in which communities lack the ability to own factors of production or enjoy the benefits of development, thus not participating in the process of change (Harahap et al., 2022).

It is a complex and multidimensional issue that can affect various aspects of a person's life, including political, social, health, education, and economic opportunities. Poverty exists across generations and societies regardless of cultural affiliation and geographical boundaries. Although the nature of poverty may vary from one community to another, from one culture to another, and from one time period to another, poverty persists in both rural and urban areas and in both developed and developing economies (Kabir and Hassan, 2010).

Islam views social justice and belief in the Almighty as fundamental principles. According to Islam, poverty is when someone lacks any of the five basic human needs, i.e., religion, physical self, intellect or knowledge, offspring, and wealth. Islamic economics identifies individual differences because each person possesses different types and levels of abilities. Therefore, even if individuals have equal opportunities, the economic status of two individuals may differ. Consequently, poverty cannot be addressed solely by income redistribution or ensuring equal opportunities for all.

The Islamic approach would ideally involve a broad approach encompassing various anti-poverty measures, such as (a) increasing income through pro-poor

programs, (b) achieving equitable income distribution, and (c) providing equal opportunities for all social groups (Kabir and Hassan, 2010). The Islamic approach to poverty alleviation involves three different forms of actions: (a) positive actions, (b) preventive actions, and (c) corrective actions, as follows:

a) Positive Actions
To reduce poverty rates, Islam implements several positive steps by harnessing income growth, functional income distribution, and equalizing opportunities.

b) *Preventive Actions*
Furthermore, Islamic economics ensures that preventive measures are taken to prevent wealth concentration in a particular group, such as controlling ownership and preventing wrong practices.

c) *Corrective Actions*
The third form of poverty alleviation actions is known as "corrective actions," which aim to encourage wealth transfers so that it is not concentrated only among the wealthy. These types of transfers include: compulsory transfers (zakat), recommended transfers (infaq and sadaqah), and the state's responsibility (law enforcement and meeting basic needs).

Relationship of Zakat on Poverty Alleviation

Zakat, as one of the pillars of Islamic economics, has a close relationship with poverty alleviation. According to (Kabir and Hassan (2010), Islam designates zakat as a mandatory charity tool intended for eight eligible groups to receive zakat. Among them, five are directed towards poverty alleviation, namely zakat for: the poor, the needy, *riqab* (slaves for their liberation), *gharim* (those in debt), and travelers in need of assistance. The other three groups include *amil* (those responsible for collecting and distributing zakat), *mualaf* (those whose hearts are inclined towards Islam), and *fi sabilillah* (those who strive in the path of Allah for preaching, jihad, and the like). Although these eight eligible groups for zakat have been mentioned in the Quran (Quran 9:103), there is a consensus that the first priority in zakat distribution should be given for the purpose of poverty alleviation by assisting the poor and the needy.

Numerous studies have explored the relationship between zakat and poverty alleviation, including a study conducted by Harahap et al., (2022) aiming to investigate the role of zakat in the economic growth of communities and poverty alleviation in North Sumatra Province, Indonesia. In terms of poverty alleviation, the findings of this research reveal that zakat significantly influences poverty alleviation by 84.40%, while the remaining 15.60% is influenced by unexamined variables. The regression coefficient of zakat on poverty alleviation is -1.843, which means that an increase of 1 unit in zakat funds allocated to the poor results in a decrease of poverty alleviation by 1114.273 - 1.843 = 1112.43. The negative coefficient indicates a negative relationship between zakat and poverty alleviation; as zakat funds directed to the poor increase, poverty decreases.

Similar results were found by Munandar et al. (2020) in their study aimed at examining the impact of the distribution of Zakat, Infak, and Sadaqah (ZIS) funds by the National Amil Zakat Agency (BAZNAS) and economic growth on poverty in Indonesia for the period 2006-2017. The t-test results show that the distribution of ZIS funds significantly impacts poverty. The regression results indicate that the coefficient of determination (R^2) is 70.6%, meaning that the distribution of ZIS funds and economic growth collectively influence poverty by 70.6%. Therefore, other unexamined variables contribute 29.4% to the total. Additionally, the study shows that a 1%

increase in ZIS distribution leads to an 8.189% reduction in poverty.

Similarly, Putri et al. (2020) aimed to investigate how economic growth and the amount of zakat funds distributed to the community impact poverty levels. Data were collected from 18 BAZNAS in districts/cities in West Sumatra over a 6-year period (2013-2019). The study demonstrated that zakat funds and economic growth had a significant negative influence on poverty levels. It also indicated that the provision of zakat funds to the community showed consistency in reducing poverty levels, making zakat funds a primary strategy for reducing poverty.

Additionally, Mohamed et al. (2019) conducted research to compare the contribution of the relationship between zakat collection and GDP to the unemployment rate and poverty in Selangor, Malaysia. Regarding zakat's role in poverty alleviation, the results indicate a significant relationship between zakat collection and poverty. Zakat collection and poverty have an inverse relationship. If zakat collection increases by one percent, the reduction in the poverty alleviation index per household in Selangor is 0.987. This means that zakat has proven to alleviate poverty in Selangor, Malaysia.

There is also Sundari (2018), who empirically investigated whether zakat has an impact on efforts to reduce poverty. The research results indicate that providing productive zakat in the form of business capital has a positive effect and has been proven to reduce the poverty rate. Therefore, the provision of productive zakat capital in the form of venture capital can be continued and enhanced.

However, in contrast to previous researchers, some found that zakat funds were unable to improve the well-being of the poor. The distribution of zakat funds to the poor did not reduce the overall poverty population (Nurjanah et al., 2019). Zakat generally did not have a significant impact on improving the well-being of society (Khasandy & Badrudin, 2019). This suggests that the well-being of the poor remains unchanged, both before and after zakat is given.

The results from these various studies indicate that the influence of zakat on poverty alleviation remains a subject of debate. Distributing zakat funds to the poor can increase their income and consumption, but in some cases, it may not fully address the issue of poverty.

Based on the literature review analysis above, the hypothesis framework can be formulated as follows:

H_0 : The distribution of zakat does not affect poverty alleviation.

H_1 : The distribution of zakat affects poverty alleviation.

Artificial Intelligence (AI) Techniques

In the realm of Artificial Intelligence, often referred to as AI, computer systems have been developed to execute tasks traditionally reliant on human intelligence, encompassing functions like visual perception, speech recognition, decision-making, and language translation. The application of AI extends across diverse domains, encompassing finance, healthcare, transportation, and education. Notably, in recent times, AI has found utilization within the context of zakat, an obligatory religious practice for Muslims, entailing the contribution of a specified portion of their annual wealth to charitable causes. (LIberto, 2022). An illustration of AI's utilization in the context of zakat is its application for the optimization of zakat distribution (Nugraha et al., 2019; Rabbani et al., 2022). An illustration of AI's utilization in the context of zakat is its application for the optimization of zakat distribution (Rabbani et al., 2022).

The Artificial Neural Network

One of the most popular types of artificial neural networks (ANNs) is the multilayer

perceptron (MLP), which consists of fully connected neurons with a nonlinear activation function (Ali et al., 2023; Kayri, 2015). MLPs have been used in various applications, including educational data analysis (Kayri, 2015), human activity classification (Majidzadeh Gorjani et al., 2021), and hypertension classification (Taravat et al., 2015). MLPs have also been used in the context of ANNs for zakat management and distribution. For example, AI can be used to optimize the distribution of zakat by using MLPs (Taravat et al., 2015). MLPs can also be used to classify the recipient of zakat into two categories, i.e., indigent and non-indigent (Majidzadeh Gorjani et al., 2021). In summary, MLPs are a powerful tool in ANNs that can be used to optimize the management and distribution of zakat.

A specific problem is solved by an ANNs, comprising interconnected neurons that collaboratively operate according to the mathematical framework originally formulated by McCulloch and Pitts. The various neurons within the ANN are linked through connections established with varying degrees of intensity, referred to as synaptic weights (synapses), wherein each input x_i of a neuron is influenced by a corresponding weight w_i. Sets of inputs are received by each neuron, resulting in the generation of an output (Hopfield, 1988). The weighted sum of the inputs is used to calculate the activation of a neuron (a):

$$a = \sum_{i=1}^{D} w_i x_i + w_0 \qquad \text{(i)}$$

Where: w_0 is a threshold or bias used to compensate the difference between the average value of the inputs. The output of the neuron (y) is then calculated from the value of a through activation or transfer function $g(a)$. There are different activation functions; among the most used are identity, step, sigmoid, hyperbolic tangent, and gaussian.

$$Y = g(a) \qquad \text{(ii)}$$

The topology or architecture of an ANNs encompasses the arrangement and interconnections of its neurons. The prediction error (E) is quantified by assessing the disparity between the computed output (y^n) and the target output (t^n) for each learning example, a task accomplished through the utilization of the mean square error:

$$a = \sum_{i=1}^{D} w_i x_i + w_0 \text{(iii)}$$

The basic architecture of the neural network is exemplified by the simple perceptron. However, tackling intricate classification problems or executing functions of greater complexity proves unattainable through the utilization of a simple perceptron alone. Achieving the desired level of precision necessitates the inclusion of more intermediate layers positioned between the input and output layers of the artificial neural network (ANN). These intermediary layers introduce a transformation in which the input patterns can be separated linearly. Consequently, this enables improved data classification or prediction to be carried out by the output unit. (Valle-Cruz et al., 2022). Figure 1 shows a multilayer perceptron architecture, which includes one or more intermediate layers of processing units, also called hidden layers.

The aim of machine learning is to have a function of the data estimated, which will result in optimal predictions regarding some outcome (Anastasopoulos and Whitford, 2018). The multilayer perceptron defines, through its connections and neurons, a function where the depend on the x_i simultaneously:

$$Z = F(X, W) \qquad \text{(iv)}$$

where:

X contains the n inputs of the ANN (x_i).

Y contains the m outputs of the ANN (y_j).

W represents the calculated weights of each layer.
$Z = F(X, W)$ is a matrix containing the relationship between inputs and outputs (applying matrix algebra).

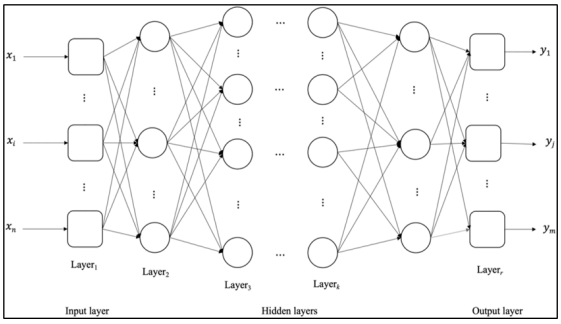

Figure 1. Artificial Neural Network
Source: Valle-Cruz, et.al (2022)

The coefficients of the parameters in a standard regression model are akin to the weights linking variables in an ANN. These weights serve to elucidate the connections between variables. Nonetheless, an ANN encompasses a surplus of weights, imparting it with greater flexibility in modeling both linear and nonlinear functions characterized by numerous interactions (Valle-Cruz et al., 2022). The determination of the relative importance of explanatory variables in a supervised ANN can be achieved through the deconstruction of model weights. In this manner, the relative significance of an explanatory variable with respect to a response variable can be ascertained by identifying all the weights that establish a connection from an input node to a response variable. The connections are tallied for each input node and normalized concerning all other inputs, ultimately yielding a single value for each explanatory variable that characterizes its relationship with the response variable within the ANN model. (Valle-Cruz et al., 2022; Goh, 1995).

Multi-objective genetic algorithms

A type of optimization algorithm known as multi-objective genetic algorithms (MOGAs) is employed for tackling problems characterized by multiple objectives in various domains, including engineering, finance, and healthcare. An illustration of MOGAs' utility can be seen in their application to create robust optimal mixture designs in cases with missing observations (Limmun et al., 2023). In this research, the utilization of a multi-objective genetic algorithm is documented to address a notable void in the existing literature, specifically focusing on their application for generating resilient optimal mixture designs when dealing. with missing observations. Another instance of MOGAs' application pertains to optimizing synchrotron radiation beamlines (Zhang et al., 2023). This study introduces a novel optimization technique based on multi-objective genetic algorithms, marking the initial endeavor to optimize a beamline with multiple objectives. MOGAs have also found use in the domain of path
planning (Ahmed and Deb, n.d.). For example, an algorithm for multi-objective optimal path planning was developed utilizing elitist non-dominated sorting genetic algorithms. The algorithm was tested on a path planning problem, demonstrating the efficacy of the proposed approach in identifying a feasible path amid an increasing number of objectives. In summary, MOGAs represent a potent optimization tool for addressing multi-objective problems across diverse fields.

Data analysis process using artificial intelligence techniques

Artificial intelligence techniques, including genetic algorithms and Artificial Neural Networks (ANNs), have been extensively examined in the realm of data analysis. A step-by-step procedure for data analysis employing ANNs and genetic algorithms was proposed in one study (Ramezanpour and Id, 2022). Another study introduced a model for prediction

and decision-making based on ANNs and genetic algorithms (Evans et al., 2013). A recent investigation delved into the progress and future research avenues concerning ANNs through the utilization of text mining techniques (Kariri et al., 2023). Furthermore, genetic algorithms and ANNs have found applications in a range of areas, such as population-based incremental learning (Baluja, 1994), optimization within additive manufacturing (Ciccone et al., 2023), and the development of deep learning models (Ahmed et al., 2023).

RESEARCH METHODOLOGY

Here is our research methodology that how we collect the data until analyses by implementing Genetic Algorithms (GA) in an artificial intelligence (AI) setting while taking into consideration the zakat.

1. *Collecting the Related Data*
   Distribution of zakat data is collected from BAZNAS[1] as one of the input features for the ANN, along with GDP and poverty data[2] as output.
2. *Correlation Analysis*
   Correlation analysis is a fundamental statistical technique used in various fields, including economics, finance, social sciences, and natural sciences. It plays a crucial role in understanding the relationships between variables, making predictions, and informing decision-making processes. The output of correlation is depicted in the following Figure 2:
3. *ANN Implementation*
   Train an ANN using historical zakat data, excluding infaq and sadaqah information, to model the relationship between input (zakat) and outputs (GDP and poverty).
4. *Build Variables Relationship Model*
   After train the ANN for several cycles and the error between input and output is minimized, we can use the weight from trained ANN to build variables relationship model.
5. *Recommendation from The Model*
   Solving the model will give insight regarding the optimal zakat distribution.

RESULTS & DISCUSSIONS

1. Collecting the Related Data

We consider the data from 2015-2022 from which BAZNAS had officially published their annual zakat management report.

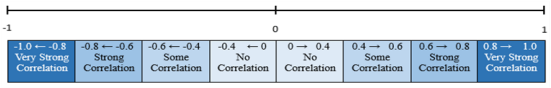

Figure 2. The Output of Correlation Analysis
Source: Lecture Notes ISE291-KFUPM

Additionally, we include data from Roisyatin & Jamaludin (2020) for year 2010-2014 span. Complete data and calculation for analysis in this study are provided in the link at footnote[3]. The GDP data used in this study is the total GDP from 34 different provinces in Indonesia in time span from 2010-2022. Then the data for poverty is the number of poor people from 34 provinces which is calculated as the average of the first and second semester of the respective year, based on BPS (Central Statistics Agency) data.

2. Correlation Analysis

It describes the strength and direction of the relationship between variables. Strength indicates how closely variables are related to each other. Direction indicates how one variable would change its value as the value of the other variable

[1] https://baznas.go.id/statistik-zakat-nasional
[2] https://www.bps.go.id/publication/arc
[3] https://s.id/ZakatAnalysis

changes. Here we calculate Pearson's *r* correlation with the following formula:

$$r = \frac{N\sum xy - \sum x \sum y}{\sqrt{\left[N\sum x^2 - \left(\sum x\right)^2\right]\left[N\sum y^2 - \left(\sum y\right)^2\right]}} \quad \text{(v)}$$

Where:

r = Pearson's r correlation coefficient, $-1 \leq r \leq 1$

N = number of values in each dataset/column

$\sum xy$ = sum of the products of the paired scores/columns

$\sum x$ = sum of x column scores

$\sum y$ = sum of y column scores

$\sum x^2$ = sum of squared x column scores

$\sum y^2$ = sum of squared y column scores

Applying the formula, the correlation between zakat variable and GDP is 0.845 (as shown in the Table 2 below) which shows a very strong positive correlation. Or in other words, we can expect a proportional increase in GDP when the distribution of zakat is increased. Then the correlation between zakat and poverty has the value of -0.8039 which represents strong negative correlation or when distribution of zakat increases, the number of poor people decreases. The same thing we observe from correlation between GDP and poverty, which also shows strong negative correlation by -0.87804. This result complies with logical causalities where the distribution of zakat will spread the wealth so each individual will experience an increase in income along with the increase in zakat distribution. Another interesting result from this correlation is that the strong negative relationship between zakat and poverty. It can be said that the zakat distribution in Indonesia has a critical impact to poverty alleviation and it is a sign that the distribution of zakat in Indonesia reach the entitled people.

Table 2 Pearson's r Correlation Calculation

	Zakat	**GDP**	**Poverty**
Zakat	1.000000	0.845029	-0.80390
GDP	0.845029	1.000000	-0.87804
Poverty	-0.80390	-0.87804	1.000000

Source: Author's Calculation (2023)

3. ANN Implementation

ANNs play a pivotal role in various machine learning tasks, including weight optimization. In ANN implementation, finding the optimal weights is a critical step. This process typically involves training the network on a dataset, where the network learns to adjust its weights iteratively to minimize the error between its predictions and the actual target values. We implement ANN architecture proposed by Valle-Cruz et al. (2022) but change activation function for both hidden and output layer with rectified linear unit (ReLU). Training the model for over 500 epochs (cycles), we obtain the sum-of squares error of 338.

4. Build Variables Relationship Model

To build the variables relationship model, first we consider the weight matrix from hidden layer and the weight matrix from output layer. Secondly, we calculate the matrix product between them to determine how the n input variables are weighted or have an impact on the m output variables at the same time. In the last part, we add the bias term in the calculation. Due to the randomness nature of obtaining weight from ANN, we repeated the model training 15 times and calculate the average of the weights. Therefore, we obtain the following coefficients for each variable of the fitness equations for the multi-objective genetic algorithm:

Max GDP=11181408.7+11217057.5(Z)Min Poverty=270306+27212825(Z)

Where the term Z is the amount of zakat as input for the equation. The relationship between zakat as input and GDP as well as poverty is depicted in the previously stated equations. We can understand the previous equation as follows: First, the ANN model plots the data and learns from it to reveal the relationship between amount of zakat distribution and both GDP along with number of poor people. Second, the ANN provides coefficients that can be used to forecast the value of GDP and poverty by inputting the zakat value (in billions) to the equations. So, we can estimate the value of GDP and number of poor people with zakat distribution with the provided equation.

5. Recommendation from The Model

The results of this research show a strong positive correlation between the distribution of zakat and GDP in Indonesia. This means that the higher the zakat distribution, the greater the contribution to Indonesia's economic growth. These findings align with most previous studies (Al-Salih, 2020; Anik and Prastiwi, 2019; Ashfahany et al., 2023; Roisyatin and Jamaludin, 2020; Suprayitno, 2020). Therefore, we recommend efforts to enhance and optimize zakat distribution by all relevant parties to positively impact economic growth in Indonesia.

Additionally, this research reveals a negative correlation between zakat distribution and poverty, which complies with most earlier studies (Harahap et al., 2022; Mohamed et al., 2019; Munandar et al., 2020; Putri et al., 2020; Sundari, 2018). It means that the zakat given to the community can demonstrate its consistency and successfully reduce the poverty rate, making zakat a primary strategy for poverty alleviation.

So, we recommend that in addition to increasing zakat distribution, the government should carry out awareness campaigns and improve literacy to encourage the Indonesian population to channel their zakat through official zakat institutions. This will lead to a more equitable distribution of zakat, enabling it to make a more substantial contribution to economic growth and sustainably reduce poverty rates in Indonesia.

CONCLUSION

Our study explores how zakat can affect the economic growth and poverty by exploiting the AI techniques, especially ANN. As zakat data are processed by computing systems to produce outputs (GDP and poverty metric), this flow is consistent with algorithmic approach that we used. We contend that this type of algorithmic method has the potential to be beneficial to enhance some technical aspects of decision making, especially for those who works as amil zakat, to set goal/target for zakat collection and distribution, since our work relating the zakat with GDP and number of poor people, even if our research could not realistically include all the critical parts of the GDP and poverty metric. In particular, this research offers an option for calculating the effect of zakat on GDP and poverty based on an algorithmic method and data analysis (for the planning stage).

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