

Graph Neural Network Modeling for Islamic Wealth Distribution Based on Nidzomul Iqtishodi Principles

Fajerin Biabdillah¹, Muhammad Tajuddin², Muh. Awaluddin A³, Abdullah Hanif⁴, Angga Hergastyasmawan⁵

^{1,4,5}Politeknik Negeri Samarinda

^{2,3}Universitas Islam Negeri Alauddin Makassar

*Correspondence e-mail: fajerin@polnes.ac.id

Receive: 2 Nov 2025; Revised: 26 December 2025; Published: 30 December 2025

Abstract

Persistent inequality and poverty reveal structural flaws in conventional wealth distribution systems. Within Islamic economic thought, especially Nidzomul Iqtishodi fil Islam, economic problems stem not from scarcity, but from inequitable wealth distribution that prevents individuals from fully meeting their basic needs. This study aims to develop a predictive framework for Islamic wealth distribution by integrating these distributive principles into a modern deep learning model. This research employs a quantitative, applied computational approach using systems-based predictive modeling. Data are collected from publicly available macroeconomic and institutional sources, including Indonesia's national Gini ratio (0.375), poverty rate (8.47%), sharia banking assets (IDR 980.30 trillion), and total Islamic finance assets (IDR 2,582.25 trillion). A Graph Neural Network (GNN) is utilized as the primary data analysis tool to construct a multi-layer socio-financial graph linking regions, zakat institutions, sharia financial intermediaries, and government transfers. The results show that a simulated increase in zakat-channeled transfers by 0.30% of GDP is associated with a predicted reduction in poverty of 0.18 ± 0.06 percentage points and a decrease in inequality of 0.003 ± 0.001 in the national Gini ratio. The proposed SDEI shows that the GNN-model improves out-of-sample poverty prediction accuracy by 11–19% compared to non-graph models.

Keywords: Neural Networks; Wealth Distribution; Islamic economic; Poverty Prediction.

1. INTRODUCTION

Modern empirical economics often focuses its research on aggregate optimisation on the production side, such as increasing national output, production factor efficiency, and GDP growth (McNerney et al., 2022; Rahman & Alam, 2021). Governments and international institutions increasingly prioritize GDP growth acceleration (Wasesa et al., 2026), labor productivity improvements through automation and artificial intelligence (Comunale & Manera, 2024), and efficiency gains in capital utilization to restore and sustain national output after



This work is licensed under [International Creative Commons 4.0 License](https://creativecommons.org/licenses/by-sa/4.0/)

DOI: [10.24252/lamaisyir.v12i2.62384](https://doi.org/10.24252/lamaisyir.v12i2.62384)

Copyright 2025© Author. *Suitable Author

economic shocks(Shui et al., 2025). This approach is based on the assumption that economic growth will automatically flow to all levels of society through market mechanisms. However, global and national phenomena show that such growth is often accompanied by persistent distribution inequality and poverty(Aiyar & Ebeke, 2019; Cingano, 2014; Ochi et al., 2024). In Indonesia, for example, GDP growth has not always been accompanied by significant improvements in the Gini index and poverty rates (Agusalim & Setiawan, 2025). This phenomenon reveals a conceptual and practical gap in the mainstream economic paradigm, which places too much emphasis on the production side and pays insufficient attention to the dimension of social justice distribution (Fadillah et al., 2024; Harahap, 2024; Huwe & Rehm, 2022).

In Islamic economic literature, *Nidzomul Iqtishodi fil Islam* offers a different orientation by making the distribution of goods and services to each individual the core of economic issues(Azlina et al., 2022; Fadillah et al., 2024; Sudarmi et al., 2025). Its basic principles emphasise the fulfilment of basic needs, fairness in the allocation of resources, and a balance between individual and community interests.(Kato, 2022) Previous studies have discussed the potential of Islamic economic instruments such as zakat, waqf, and sharia microfinance as means of wealth redistribution. However, these studies are generally descriptive-normative in nature and have not developed data-based predictive models capable of empirically projecting the impact of redistributive policies. This is where the research gap lies: there has been no study that integrates Islamic distribution principles into a predictive modelling framework using graph-based learning capable of capturing socio-financial linkages between regions and institutions(Latifah, 2021; Ma et al., 2025; Motahar & Yahoo, 2025; Yu et al., 2025; Zhou Yu Liu et al., 2023).

Based on this gap, this study aims to develop a Graph Neural Network (GNN)-based predictive model that can estimate poverty and inequality trajectories at the regional level when Islamic economic redistribution channels are strengthened. This study was conducted in four stages: (1) formalising a socio-financial graph representing the relationships between regions and Islamic institutions such as zakat agencies and Islamic banks; (2) formulating outcome indicators in line with Islamic values, namely Shariah-Driven Economic Inclusion (SDEI); (3) training various GNN variants to predict changes in poverty and inequality resulting from changes in zakat policy or Islamic microfinance; and (4) conducting counterfactual analysis and ablation studies to assess policy elasticity and model validity.

This research holds significant theoretical and practical importance in addressing the central problem of wealth distribution failure highlighted in Islamic economic thought. Theoretically, it advances the field of Islamic economics by operationalizing the normative principles of distributive justice—as articulated in *Nidzomul Iqtishodi fil Islam*—into a rigorous quantitative and predictive modeling framework, thereby responding to the long-standing gap between normative Islamic theory and empirical economic analysis. Practically, this study directly targets the core research problem of persistent poverty and inequality caused by ineffective distribution mechanisms, rather than insufficient production. By providing data-driven evidence on how Islamic redistribution instruments such as zakat and sharia-based microfinance influence poverty and inequality outcomes, the findings offer a concrete empirical foundation for designing more targeted, accountable, and effective redistribution policies. Consequently, this research not only integrates sharia values with advanced machine learning techniques but also establishes a new paradigm for analyzing and projecting social welfare within modern Islamic economics, where distributional justice—rather than aggregate growth—becomes the primary indicator of economic success.

2. METHODS

This study employs a quantitative, applied computational research design aimed at predicting wealth distribution outcomes within an Islamic economic framework. The research model is constructed as a system-level socio-financial network, where regions, zakat institutions, sharia financial intermediaries, and government transfer mechanisms are represented as interconnected nodes within a multi-layer graph structure. The primary analytical model used is a Graph Neural Network (GNN), selected for its ability to capture relational dependencies, spatial spillovers, and institutional interactions that are essential to modeling distribution processes rather than isolated economic variables. Publicly available macroeconomic and institutional data are utilized to parameterize node attributes and edge weights, including poverty rates, inequality indicators, zakat flows, and sharia financing intensity. Data analysis is conducted through supervised predictive learning, where the GNN is trained to estimate changes in poverty and inequality, complemented by the Sharia Distribution Equity Index (SDEI) to assess distributive justice in line with Islamic principles. Model performance is evaluated using out-of-sample error metrics and comparative baseline models, ensuring that the analytical approach is both methodologically rigorous and aligned with the research objectives.

Graph Construction

Let $G = (V, E)$ with $|V| = N_{\text{districts}} + N_{\text{institutions}} + \text{hubs}$. Node features $X \in \mathbb{R}^{|V| \times F}$. Edge types $e \in \{\text{spatial, zakat, micro-finance, fiscal, remittance}\}$ with relation-specific weights. Adjacency: We use a multiplex graph with relation-specific adjacency matrices $\{A_r\}$. Spatial A_{sp} derived from contiguity + KNN on centroids; institutional $A_{\text{zak}}, A_{\text{fin}}, A_{\text{fisc}}$ from intensity measures; A_{rem} from migration proxies. All A_r are row-normalized.

Model Family

We compare three GNNs: GraphSAGE, GAT, and a Relational-GNN (R-GCN). The predictor produces district-level outputs for $\Delta\text{Poverty}$ and ΔGini and an auxiliary SDEI score.

Table 1. Architectures

Model	Layers	Hidden	Aggregator	Params (approx.)
GraphSage	3	128	mean/max	0.35-0.55 M
GAT	3	128	4-8 heads	0.60-0.95 M
R-GCN	2-3	160	Relation-specific	0.45-0.70 M

Objective And Islamic Fairness Regularization

1. R_{fair} (Needs-First Regularizer): Penalizes predictions leading to unmet basic-needs coverage in any district beyond a threshold τ , embodying a max-min priority on the worst-off (leximin-like).
2. R_{smooth} : Total variation over the spatial graph to discourage implausible discontinuities unless supported by strong institutional edges.

Sharia Distribution Equity Index (SDEI)

$SDEI \in [0,1]$ summarizes distributional adequacy:

$$SDEI = 1 - w_1 \cdot \text{Pov} - w_2 \cdot \text{Gini} - w_3 \cdot (\text{UnmetBasicNeeds}) - w_4 \cdot (\text{InequitableTargeting}),$$
 with $(w_1, \dots, w_4)$ set by policy preference (default equal) and components normalized.

Training Protocol

1. Data split: Rolling-origin time-series splits ($T-3, T-2, T-1 \rightarrow T$) at district level; spatial leave-one-province-out for robustness.
2. Optimization: AdamW, early stopping on validation SDEI loss; label-noise robustness via Huber loss variant in sensitivity checks.

3. Hyperparameters: batch 8-16 subgraphs; LR 2e-3; weight decay 1e-4; dropout 0.1-0.2.

3. RESULT AND FINDINGS ANALYSIS

Islamic Distributive Principles

Islamic economics places wealth distribution at the centre of its concerns, making a clear distinction between the process of wealth creation and the mechanism of its distribution to individuals so that everyone's basic needs can be met. In this view, poverty is not the result of a lack of aggregate wealth in society, but rather is caused by a failure to distribute wealth fairly and evenly.(Aisyah et al., 2025) Therefore, Islamic economic policy requires that every individual be guaranteed the fulfilment of their basic needs, thereby creating social justice and shared prosperity.(Rezeki et al., 2023).

Table 2. Comparative Review of Islamic Wealth Distribution Studies (2021-2025)

Journal / Author / Year	Primary Focus	Geographic Scope	Methodology Type	Main Output / Findings	Empirical Quantification
Graph Neural Network for Islamic Wealth Distribution Based on Nidzomul Iqtishodi (This Study, 2025)	Operationalization of <i>Nidzomul Iqtishodi</i> through GNN and Sharia-based fairness (SDEI) for poverty and inequality prediction	Indonesia (514 districts, zakat institutions, sharia finance, fiscal hubs)	Supervised Graph Neural Networks (GraphSAGE, GAT, R-GCN) with counterfactual policy simulation	Strengthening zakat-linked transfers and sharia microfinance reduces poverty and inequality; institutional channels are decisive	Δ Poverty -0.18 ± 0.06 pp; Δ Gini -0.003 ± 0.001 ; 11-19% accuracy improvement vs non-graph baselines
(Darajat, 2025) - Wealth Distribution in Islamic Economy	Distributive justice through integrated zakat, waqf, and sharia	Indonesia (Yogyakarta case study)	Qualitative exploratory case study with institutional interviews	Identifies institutional prerequisites: consolidation, digitalization	Descriptive; no quantitative impact estimation

	finance mechanisms			n, and regulatory alignment	
(Ibnu Sholeh et al., 2025) – <i>Islamic Finance as Catalyst for Poverty Reduction</i>	Role of Islamic finance (zakat, waqf, microfinance) in poverty alleviation and inclusion	Comparative (Pakistan, Bangladesh, Indonesia)	Comparative case studies with impact assessment	Rural empowerment, waqf-supported education, and enhanced financial inclusion pathways	Qualitative impact assessment; elasticity not quantified
(Business & Research, 2021) – <i>Role of Zakat in Reducing Income Inequality</i>	Empirical impact of zakat on income inequality among recipients	Malaysia (Selangor, three sub-districts)	Lorenz Curve and Gini coefficient before-after analysis	Zakat distribution significantly reduces income inequality among beneficiaries	$\Delta\text{Gini} = -0.05$ to -0.07 (recipient-level only)
(Laksmi & Soseco, 2024) – <i>Do Microfinance Institutions Matter?</i>	Effectiveness of microfinance institutions in poverty reduction	Indonesia (provincial cross-sectional data)	Econometric panel regression	Microfinance access alone does not significantly reduce poverty due to targeting and infrastructure issues	Coefficients statistically insignificant ($p > 0.05$)

Instruments such as zakat, waqf, public assistance, and community social safety nets are seen as key tools in wealth distribution policy. Zakat, for example, functions as a mandatory mechanism that channels wealth from the wealthy to eight categories of recipients specified in the Qur'an, so that their basic needs can be met and economic inequality can be reduced (Ekawaty, 2025; Maulina et al., 2023; Rizal et al., 2023). Waqf plays a role in creating long-term social investments, such as education, health, and infrastructure, whose benefits can be felt by the wider community (Rusydiana et al., 2025). Empirical research shows that effective management of zakat and waqf can reduce poverty and improve community welfare, both directly through assistance and indirectly through economic empowerment. (A.A & Rosidta, 2023).

Research shows that the effective implementation of zakat and waqf can reduce poverty levels, decrease unemployment, and improve income distribution in member countries of the Organisation of Islamic Cooperation (OIC). (Rusydiana et al., 2025) Quantitative studies prove that zakat plays a significant role in reducing poverty and inequality, as well as encouraging the creation of new jobs through productive programmes. (Ascarya, 2021) Furthermore, the integration of Islamic social instruments with sharia microfinance has also proven effective in empowering vulnerable groups and increasing financial inclusion. (Al-Isawi, 2024)

From a theoretical perspective, Islamic economics rejects the practices of usury (interest) and speculation (gharar), which are considered to exacerbate inequality and injustice. Instead, profit-sharing systems such as mudharabah and musyarakah are encouraged to create fairness in the distribution of business profits. Simulations of wealth distribution models based on econophysics show that prohibiting usury and implementing periodic redistribution through zakat and waqf can curb the growth of the Gini index, thereby controlling wealth disparity. (Kato, 2022) This confirms that Islamic economics offers a more ethical alternative that is oriented towards social justice compared to pure capitalism. (Chalid & Zubaidah, 2025)

In the context of sustainable development, Islamic social finance instruments such as zakat, waqf, and qard al-hasan are considered capable of contributing to the achievement of the Sustainable Development Goals (SDGs), particularly in overcoming poverty, improving welfare, and strengthening social inclusion. A systematic study shows that Islamic social finance instruments can fill the SDG financing gap, especially in developing countries facing budget constraints. Indonesia and Malaysia are examples of countries that are actively developing innovations and integrating Islamic social instruments to support sustainable development. (Dirie et al., 2023)

Overall, economic distribution in Islam is not merely a transfer of wealth, but also a systematic effort to build social justice, strengthen solidarity, and create a prosperous and civilised society. With good management, Islamic economic distribution instruments can be a real solution in overcoming poverty and inequality, and promoting inclusive and sustainable development. (Rezeki et al., 2023)

The Qur'an itself emphasises the equitable redistribution of wealth. This is confirmed in QS Al-Hasyr/59: 7 regarding the redistribution of fai' wealth. Fai' here refers to wealth that Allah returned to His Messenger from the disbelievers of a certain land, such as the Banu Quraizhah, Banu Nadhir, Fadak, and Khaibar, which was obtained through peace without war, that is, without the involvement of Muslim cavalry and infantry. In this context, Allah decreed that the determination of the law and its distribution were under His will, and during the lifetime of the Messenger of Allah, may peace be upon him, these assets became the right of the Prophet to manage. After his death, its management was transferred to the general interests of the Muslim community. From this fai' wealth, the Prophet used some of it to meet the needs of his close relatives, namely the Banu Hashim and Banu al-Muththalib, who were prohibited by Sharia law from receiving zakat or alms, so they were given special rights in the distribution of fai'. In addition, fai' was also intended for orphans, namely those who lost their fathers before reaching puberty; for the poor, namely individuals experiencing economic hardship and lack of wealth; and for ibn al-sabil, namely travellers who ran out of provisions on their journey and had no means of returning to their homeland.

The fai' distribution system reflects Islam's concern for vulnerable groups in society. The rationale behind this distribution system is to prevent the accumulation of wealth among a small economic elite and to ensure that the circulation of wealth reaches all levels of society. (Az-Zuhaili, 1997) Thus, the instrument of wealth distribution in Islam serves to uphold justice and create inclusive economic liquidity among the people. This principle forms the foundation of the Islamic economic system, which is oriented not only towards growth, but also towards equity and collective welfare.

However, for this redistribution policy to be truly effective, its impact needs to be measured empirically before it is widely implemented. Data-based evaluation is crucial to ensure that these instruments are truly capable of guaranteeing the fulfilment of basic needs and creating social justice in accordance with the principles of Islamic economics. Thus, strengthening governance, transparency, and collaboration between the government, zakat/waqf management institutions, and the community is key to optimising the role of Islamic economic instruments as a real solution to the problems of poverty and inequality. (Razak, 2019)

Data-Driven Poverty and Inequality Prediction

In recent years, machine learning approaches have revolutionised the prediction of poverty, inequality and welfare by utilising a variety of data sources such as household surveys, satellite imagery, mobility data and financial transactions. Recent studies show that combining survey data and satellite imagery, processed with machine learning and deep learning algorithms, can produce highly accurate estimates of poverty and inequality, even in areas with limited survey data. (Newhouse et al., 2025) These models have been applied in

various developing countries, including Africa, India, Mexico, and Southeast Asia, to map poverty and inequality spatially and temporally. (Jean et al., 2016)

Graph-based methods are increasingly popular because they are able to capture spatial, social, and institutional linkages between regions. Graph representation allows models to integrate geographical proximity, institutional fund flows (such as zakat and sharia microfinance), and fiscal networks between the centre and the regions, making predictions more contextual and precise. (Fitradinata et al., 2024) Recent studies have demonstrated that graph neural network (GNN) models and other deep learning variants that utilise mobility data and socio-economic networks can outperform conventional methods in predicting income distribution and poverty. (Gao et al., 2024)

In addition to technical aspects, it is important to ensure that the objectives of the predictions remain aligned with the principles of Islamic economics, namely the fulfilment of the basic needs of every individual and the fair distribution of wealth. Empirical research confirms that the integration of Islamic social instruments such as zakat, waqf, and sharia microfinance into predictive models can strengthen poverty alleviation efforts and reduce inequality in a sustainable manner. (Saiti et al., 2021) Overall, the integration of graph-based machine learning with Islamic economic principles opens up great opportunities to map, predict, and intervene in poverty and inequality more effectively and fairly, while strengthening the role of Islamic social instruments in sustainable development. (Pradhan & Agrawal, 2025)

In the context of this study, a graph learning approach was used to explicitly capture three types of important relationships that influence the dynamics of poverty and inequality. First, geographical proximity between regions reflects spatial influences, whereby the economic conditions of one region often correlate with those of neighbouring regions. Second, institutional flows, which include the distribution and interaction of institutions such as zakat agencies and sharia microfinance institutions, which act as channels for economic redistribution. Third, fiscal networks between central and regional governments, such as financial transfers between levels of government, which can affect the balance of development and welfare at the local level.

Data and Variables

We use publicly reported Indonesian aggregates as anchors and provide a replicable data model for extension with microdata (when accessible under license). Values below are national summary points used to calibrate simulation scales and priors.

Table 3. National aggregates used as priors

Indicator	Latest Reference	Value
Gini ratio (national)	Mar-2025	0.375
Gini ratio (urban)	Mar-2025	0.395
Gini ratio (rural)	Mar-2025	0.326
Poverty rate	Mar-2025	8.47% (23.85 million persons)
Islamic finance assets (ex-equites)	2023	IDR 2,582.25 trillion
National sharia banking assets	Dec-2024	IDR 980.30 trillion

Table 4. Example provincial anchor

Province	Gini ratio (Mar-2025)	Urban Gini	Rural Gini
East Java (Jatim)	0.369	0.383	0.335

Note: Tables 3–4 are used to (i) scale prior distributions for simulated district panels; (ii) validate that model outputs aggregate back to the reported national/provincial values within tolerance.

Data Model For a District-Instition Graph

Each district (node) is connected to: (i) adjacent districts (spatial edges), (ii) local Islamic philanthropy institutions (zakat boards), (iii) sharia financial service points (bank branches, BPRS, micro-finance kiosks), and (iv) fiscal transfer hubs.

Table 5. Node sets and features

Node type	Examples	Core features (t)
District	514 nodes	Poverty rate t-1, Gini t-1, unemployment, HH expenditure per capita, health & education coverage, prices, population, rural, share, urbanization, digital access, shocks (disaster, commodity)
Zakat Institution	LAZ/BAZNA Z local	Zakat receipts per capita, payout ratio, admin overhead, beneficiary mix
Sharia Finance	BSI baranches, BPRS, Fintech sharia	Micro-finance penetration (% adults), Islamic credit share, NPF, account ownership
Fiscal Hubs	Provincial trasury	Per-capita intergovernmental transfers, social assistance intensity

Table 6. Edge sets and weights

Edge type	Definition	Weight(s)
Spatial adjacency	Contiguity or K-NN Distance	Normalized distance, commuting/mobility index
Zakat flow	Institution-district transfers	Per-capita transfer intensity; targetting index
Micro-finance flow	Sharia finance-district	Share of islamic micro loans to low-income HHs
Fiscal transfer	Center/province-district	Per-capita social/fiscal transfers
Migration & remittance	District-district	Remittance volume proxy

Table 7. Outcomes and auxiliary targets

Target	Definition
$\Delta\text{poverty}_t + \text{Kementrian Agama Republik Indonesia, Al-Qur'an Dan Terjemahannya (Jakarta: Lajnah Pentashihan Mushaf Al-Qur'an, 2019), h. 113.}$	Change in headcount (%) next period
Δgini_{t+1}	Change in Gini next period
SDEI_t	Composity equity index (see s4.3)

Harmonization and Scaling

Because Gini is reported as ratio (0–1) by BPS and as index (0–100) by other sources, we convert to ratios. Fiscal and financial flows are scaled per capita and per HH. Zakat intensity is parameterized as % of district GDP (or gross regional product) and as per-capita transfer amounts.

Experiments

Because microdata access is constrained, we calibrate synthetic district panels to match national and provincial anchors (Tables 3–4). We then evaluate models on their accuracy in predicting next-period changes and their sensitivity to policy levers.

a) Calibration Targets and Sanity Checks

Aggregating district predictions reproduces $\text{Gini}=0.375\pm0.001$ and $\text{poverty}=8.47\%\pm0.02$ at national level. Provincial rollups (example: East Java) match $\text{Gini}=0.369\pm0.002$.

b) Baselines

OLS with spatial lag, Gradient Boosting (GBM), and LSTM on district sequences (no graph). GNN variants: GraphSAGE, GAT, R-GCN.

Table 8. Predictive performance (MAE, percentage points)

Model	Δ Poverty ($\downarrow$ better)	Δ gini ($\downarrow$)	SDEI ($\downarrow$)
OLS (spatial lag)	0.185	0.0068	0.042
GBM	0.164	0.0061	0.039
LSTM (seq)	0.157	0.0059	0.037
GraphSAGE	0.139	0.0052	0.032
GAT	0.128	0.0049	0.031
R-GCN	0.133	0.0051	0.032

c) Counterfactual Policy Experiments

We define three levers: (i) Zakat intensity (ZI, % of district GDP); (ii) Sharia micro-finance penetration (SMP, % adults); (iii) Targeting quality (TQ, share of payouts reaching bottom 40%). Shocks are applied for one period.

Table 9. National counterfactuals (1-year horizon)

Policy lever	Shock	Δ povrty (pp)	Δ gini (ratio)
ZI +0.30% of GDP	-0.18 ± 0.06	-0.003 ± 0.001	+0.012
SMP + 1.5 PP	-0.07 ± 0.03	-0.001 ± 0.0005	+0.004
TQ + 10 pp	-0.10 ± 0.04	-0.002 ± 0.001	-0.009

Table 10. Distribution or effects across districts (quantiles)

Quantile	Δ poverty (ZI shock)	Δ gini (ZI shock)
10th (least)	-0.05	-0.001
Median	-0.16	-0.003
90th (most)	-0.32	-0.006

d) Ablation Studies

We test removal of edge families and fairness regularization.

Table 11. Ablations (GAT core)

Variant	Δ poverty MAE	Δ gini MAE	Notes
Full (all edges)	0.128	0.0049	-
-Spatial edges	0.147	0.0057	loses spillovers
-Zakat edges	0.139	0.0052	-
-Micro-finance edges	0.136	0.0051	-
-Fairness reg. ($\beta=0$)	0.133	0.0051	higher tail risk

e) Robustness

1. Spatial holdout: training without one province yields <12% degradation.
2. Label noise: Huber loss stabilizes Δ Gini predictions under 5% noise.
3. Alternative scalings: results robust to rescaling flows per capita vs per HH

The graph lens clarifies how institutional channels, not merely geographic proximity, shape distribution outcomes. The fairness regularizer enforces an Islamic normative priority: minimizing the worst shortfalls in basic-needs coverage. Our counterfactuals suggest zakat-linked transfers, if targeted to the bottom 40%, have measurable near-term effects, while micro-finance expansion adds smaller but still meaningful gains. The SDEI bridges technocratic outputs with Islamic jurisprudence by penalizing any predicted state that tolerates unmet basic needs.

Interpretability and Governance Attention weights (in GAT) and gradient-based attributions can highlight the districts and institutions that most drive predicted improvements or regressions (Yang & Lee, 2024). These can inform BAZNAS/LAZ targeting audits and provincial planning (Syamsuri et al., 2024).

Digital rails Policy sandboxes could test GNN-guided disbursement schedules (monthly/quarterly), with privacy-preserving data sharing (Bahaaudeen, 2025) (federated or trusted execution) between zakat bodies and financial regulators (Muyassarrah et al., 2025).

f) Policy Implications

1. Needs-first budgeting: encode max-min constraints into program design and monitor SDEI quarterly (Ishak & Mohamed, 2023).
2. Targeting upgrades: prioritize bottom-40% coverage; audit leakage using network-based anomaly scores.

3. Micro-finance deepening: focus expansions where graph attribution shows highest marginal SDEI gains.
4. Data governance: establish secure inter-institutional data pipelines to enrich graph features while respecting privacy law.

g) Limitations and Ethics

1. Aggregates anchor the simulations; district microdata are needed for operational deployment.
2. Zakat and social assistance effectiveness varies by local governance capacity; elasticities here are priors, not causal claims.
3. Guardrails: avoid bias amplification; perform fairness and harm audits; ensure sharia supervisory oversight.

4. CONCLUSION

This study concludes that persistent poverty and inequality are primarily driven by ineffective wealth distribution mechanisms rather than insufficient economic production. By embedding the distributive justice principles of Nidzomul Iqtishodi fil Islam into a Graph Neural Network-based predictive framework, the results empirically demonstrate that Islamic redistribution instruments can generate measurable distributional improvements. Specifically, a simulated increase in zakat-channeled transfers equivalent to 0.30% of GDP is associated with a predicted reduction in the national poverty rate by 0.18 ± 0.06 percentage points and a decline in the Gini ratio by 0.003 ± 0.001 within one year. Additionally, expanding sharia micro-financing in low-income districts by 150 basis points produces a further poverty reduction of 0.07 ± 0.03 percentage points. The proposed Sharia Distribution Equity Index (SDEI) confirms that the Graph Neural Network model improves out-of-sample poverty prediction accuracy by 11–19% compared to non-graph models and by 7–12% over LSTM, indicating the analytical advantage of relational modeling for distributional analysis. These findings directly address the research problem by validating that distribution-focused, Islamic-based economic interventions are both quantifiable and effective. As an implication, the proposed framework provides a robust empirical basis for policymakers, zakat authorities, and Islamic financial institutions to design targeted, data-driven redistribution strategies, while future research may extend this model using micro-level administrative data and real-time digital zakat systems to support policy experimentation and sustainable poverty alleviation.

ACKNOWLEDGEMENT:

We thank our institution, State Polytechnic of Samarinda and Islamic State University of Alauddin Makassar for providing a place to conduct this research.

AUTHORS' CONTRIBUTIONS:

Fajerin Biabdillah, Muhammad Tajuddin, Muh. Awaluddin A, Abdullah Hanif, Angga Hergastyasmawanda, Writing original draft preparation. Ideas; formulation or evolution of overarching research goals and aims.

CONFLICT OF INTERESTS:

We state that there are no known conflicts of interest linked with this publication, and that there has been no significant financial assistance for this work that could have influenced its outcome

REFERENCES

- A.A, F. M., & Rosidta, A. (2023). Peran Wakaf Dan Zakat Dalam Meningkatkan Ekonomi Masyarakat Indonesia. *Lisyabab: Jurnal Studi Islam Dan Sosial*. <https://doi.org/10.58326/jurnallisyabab.v4i2.193>
- Agusalim, L., & Setiawan, Y. (2025). COVID-19, Economic Growth, and Income Inequality: Empirical Study in Indonesia. *Economics Development Analysis Journal*. <https://doi.org/10.15294/edaj.v13i4.3107>
- Aisyah, A., Arsyadi, B., Wahab, A., & Lutfi, M. (2025). Wealth Distribution in Islam: The Role of Sharia Instruments in Improving Social Welfare. *YASIN*. <https://doi.org/10.58578/yasin.v5i1.4699>
- Aiyar, S., & Ebeke, C. (2019). *Inequality of Opportunity, Inequality of Income and Economic Growth*, WPI/19/34, February 2019.
- Al-Isawi, A. T. J. (2024). Islamic Economic Mechanisms to Achieve Inclusiveness and Islamic Finance for Sustainability. *Journal of Ecohumanism*. <https://doi.org/10.62754/joe.v3i8.4933>
- Ascarya, A. (2021). The role of Islamic social finance during Covid-19 pandemic in Indonesia's economic recovery. *International Journal of Islamic and Middle Eastern Finance and Management*. <https://doi.org/10.1108/imefm-07-2020-0351>

- Azlina, N., Maesarach, M., & Said, M. (2022). Islamic Economic Methodology Approach To Achieve Economic Equity: Epistimological Study. *Journal of Business and Entrepreneurship*. <https://repository.unar.ac.id/jspui/bitstream/123456789/12468/1/3.pdf>
- Az-Zuhaili, W. (1997). *al-Tafsîr al-Munir*. Dâr al-Fikr.
- Bahaaudeen, A. (2025). Governance in the Digital Era: The Role of Blockchain Technology in Enhancing Accountability. *Journal of Cultural Analysis and Social Change*, 2025(2), 770–781. <https://doi.org/10.64753/JCASC.V10I2.1680>
- Business, G., & Research, M. (2021). The Role of Zakat in Reducing Income Inequality Among Muslim Society in Selangor. *An International Journal*, 13(4).
- Chalid, F. I., & Zubaidah, S. (2025). Komparasi Ketimpangan Distribusi Pendapatan Dalam Perspektif Ekonomi Konvensional Dan Ekonomi Islam. *Musyarakah: Journal of Sharia Economic (MJSE)*. <https://doi.org/10.24269/mjse.v5i1.11829>
- Cingano, F. (2014). *OECD Social, Employment and Migration Working Papers No. 163 Trends in Income Inequality and its Impact on Economic Growth*. <https://doi.org/10.1787/5jxrjncwvxv6j-en>
- Comunale, M., & Manera, A. (2024). The Economic Impacts and the Regulation of AI: A Review of the Academic Literature and Policy Actions. *IMF Working Papers*, 2024(065). <https://doi.org/10.5089/9798400268588.001.A001>
- Darajat, U. A. (2025). Wealth Distribution Inequality and Social Justice in Islamic Economics: An Evaluation of the Role of Zakat, Waqf, and Islamic Philanthropic Instruments in the Digital Economy Era in Indonesia. *Journal of Social Science and Economics*, 4(2), 152–165. <https://doi.org/10.37812/JOSSE.V4I2.2037>
- Dirie, K., Alam, Md. M., & Maamor, S. (2023). Islamic social finance for achieving sustainable development goals: a systematic literature review and future research agenda. *International Journal of Ethics and Systems*. <https://doi.org/10.1108/ijoes-12-2022-0317>

- Ekawaty, M. (2025). Welfare Transformation through Islamic Economics: A Holistic Approach to Wealth Distribution and Social Inclusion. *International Journal of Business and Applied Economics*, 4(5), 2791–2804. <https://doi.org/10.55927/IJBAE.V4I5.403>
- Fadillah, M. I., Purnomo, B. S., & Purnamasari, I. (2024). Islamic Economic Principles: A Critical Review of Capitalism and a Vision for Justice. *Equity: Jurnal Ekonomi*, 12(2), 102–115. <https://doi.org/10.33019/EQUITY.V12I2.381>
- Fitradinata, K., Fadhli, M., Nugraha, R. F., & Hasan, Z. (2024). Poverty Alleviation Strategy Through the Sharia Economic Model. *Maklumat: Journal of Da'wah and Islamic Studies*. <https://doi.org/10.61166/maklumat.v2i2.20>
- Gao, Q.-L., Zhong, C., Yue, Y., Cao, R., & Zhang, B. (2024). Income estimation based on human mobility patterns and machine learning models. *Applied Geography*. <https://doi.org/10.1016/j.apgeog.2023.103179>
- Harahap, Z. R. A. (2024). Beyond the Neoclassical Approach Addressing Income Inequality in Indonesia Through Institutional Economics. *Journal of Sustainable Economics*. <https://doi.org/10.32734/jse.v2i2.18923>
- Ibnu Sholeh, M., Gambhir Singh, I., & Kh Muhammad Ali Shodiq Tulungagung, S. (2025). Islamic Finance As A Catalyst For National Economic Development In OIC Member States. *International Journal of Economics and Development*, 1(1), 14–31. <https://doi.org/10.71305/IJED.V1I1.345>
- Ishak, M. N., & Mohamed, A. (2023). Harmonization of Islamic Economics With Artificial Intelligence: Towards an Ethical and Innovative Economic Paradigm. *Al-Kharaj: Journal of Islamic Economic and Business*, 5(4). <https://doi.org/10.24256/KHARAJ.V5I4.4387>
- Jean, N., Burke, M., Xie, S. M., Davis, W., Lobell, D., & Ermon, S. (2016). Combining satellite imagery and machine learning to predict poverty. *Science*, 353, 790–794. <https://doi.org/10.1126/science.aaf7894>
- Kato, T. (2022). Islamic and capitalist economies: Comparison using econophysics models of wealth exchange and redistribution. *PLoS ONE*, 17. <https://doi.org/10.1371/journal.pone.0275113>
- Laksmi, N. K., & Soseco, T. (2024). Do Multifinance Institutions Matter for Poverty Reduction? Evidence from Indonesia. *Jurnal Ekonomi*

- Pembangunan*, 22(1), 29–40.
<https://doi.org/10.29259/JEP.V22I1.23095>
- Latifah, E. (2021). Penerapan Zakat, Infak, Sedekah, dan Wakaf sebagai Strategi Kebijakan Fiskal pada Sharia Microfinance Institution. *Indonesian Journal of Islamic Economics and Finance*.
<https://doi.org/10.37680/ijief.v1i1.841>
- Ma, Y., Choi, M., & Weng, Y. (2025). GNN-MAM: A graph neural network based multiple attention mechanism for regional financial risk prediction. *Alexandria Engineering Journal*, 127, 1004–1014.
<https://doi.org/10.1016/J.AEJ.2025.06.023>
- Maulina, R., Dhewanto, W., & Fatur Rahman, T. (2023). The integration of Islamic social and commercial finance (IISCF): Systematic literature review, bibliometric analysis, conceptual framework, and future research opportunities. *Heliyon*, 9(11), e21612.
<https://doi.org/10.1016/J.HELIYON.2023.E21612>
- McNerney, J., Savoie, C., Caravelli, F., Carvalho, V. M., & Doyne Farmer, J. (2022). How production networks amplify economic growth. *Proceedings of the National Academy of Sciences of the United States of America*, 119(1), e2106031118. <https://doi.org/10.1073/PNAS.2106031118/-/DCSUPPLEMENTAL>
- Motahar, S. A., & Yahoo, M. (2025). The Key Inequality Indicators Forecasting Economic Growth Under Heterogeneity and Nonlinearity: A Machine Learning Approach. *SAGE Open*, 15(2).
<https://doi.org/10.1177/21582440251346534;PAGEGROUP:STRING:PUBLICATION>
- Muyassarrah, M., Mawadah, S., Saadah, N., Faizah, F. N., Nurlaily, L., & Mansur, M. (2025). Revised Zakat Distribution: Perspectives on Digital Transformation for Poverty Alleviation. *Journal of Islamic Thought and Civilization*, 15(2), 192–215. <https://doi.org/10.32350/JITC.152.11>
- Newhouse, D., Ramakrishnan, A., Swartz, T., Merfeld, J., & Lahiri, P. (2025). Small Area Estimation of Monetary Poverty in Mexico Using Satellite Imagery and Machine Learning. *Oxford Bulletin of Economics and Statistics*. <https://doi.org/10.1111/obes.12678>

- Ochi, A., Labidi, M. A., & Saidi, Y. (2024). The Nexus Between Pro-poor Growth, Inequality, Institutions and Poverty: Evidence from Low and Middle Income Developing Countries. *Social Indicators Research* 2024 172:2, 172(2), 703–739. <https://doi.org/10.1007/S11205-024-03326-7>
- Pradhan, N., & Agrawal, A. (2025). Mapping fine-scale socioeconomic inequality using machine learning and remotely sensed data. *PNAS Nexus*, 4. <https://doi.org/10.1093/pnasnexus/pgaf040>
- Rahman, M. M., & Alam, K. (2021). Exploring the driving factors of economic growth in the world's largest economies. *Heliyon*, 7(5), e07109. <https://doi.org/10.1016/J.HELIYON.2021.E07109>
- Razak, S. H. A. (2019). Zakat and waqf as instrument of Islamic wealth in poverty alleviation and redistribution. *International Journal of Sociology and Social Policy*. <https://doi.org/10.1108/ijssp-11-2018-0208>
- Rezeki, S. G., Ferdiansyah, V., Adisa, Y., Ginting, D. C. A., & Amelia, R. (2023). Fair Wealth Distribution Through Instruments In Islamic Economics. *Cashflow : Current Advanced Research On Sharia Finance And Economic Worldwide*. <https://doi.org/10.55047/cashflow.v2i3.657>
- Rizal, S., Pakkanna, M., & Rizal, S. (2023). Digitalization of Zakat in Stimulating Community Socio-Economic Development in the Middle of the Covid-19 Pandemic (Maqashid Syariah Perspective). *European Journal of Humanities and Social Sciences*, 3(1), 23–33. <https://doi.org/10.24018/EJSOCIAL.2023.3.1.384>
- Rusydiana, A., Prakoso, M. F. D., Aslan, H., & Riani, R. (2025). Unveiling the effects of zakat toward socioeconomic empowerment in OIC countries. *International Journal of Ethics and Systems*. <https://doi.org/10.1108/ijoes-10-2024-0331>
- Saiti, B., Dembele, A., & Bulut, M. (2021). The global cash waqf: a tool against poverty in Muslim countries. *Qualitative Research in Financial Markets*. <https://doi.org/10.1108/qrfm-05-2020-0085>
- Shui, K., Mak, A., & Kong, H. (2025). *Technology and Innovation Report 2025: Inclusive Artificial Intelligence for Development*.
- Sudarmi, Abubakar, A., & Irham, M. (2025). Property Rights In The Perspective Of The Qur'an (A Comparison Of Ownership In The Capitalist, Socialist And Islamic Economic Systems). *Economics and Business*

Journal (ECBIS), 3(2), 140–146.
<https://doi.org/10.47353/ECBIS.V3I2.169>

Syamsuri, S., Johari, F., Nadhilah, N., & Sa'adah, Y. (2024). Forecasting the Financial Soundness of Indonesia's National Board of Zakat (BAZNAS) Using Artificial Neural Network Models. *TEM Journal*, 13(1), 605–615. <https://doi.org/10.18421/TEM131-63>

Wasesa, M., Hidayat, T., Andariesta, D. T., Attazahri, A. K., Satritama, B., Wasesa, H. A., Zulhan, Z., Mubarak, M. Z., & Putro, U. S. (2026). Navigating trade policies and sustainability: a system dynamics analysis of Indonesia's nickel supply chain. *Resources Policy*, 112, 105786. <https://doi.org/10.1016/J.RESOURPOL.2025.105786>

Yang, Q., & Lee, Y. C. (2024). Ethical AI in Financial Inclusion: The Role of Algorithmic Fairness on User Satisfaction and Recommendation. *Big Data and Cognitive Computing 2024*, Vol. 8, Page 105, 8(9), 105. <https://doi.org/10.3390/BDCC8090105>

Yu, G., Li, Q., Zhao, Y., Wang, J., Chen, Y., & Chen, S. (2025). *Utilizing Effective Dynamic Graph Learning to Shield Financial Stability from Risk Propagation*.

Zhou Yu Liu, Z., Ding, J., & Jin Yong Li BNRist, D. (2023). *Hierarchical Knowledge Graph Learning Enabled Socioeconomic Indicator Prediction in Location-Based Social Network*. <https://doi.org/10.1145/3543507.3583239>