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Investment Dynamics in the Economies of Selected ASEAN Countries

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ABSTRACT

Research Originality: This research is original in its dynamic panel analysis of investment efficiency determinants in ASEAN+8 economies during 2019-2023, revealing persistent efficiency patterns and nonlinear governance effects.

Research Objectives: This study investigates the impact of foreign direct investment, governance quality, trade openness, and capital intensity on investment efficiency (ICOR) in ASEAN economies.

Research Methods: This study employs System GMM estimation on panel data from 8 ASEAN countries. Key variables include ICOR, FDI inflows, the Corruption Perception Index, trade openness (% of GDP), and capital per worker.

Empirical Results: The analysis reveals strong persistence in investment efficiency over time. While foreign direct investment has only a limited short-term effect, trade openness is a critical long-run driver of efficiency. The relationship with governance quality is complex and nonlinear. Furthermore, capital per worker was not a significant determinant of investment efficiency in the region.

Implications: These results suggest ASEAN policymakers should combine FDI quality targeting with institutional reforms and maintain long-term trade liberalization commitments to enhance investment efficiency.

Keywords:

investment efficiency; foreign direct investment; governance quality; trade policy; capital per worker

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INTRODUCTION

Investment is a fundamental element that plays a crucial role in ASEAN economic integration efforts. This effort is reflected in the ASEAN Economic Community (AEC) Blueprint 2025, where investment is a key component in the first characteristic of AEC to realize an integrated and cohesive economy. ASEAN's strategic vision for investment aims to enhance the region's attractiveness as a global destination by establishing an open, transparent, and predictable investment regime. The ASEAN Comprehensive Investment Agreement (ACIA) is the key policy instrument for realizing this vision and creating a free and open investment environment (ASEAN Secretariat, 2022).

The dynamics of investment efficiency in ASEAN countries present a compelling research topic due to the region's rapid economic growth and integration. The Incremental Capital-Output Ratio (ICOR) is a critical indicator of how effectively capital contributes to economic growth. A low ICOR reflects high investment efficiency, indicating that less investment is required to produce additional output. Recent studies by Fafurida et al. (2023) and Utomo (2023) highlight significant variations in ICOR across ASEAN countries, influenced by disparities in infrastructure, technological innovation, and governance quality. However, the literature's relationship between foreign direct investment (FDI), governance indicators like the Corruption Perception Index (CPI), trade openness, and capital per worker remains inconsistent, warranting further investigation.

Previous research offers mixed findings on the impact of FDI on investment efficiency. While Alfaro et al. (2020) and Pineli et al. (2018) argue that FDI enhances economic growth through technology transfer and skill development, Ivanović (2015) and Levine (2022) find no significant effect, suggesting that FDI's benefits depend on host-country conditions. Similarly, the role of governance is debated: Mauro (2020) and Sekkat (2021) demonstrate that corruption hampers investment efficiency, whereas Huntington (2018) contends that in weak institutional settings, corruption might "grease the wheels" of growth. Trade openness, another critical factor, is shown by Romer (2020) to boost efficiency, but Rodrik (2021) cautions that its benefits are contingent on complementary domestic policies.

This study addresses several gaps in the existing literature. First, while prior research has examined FDI and governance separately, few studies integrate these factors with trade openness and capital per worker in a dynamic panel framework. Second, the inconsistent findings in previous studies suggest the need for a more nuanced analysis, particularly in the ASEAN context, where economic structures and institutional quality vary widely. Third, this research employs the System Generalized Method of Moments (Sys-GMM) to account for endogeneity and dynamic effects, offering more robust estimates than earlier studies relying on static models.

The novelty of this study lies in its comprehensive approach to analyzing investment dynamics in ASEAN+8 countries, incorporating recent data (2019–2023) and advanced econometric techniques. By explicitly examining the interplay between FDI, governance, trade openness, and capital intensity, this research provides updated insights into the determinants of investment efficiency. The findings are expected to

contribute to the theoretical debate on investment-growth linkages and offer actionable policy recommendations for ASEAN policymakers to enhance capital productivity.

METHODS

This study employs a dynamic panel data analysis to examine the determinants of investment efficiency in ASEAN+8 economies from 2019 to 2023. These five years were selected to capture recent trends, including pre-pandemic economic conditions, the disruptions caused by COVID-19, and subsequent recovery efforts. This timeframe allows the study to show how significantly external shocks and policy responses have influenced investment dynamics.

Table 1. Operational Variables

Variables	Definitions	Measurements	Sources	References
Incremental Capital Output Ratio (ICOR)	Measures investment efficiency by comparing capital investment to economic output growth.	Ratio of investment (% of GDP to GDP growth rate (unitless score). Lower ICOR = higher efficiency.	World Bank, ASEAN Stats	(Fafurida et al., 2023)
Foreign Direct Investment (FDI)	Net inflows of cross-border investment for acquiring lasting interest in enterprises.	Annual FDI inflows (millions of USD, nominal).	ASEAN Stats, World Bank	(Alfaro et al., 2020)
Corruption Perception Index (CPI)	Measures perceived public-sector corruption. Higher scores indicate cleaner governance.	Scaled from 0 (highly corrupt) to 100 (very clean). Annual country scores.	Transparency International	(Mauro, 2020 & Utomo, 2023)
Trade Openness	The degree of a country's integration into global trade.	Sum of exports + imports as % of GDP.	World Bank, ASEAN Stats.	(Romer, 2020 & Rodrik, 2021)
Capital per Worker	Capital intensity in production reflects labor productivity.	Gross fixed capital formation divided by the employed labor force (% output per worker).	ILO (ILOSTAT), World Bank	(Barro, 2020)

The research utilizes secondary data from reputable sources, including ASEAN Stats for Foreign Direct Investment (FDI) and trade openness metrics, Transparency International for the Corruption Perception Index (CPI), and the World Bank and International Labour Organization (ILO) for data on capital per worker and GDP-related indicators. The dataset covers eight ASEAN countries, ensuring a representative analysis of regional investment patterns. The study applies the System Generalized Method of Moments (Sys-GMM) estimator to address potential endogeneity and dynamic relationships. This approach is particularly suitable for panel data with a short period and persistent variables, as it combines both level and first-differenced equations to improve efficiency. The model includes a lagged dependent variable (ICOR_{it-1}) to account for persistence in investment efficiency, while other key regressors, such as FDI, CPI, trade openness, and capital per worker, help assess their impact on ICOR.

Several diagnostic tests were conducted to ensure the robustness of the results. The Sargan test confirmed the instruments' validity, while the Arellano-Bond test checked for autocorrelation in the residuals. Additionally, an unbiasedness test compared the Sys-GMM estimates with those from Fixed Effects (FEM) and Pooled Least Squares (PLS) models to verify consistency. These tests collectively support the reliability of the findings.

The Sys-GMM approach was selected for its superior ability to control for endogeneity and dynamic effects, advantages not offered by alternative methods like Difference GMM (FD-GMM) or static panel models. By incorporating lagged variables and robust instrumentation, this method provides more accurate estimates, making it well-suited for analyzing investment efficiency in rapidly evolving economies like those in ASEAN.

This methodological framework allows the study to capture the complex relationships between investment efficiency and its determinants, offering policy-relevant insights for enhancing regional capital productivity. Table 1 presents more detailed information about the operational variables.

Furthermore, the research model equation is as follows (Ibrahim & Iliya, 2023):

$$ICOR_{it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 CPI_{it} + \beta_3 TO_{it} + \beta_4 MpP_{it} + \mu_{it} \quad (1)$$

To include the lag of ICOR as another explanatory variable, the model can be expanded and specified below;

$$ICOR_{it} = ICOR_{it-1} + \beta_1 FDI_{it} + \beta_2 CPI_{it} + \beta_3 KP_{it} + \beta_4 CpW_{it} + \mu_{it} \quad (2)$$

Where:

$ICOR$	: Incremental Capital Output Ratio
$ICOR_{it-1}$	: Lag Incremental Capital Output Ratio
FDI	: Foreign Direct Investment
CPI	: Corruption Perception Index
TO	: Trade Openness
CpW	: Capital per Worker
i	: 8 ASEAN Countries
t	: Period 2019-2023
$t-1$	: Time period t-1
μ_{it}	: Residuals for the i-th country and t-th period group
β_0	: Constant
$\beta_1, \beta_2, \beta_3, \beta_4$	: Coefficient

RESULT AND DISCUSSION

The analysis of investment dynamics in ASEAN+8 economies from 2019 to 2023 reveals critical insights into the determinants of investment efficiency, captured by the ICOR. The application of the System GMM estimator provides robust estimates that account for endogeneity and the dynamic nature of efficiency, offering a more nuanced understanding than previous static analyses.

A central finding is the strong persistence of investment efficiency, evidenced by the highly significant coefficient (0.914) for the lagged ICOR. This indicates that approximately 91% of a country's efficiency level in one year carries over to the next. This path dependency, aligning with Fafurida et al. (2023), suggests that efficiency is ingrained within a country's institutional and economic structure. Consequently, breaking cycles of low efficiency or maintaining high performance requires deep, structural reforms rather than transient policy measures. This persistence underscores the importance of long-term strategic planning over short-term interventions.

Contrary to the common expectation that FDI is a straightforward catalyst for efficiency, our results show a minimal and statistically insignificant short-term effect (-0.0116). This finding challenges studies like Alfaro et al. (2020) but resonates with the nuanced view of Ivanović (2022) in the ASEAN context. This ambiguity can be attributed to the quality and absorptive capacity dichotomy. A significant portion of FDI inflows into ASEAN is directed towards low-value-added manufacturing and resource extraction, which offer limited technology spillovers. Furthermore, the region's varying levels of human capital and technological readiness may inhibit its ability to absorb and leverage advanced foreign technologies, diluting FDI's potential impact. This suggests that the mere volume of FDI is less important than its sectoral composition and the host economy's preparedness to benefit from it.

The relationship between governance quality, measured by the CPI, and investment efficiency presents a particularly complex and counterintuitive result. The positive, albeit statistically insignificant, coefficient contradicts simplistic narratives that cleaner governance automatically translates to better economic outcomes. This finding nevertheless lends tentative support to Huntington's (2018) thesis that certain types of corruption can, in specific contexts, grease the wheels of commerce in otherwise inefficient bureaucracies. "Greasing the wheels" hypothesis, suggesting that certain informal practices might expedite processes. However, this should not be misconstrued as an endorsement of corruption. Instead, it highlights a more critical issue: the weakness of formal institutions. The problem may not be the absence of anti-corruption laws but rather deep-seated institutional inefficiencies that make investors seek alternative, informal routes. Therefore, the policy focus should shift from merely punishing corruption to streamlining regulations and strengthening the overall institutional framework to reduce the need for such practices.

Perhaps the most impactful finding is the stark difference between short-term and long-term effects of trade openness. The immediate effect is modest and insignificant (-0.186), but the long-run elasticity is substantial and negative (-2.158). This powerful result strongly supports the arguments of Rodrik (2021) and Romer (2020). It indicates that the benefits of openness are not instantaneous; they materialize over time as industries undergo restructuring, integrate into global value chains, and are exposed to competitive pressures that drive innovation and productivity. This underscores trade liberalization as a long-term strategic commitment whose dividends are paid through sustained enhancements in allocative and productive efficiency.

Finally, the result for capital per worker is perhaps the most surprising; it shows no significant effect on investment efficiency. This directly challenges traditional growth models that emphasize capital accumulation. It aligns, however, with Pritchett's (2020) argument that simply adding more physical capital is ineffective if not complemented by investments in human capital and efficient management. A factory with advanced machinery will not be productive if the workforce lacks the skills to operate it or if management is inefficient. This finding shifts the focus from the quantity of capital to the quality of its deployment, emphasizing that complementary investments in human capital and institutional support are prerequisites for capital intensity to translate into genuine efficiency gains.

At this stage, the dynamic panel data regression model is estimated using the two-step GMM first-difference approach and the System GMM (Sys-GMM) estimator approach shown in Table 2. Table 2 shows the coefficient value and standard error for each independent variable using the Arellano-Bond FD-GMM approach. The coefficient value shows the effect of changes in the independent variable on the dependent variable. This indicates how much change occurs in the ICOR variable for each unit change in each independent variable, where a positive coefficient indicates a unidirectional relationship and a negative coefficient indicates an opposite relationship.

Table 2. Arellano-Bond FD-GMM Model Arellano-Bond FD-GMM Model

Variables	Coefficient	Std.Error	Z-Value	P-Value
ICOR _{it-1}	.5923465	.3711614	1.60	0.111
FDI _{it}	-.016401	.0209445	-0.78	0.434
CPI _{it}	.0696094	.3046488	0.23	0.819
TO _{it}	-.0312875	.2337727	-0.13	0.894
CpW _{it}	-.0067112	.0140994	-0.48	0.634
Cons	.110115	1.409233	0.08	0.938

Table 3 shows the coefficient value and standard error for each independent variable using the SYS-GMM Blundell and Bond approach. The coefficient value shows the effect of changes in the independent variable on the dependent variable. This indicates how much the ICOR variable changes for each unit change in each independent variable, where positive values indicate a unidirectional relationship, while negative values indicate an opposite relationship.

The Sargan test is a statistical testing method used to evaluate the validity of instrumental variables in econometric models. This test aims to identify overidentifying restrictions in the model. The test is conducted with the following hypothesis:

H_0 : The condition of overidentifying restrictions in the model estimation is valid (the instrument variable is not correlated with the error term)

H_1 : The overidentifying restrictions condition in the model estimation is invalid (the instrument variable is correlated with the error term)

Table 3. Blundell and Bond's SYS-GMM model

Variables	Coefficient	Std.Error	Z-Value	P-Value
ICOR _{it-1}	.9138864	.1105802	8.26	0.000
FDI _{it}	-.0115803	.0210472	-0.55	0.582
CPI _{it}	.0524174	.2940645	0.18	0.859
KP _{it}	-.1858231	.2113038	-0.88	0.379
MpP _{it}	.0002011	.0130448	0.02	0.988
Cons	.7035767	1.243452	0.57	0.572

The test uses a significance level (α) of 0.05, or 5%. If the probability value of the Sargan statistic is greater than α (p-value > 0.05), then H_0 is rejected, which means that the instrument variable used in the model is valid. Conversely, if the probability value is smaller than α (p-value < 0.05), then H_0 is rejected, which indicates that the instrument variable is invalid. The following presents the results of the Sargan test to evaluate the validity of the instrument variables in the GMM estimation model (Algifari, 2021). The test results include the value of the Sargan statistic and its probability:

Table 4. Sargan Test

Model	Statistical value	P-value
FD-GMM	4.950485	0.4220
Sys-GMM	8.167252	0.4173

Based on the data presented in Table 4 regarding the Sargan Test, it can be concluded that two models were tested: FD-GMM and Sys-GMM. The FD-GMM model produces a statistical value of 4.950485 with a P-value of 0.4220, while the Sys-GMM model has a higher statistical value of 8.167252 with a P-value of 0.4173. Both models show a P-value greater than the significance level of 0.05 (5%), which indicates that the instruments used in both models are valid. This indicates that there is no problem of overidentifying restrictions in the model, which means that the model specifications and instruments used in the estimation are correct. Based on the results of this Sargan test, both models can be considered robust and reliable for further analysis.

The Arellano-Bond test is a statistical testing method used to evaluate the consistency of estimators generated from the Generalized Method of Moments (GMM) process. This test detects the presence or absence of autocorrelation in the residuals that have been transformed into first differences. The GMM estimator is considered consistent if there is no autocorrelation in the second-order residuals (second-order serial correlation). The hypotheses tested are:

H_0 : There is no autocorrelation in the second-order residuals

H_1 : There is autocorrelation in the second-order residuals.

The test is conducted with a significance level (α) of 0.05. If the probability value of the Arellano-Bond statistic is greater than α (p-value > 0.05), then H_0 fails to be rejected,

indicating that the GMM estimator is consistent. Conversely, if the probability value is smaller than α (p-value < 0.05), then H_0 is rejected, indicating an autocorrelation problem, and the estimator is inconsistent. The following are the results of the Arellano-Bond test to evaluate the consistency of the GMM estimator through autocorrelation testing on the residuals (Algifari, 2021). The test results include the Arellano-Bond statistical value for the second order (AR2) along with its probability:

Table 5. Arellano-Bond Test

Model	Statistical value	P-value
FD-GMM	1.2311	0.2183
Sys-GMM	1.0209	0.3073

Based on the results shown in Table 5 regarding the Arellano-Bond Test, the FD-GMM model has a statistical value of 1.2311 with a P-value of 0.2183. In contrast, the Sys-GMM model produces a slightly lower statistical value of 1.0209 with a P-value of 0.3073. Both models show a P-value greater than 0.05 (5%) significance level, indicating the absence of second-order autocorrelation in the model. These results indicate that the assumption of no serial autocorrelation in the error terms is met, which is an important requirement in GMM estimation. Thus, both models can be considered valid and meet the assumptions required for dynamic panel data analysis.

The next test evaluates the unbiasedness of the estimator by comparing the dependent variable lag coefficients generated from the First-Difference GMM (FD-GMM) and System GMM (SYS-GMM) methods against two reference models. The reference models used are the Fixed Effect Model (FEM), which tends to produce downward bias, and the Pooled Least Squares (PLS), which tends to produce upward bias. An unbiased estimator should have a value that is between the FEM and PLS estimators (Algifari, 2021). A comparison of the results of the dependent variable lag coefficient estimation between the FD-GMM, SYS-GMM, FEM, and PLS models is presented in the following table:

Table 6. Comparison of FG-GMM, SYS-GMM, FEM, and PLS estimators

Coefficient			
FD-GMM	FEM	SYS-GMM	PLS
.59234655	.91388643	.84039487	1.0147977

Based on the analysis of the unbiasedness test on the dynamic panel from Table 6, it can be seen that the FEM coefficient value is 0.91388643 and the PLS coefficient value is 1.0147977, so the consistent estimator should be between the two values. Among the four existing models —FD-GMM (0.59234655), FEM (0.91388643), SYS-GMM (0.84039487), and PLS (1.0147977) —it can be observed that the SYS-GMM coefficient value of 0.84039487 falls within the range between FEM and PLS. Meanwhile, the FD-GMM value is below the FEM value, so it does not meet the criteria. Thus, based on this unbiasedness test, the SYS-GMM model can be considered the best and unbiased estimator

because it meets the requirements to be between the FEM and PLS estimator values. These results indicate that SYS-GMM provides more reliable and consistent estimates for dynamic panel analysis in this study.

Dynamic panel data regression is a method used to analyze the short-run and long-run multiplier effects of endogenous variables. Table 7 presents the results of the short-run and long-run elasticity coefficient estimates for variables that affect the inflation rate based on the Blundell-Bond System Generalized Method of Moments (Sys-GMM) model.

Table 7. Short- and Long-Run Elasticity

Variable	Short-Run Elasticity	Long-Run Elasticity
FDI _{it}	-.0115803	-.1344765
CPI _{it}	.0524174	.6087007
TO _{it}	-.1858231	-2.157884
CpW _{it}	.0002011	.0023347

Based on the dynamic panel data regression model, the analysis of short-term and long-term effects on investment dynamics in the ASEAN 8+ region yields the following interpretations: FDI exhibits a negative relationship with ICOR in both the short and long term, with elasticity coefficients of -0.0115803 and -0.1344765, respectively. This implies that a 1% increase in FDI leads to a reduction in ICOR by 0.011% in the short term and 0.134% in the long term. These results suggest that FDI contributes to enhanced capital use efficiency within the region, though the effect remains modest.

In contrast, the CPI shows a positive influence on ICOR, with short-term and long-term elasticities of 0.0524174 and 0.6087007, respectively. A 1% improvement in CPI corresponds to an increase in ICOR of 0.052% in the short run and 0.608% in the long run. This counterintuitive result highlights the complex interplay between governance quality and investment efficiency, suggesting that perceived reductions in corruption may not directly translate into more efficient capital allocation in the ASEAN context.

Trade openness demonstrates a substantial negative impact on ICOR, with a short-run elasticity of -0.1858231 and a significantly stronger long-run elasticity of -2.157884. A 1% increase in trade openness is associated with a 0.185% short-term decrease and a 2.157% long-term decrease in ICOR. The pronounced long-term effect underscores the critical role of trade liberalization in fostering sustained improvements in capital efficiency.

Finally, capital per worker displays a positive but negligible effect on ICOR, with elasticity coefficients of 0.0002011 in the short term and 0.0023347 in the long term. A 1% rise in capital per worker results in only a 0.0002% short-term and 0.002% long-term increase in ICOR. This minimal influence indicates that capital intensity alone is not a decisive factor in shaping investment efficiency across the ASEAN 8+ region.

The interaction between these variables provides a comprehensive picture of investment efficiency in ASEAN. The strong persistence of ICOR suggests that policies must be consistent and long-term to change a country's efficiency trajectory. The limited impact of

FDI and capital per worker, coupled with the profound long-term effects of trade openness, suggests that “software” factors (institutions, policies, skills) are more decisive than “hardware” factors (capital volume). Complex results for governance (CPI) further reinforce that the quality of institutions is a fundamental determinant of how effectively other inputs, whether foreign capital, domestic investment, or trade flows, are converted into economic growth.

This analysis moves the debate beyond linear relationships. It shows that the effectiveness of FDI depends on the quality of institutions and human capital, that governance affects efficiency in a non-linear way, and that trade policy has a J-curve effect on efficiency. This nuanced understanding is crucial for policymakers, suggesting that a piecemeal approach is insufficient. A synergistic strategy combining targeted FDI promotion, a firm commitment to trade openness, and deep institutional reforms to reduce bureaucratic inefficiency is essential to significantly improve efficiency.

CONCLUSION

This study demonstrates that investment efficiency in ASEAN+8 economies is highly persistent, underscoring the need for sustained, long-term policy approaches rather than short-term interventions. While FDI shows limited short-term impact, trade openness emerges as a critical driver of efficiency improvements over the long run. The relationship between governance quality, proxied by the CPI, and investment efficiency is complex and nonlinear, suggesting that anticorruption measures alone are insufficient. Furthermore, capital intensity per worker does not significantly influence investment efficiency, highlighting that human capital and institutional quality improvements must complement physical capital accumulation.

These findings offer clear policy implications: ASEAN policymakers should prioritize high-quality FDI that facilitates genuine technology transfer, maintain commitments to trade liberalization, and pursue holistic institutional reforms that address deeper governance weaknesses. A balanced development strategy integrating investment in physical capital, human capital, and institutions is essential to enhance investment efficiency and support sustainable economic growth in the region.

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Government's Role in Enhancing Economic Inclusion Through Digital Infrastructure Equity in Indonesia

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ABSTRACT

Research Originality: This research is original in its examination of the equitable distribution of digital infrastructure in enhancing economic inclusion in Indonesia, employing a fixed effect model and quantile regression approach.

Research Objectives: This study investigates the impact of the equitable distribution of digital infrastructure on enhancing economic inclusion in Indonesia.

Research Methods: This study employs a fixed effect model and quantile regression, analyzing data from 34 provinces between 2019 and 2023. Key variables include internet access, internet speed, the number of Base Transceiver Stations (BTS), and digital literacy.

Empirical Results: The findings reveal that internet access and internet speed have a positive and significant impact on digital financial inclusion, whereas the number of BTS and digital literacy exhibit no significant effect. The impact of digital infrastructure varies across regions, with areas exhibiting lower financial inclusion requiring greater infrastructure optimization compared to those with higher inclusion levels.

Implications: The results imply that digital infrastructure development plays a critical role in promoting equitable financial inclusion. Consequently, policymakers are urged to prioritize and accelerate the expansion of digital infrastructure, particularly in regions lagging behind, to reduce financial exclusion and foster inclusive economic development at the national level.

Keywords:

digital infrastructure; economic inclusion; government; panel data; quantile regression

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INTRODUCTION

The digital economy plays a fundamental role in fostering inclusive economic growth. The integration of digital technologies into economic systems can accelerate growth by improving resource allocation, promoting innovation, and facilitating industrial upgrading (Xiang et al., 2022; Xin et al., 2023). However, the relationship between the digital economy and inclusive growth often follows an inverted U-shape (Xiang et al., 2022). This is particularly evident in developing regions, where digital economic expansion may hinder economic growth due to prevailing digital divides (Zheng & Huang, 2024).

In developing countries, the negative impact of the digital divide on economic growth underscores the importance of the quality and availability of digital infrastructure. Poor infrastructure results in inefficiencies in the digital economy, ultimately impeding digital transformation (Garcia-Escribano et al., 2015). Limited digital access due to inadequate infrastructure exacerbates regional disparities in digitalization (Andres et al., 2014).

The issue of unequal digital infrastructure has become a significant concern for the government, as equitable access is crucial for fostering inclusive growth. The government plays a central role in enhancing economic inclusion by investing in digital infrastructure to minimize the digital divide (Ali & Faroque, 2023). Digital infrastructure should be regarded as a public good, ensuring that all citizens have access to the internet and digital services, which are essential for participating in the digital economy (Dana, 2024; Purandare, 2024). Such infrastructure significantly contributes to high-quality economic development by optimizing the allocation of financial resources and enhancing industrial structures (Liu, 2023).

As a developing and archipelagic country, Indonesia faces considerable challenges in enhancing its digital infrastructure to support inclusive growth. Most digital transformation efforts remain concentrated in Java, while eastern regions experience lower access and infrastructure quality (Jaya et al., 2024). Nevertheless, the Indonesian government has made efforts to improve digital access equity through a range of policies.

Several initiatives have been undertaken, such as constructing the “Palapa Ring” to connect internet networks nationwide, developing Base Transceiver Station (BTS) towers in remote areas, and providing internet subsidies to low-income communities. BTS towers significantly enhance mobile signal strength and internet access, particularly in remote regions, thereby improving communication capabilities (Apriliana & Widodo, 2023). Improved connectivity via BTS has the potential to stimulate local economic development by facilitating e-commerce and access to information, both of which are critical for small businesses (Ayédoun & Ayédoun, 2020).

In addition, the government has sought to improve the digital literacy among Indonesian citizens through the National Digital Literacy Movement (Gerakan Nasional Literasi Digital, GNLD). This initiative not only seeks to provide access to digital technology but also helps the population use it effectively. Enhancing digital skills enables individuals to engage in entrepreneurial activities, generate employment, and reduce regional disparities (Xie & Chen, 2024). Hence, digital literacy plays a vital role in promoting inclusive

growth by expanding access to opportunities, fostering entrepreneurship, and bridging social inequalities.

Given these developments, it is essential to examine the effectiveness of government efforts in promoting inclusive growth through equitable digital infrastructure. This study aims not only to analyze the impact of digital infrastructure on inclusive growth but also to explore this relationship in greater depth across various regional quantiles.

METHOD

This study employed panel data comprising 34 provinces in Indonesia over the period 2019–2023. The sample selection excluded any administrative changes resulting from the enactment of Law No. 14 concerning the Establishment of South Papua Province, ensuring consistency in provincial boundaries during the observation period. The independent variables used in this study included the number of digital infrastructure access points (X1), internet speed (X2), the number of Base Transceiver Stations (BTS) (X3), and digital literacy (X4). The dependent variable was digital financial inclusion (Y). All variables were measured using a ratio scale. The data for this study were obtained from authoritative and official sources, namely the Ministry of Communication and Information Technology (Kemkominfo) of the Republic of Indonesia, Statistics Indonesia (BPS), and Bank Indonesia.

This study adopted a quantitative approach that emphasizes clearly defined and measurable variables, employs standardized instruments, follows a systematic research process, relies on objective data, and utilizes established theoretical frameworks. The research design is causal-associative, aiming to investigate cause-and-effect relationships between multiple variables. The study applied a non-probability sampling technique, specifically purposive sampling, which involves selecting samples based on specific criteria relevant to the research objectives, ensuring that the chosen data fit the study's analytical needs. The model specification employed in this study is as follows:

$$y_{it} = \alpha_0 + \beta_1 x1_{it} + \beta_2 x2_{it} + \beta_3 x3_{it} + \beta_4 x4_{it} + \varepsilon_{it} \quad (1)$$

Equation (1) illustrates that the enhancement of digital financial inclusion (Y) can be influenced by several key factors, namely internet access (X1), internet speed (X2), the number of Base Transceiver Stations—BTS (X3), and digital literacy (X4). This study employed panel data analysis and quantile regression as the primary analytical methods.

The use of panel data aims to examine the role of government in fostering financial inclusion through the expansion of infrastructure access, improvement of internet speed, development of BTS networks, and enhancement of digital literacy. Within panel data analysis, three primary models are commonly utilized: the Common Effect Model (CEM), the Fixed Effect Model (FEM), and the Random Effect Model (REM). The Common Effect Model (CEM) assumes no variations in individual and temporal characteristics (Wang et al., 2022). The transformation of the model into the Common Effect Model (CEM) follows the specification presented in Equation (1). Conversely, the Fixed Effect Model (FEM) accounts for heterogeneity across individuals by incorporating dummy

variables for each entity (Wang et al., 2022). The Fixed Effect Model (FEM) is expressed using the Least Squares Dummy Variable (LSDV) approach, as follows:

$$y_{it} = a_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + \beta_3 x_{3it} + \beta_4 x_{4it} + \sum_{i=2}^N \delta_i D_i + \varepsilon_{it} \quad (2)$$

equation (2) represents the Least Squares Dummy Variable (LSDV) model, where D_i serves as a dummy variable for each region. This approach enables the model to account for region-specific effects that remain constant over time.

On the other hand, the Random Effect Model (REM) assumes that individual differences are random and uncorrelated with the independent variables (Wang et al., 2022). Unlike the Fixed Effect Model, which introduces dummy variables to control for heterogeneity, the Random Effect Model treats these variations as part of the error term, allowing for more efficient parameter estimation when the assumption of no correlation holds. The specification of the Random Effect Model (REM) is formulated as follows:

$$y_{it} = a_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + \beta_3 x_{3it} + \beta_4 x_{4it} + u_i + \varepsilon_{it} \quad (3)$$

Equation (3) represents the Random Effect Model (REM), where u_i denotes the individual-specific error term, which is assumed to be random and uncorrelated with the independent variables. This model allows for variations across entities while maintaining efficiency in parameter estimation.

This study also employed the quantile regression method to analyze the role of government in improving financial inclusion through internet access, internet speed, the number of Base Transceiver Stations (BTS), and digital literacy across different quantiles. Unlike conventional regression methods, quantile regression offers for a more detailed examination of relationships at various points in the conditional distribution of the dependent variable. Furthermore, quantile regression effectively addresses issues related to classical assumptions, such as heteroscedasticity and non-normal error distributions (Cade et al., 2022; Yu et al., 2021). The quantile regression equation is formulated as follows:

$$Q_{Y_{it}}(\tau) = a_0(\tau) + \beta_1(\tau)x_{1it} + \beta_2(\tau)x_{2it} + \beta_3(\tau)x_{3it} + \beta_4(\tau)x_{4it} + \varepsilon_{it} \quad (4)$$

Equation (4) represents the quantile regression method, where the quantiles (τ) values are set at 0.25, 0.50, and 0.75 to examine the impact across different economic groups: low, middle, and high quantiles.

RESULTS AND DISCUSSION

The panel data analysis indicated that the Fixed Effects Model (FEM) was the most appropriate specification for this study. The Chow test yielded a p-value of 0.0000, which is less than the significance level of $\alpha = 0.05$, indicating that the FEM provides a better fit compared to the Common Effects Model (CEM). Furthermore, the Hausman test produced a p-value of 0.000, which is also below the 0.05 threshold, suggesting that the FEM is superior to the Random Effects Model (REM). These findings confirm that the Fixed Effects Model effectively captures the unobserved heterogeneity across provinces

and is therefore the most suitable model for estimating the relationship between digital infrastructure and digital financial inclusion in Indonesia.

Table 1 presents the estimation results of the panel data analysis. The Fixed Effects Model (FEM) was identified as the most appropriate model for estimation. The variable of internet access (X1) had a p-value of 0.62, which is greater than the 0.05 significance level, indicating that it does not have a statistically significant effect on digital financial inclusion. This suggests that ease of internet access does not directly contribute to inclusive growth, possibly because lower- and middle-income populations do not frequently use the internet for economic activities (Sojka & Pietrucha, 2024). Likewise, digital literacy (X4) was found to have an insignificant relationship with inclusive growth, as its p-value of 0.69 exceeds the 0.05 threshold. Although the level of digital literacy in Indonesia has improved, it has not yet translated into widespread adoption or optimal use of digital financial services. This implies that digital literacy alone may not be sufficient to drive inclusive growth without corresponding improvements in digital engagement and economic participation.

Table 1. Estimation Results of Panel Data Analysis

Variable	Common Effects Model (CEM)	Fixed Effect Model (FEM)	Random Effect Model (REM)
Internet Access (X1)	-3,32* [-3,49] (0,00)	0,21 [0,49] (0,62)	-0,57 [-1,39] (0,165)
Internet Speed (X2)	0,00* [3,14] (0,00)	0,00* [5,27] (0,00)	0,00* [5,04] (0,00)
The Number of BTS (X3)	-0,00* [-2,47] (0,01)	-0,01* [-4,06] (0,00)	-0,00* [-2,73] (0,00)
Digital Literacy (X4)	92,1* [5,58] (0,00)	-4,82 [-0,39] (0,69)	16,3 [1,41] (0,16)
Model Selection Test			
	Chow Test	Hausman Test	
Prob.	0,00	0,00	

*Significant level 0,005

In contrast, internet speed (X2) demonstrated a positive relationship with inclusive growth. The p-value of 0.00 is below the 0.05 level, indicating statistical significance. The development of high-speed internet has been shown to positively influence financial inclusion, as observed in China, where a higher proportion of internet users is associated with expanded access to financial services (Zhang et al., 2023). Interestingly, the number of Base Transceiver Stations (BTS) (X3) is negatively associated with inclusive growth. This negative effect may stem from regions with low digital penetration, where insufficient

digital literacy and limited economic accessibility hinder the effective utilization of BTS infrastructure. As a result, the presence of BTS alone does not necessarily translate into equitable distribution of economic benefits.

To gain a deeper understanding of regional disparities, this study further applied quantile regression analysis. This approach helps examine how digital infrastructure impacts inclusive growth, which varies across different quantiles of regional development, thereby identifying policy gaps in digital infrastructure improvement strategies.

The estimation results from quantile regression in Table 2 explain that Internet Access (X1) had a positive coefficient across all quantiles ($\tau = 0.25, 0.50, \text{ and } 0.75$). At the 0.25 quantile, the coefficient is 0.01 with a t-statistic of 2.06 and a p-value of 0.04, indicating that internet access has a positive impact on digital financial inclusion in regions with low levels of inclusion. The effect strengthens at higher quantiles, with the coefficient increasing to 0.02 at the 0.75 quantile, a t-statistic of 4.51, and a p-value of 0.00, suggesting a more substantial impact in regions with higher financial inclusion levels.

Table 2. Quantile Regression Estimation Results

Variable	Quantile 1 ($\tau=0.25$)	Quantile 2 ($\tau=0.5$)	Quantile 3 ($\tau=0.75$)
Internet Access (X1)	0.01* [2.06] (0.04)	0.01* [2.68] (0.00)	0.02* [4.51] (0.00)
Internet Speed (X2)	0.06* [9.15] (0.00)	0.67* [9.15] (0.00)	0.69* [4.25] (0.00)
The Number of BTS (X3)	15.36* [5.08] (0.00)	17.41* [5.43] (0.00)	18.49* [2.24] (0.02)
Digital Literacy (X4)	6.76* [2.11] (0.03)	5.43* [2.08] (0.03)	11.33* [2.47] (0.01)
Adj. R-Square	0.34	0.43	0.47
Systemic Quantiles Test	0.708		
Quantile Slope Equality Test	0.01		

*Significant level 0.005

Internet Speed (X2) also exhibited a positive effect across all quantiles, with higher coefficients compared to other variables. At the 0.25 quantile, the coefficient is 0.06, with a t-statistic of 9.15 and a p-value of 0.00, indicating that faster internet speeds significantly boost digital financial inclusion, especially in regions with low inclusion levels. This effect remains consistent across 0.50 and 0.75 quantiles, with coefficients of 0.67 and 0.69, respectively, demonstrating that internet speed is a crucial factor in expanding access to digital financial services across different regions.

The Number of BTS (X3) also had a positive influence on digital financial inclusion across all quantiles, though with a more moderate increase than internet speed. At the 0.25 quantile, the coefficient is 15.36, with a t-statistic of 5.08 and a p-value of 0.00, highlighting that the BTS infrastructure plays a key role in improving digital connectivity. The impact remains significant at the 0.50 and 0.75 quantiles, with coefficients of 17.41 and 18.49, respectively. However, the t-statistic at the 0.75 quantile is lower (2.24) than at previous quantiles, suggesting that the effect of BTS infrastructure might be more substantial in regions with medium financial inclusion levels compared to highly developed ones.

Digital Literacy (X4) had a positive impact on digital financial inclusion, but its effect is more potent at higher quantiles. At the 0.25 quantile, the coefficient is 6.76, with a t-statistic of 2.11 and a p-value of 0.03, indicating that digital literacy significantly contributes to financial inclusion in regions with low levels of inclusion. However, its impact increases significantly at the 0.75 quantile, where the coefficient rises to 11.33 with a t-statistic of 2.47, suggesting that digital literacy becomes more important in regions with a higher financial inclusion level.

The Adjusted R-Square showed an increase from 0.34 at the 0.25 quantile to 0.43 at the 0.50 quantile and 0.47 at the 0.75 quantile. This indicates that the model provides a more accurate explanation of variations in digital financial inclusion in regions with higher levels of inclusion. This result means that the analyzed factors become increasingly relevant in explaining differences in digital financial inclusion as financial development progresses.

The Systemic Quantiles Test results showed a probability value of 0.708, which is greater than the significance level ($\alpha = 0.05$). This suggests that there are no significant differences in the effects of independent variables on digital financial inclusion across different quantiles. In other words, the impact of the independent variables remains relatively stable across the distribution of financial inclusion, suggesting that policies can be applied universally without significant differentiation between regions with varying levels of financial inclusion. Conversely, the Quantile Slope Equality Test results showed a probability value of 0.01, which is less than the $\alpha = 0.05$. This indicates significant differences in the impact of variables across different quantiles. In other words, the effects of independent variables are not uniform across the distribution of financial inclusion, suggesting that policy approaches should consider regional characteristics based on different levels of financial inclusion.

Based on the results of the Systemic Quantiles Test and Quantile Slope Equality Test, it can be concluded that although the model generally follows a consistent pattern, there are differences in the impact of each variable at various levels of financial inclusion. Therefore, while policies can be broadly applied, adjustments should be made to strategies based on the identified differences across various levels of financial inclusion.

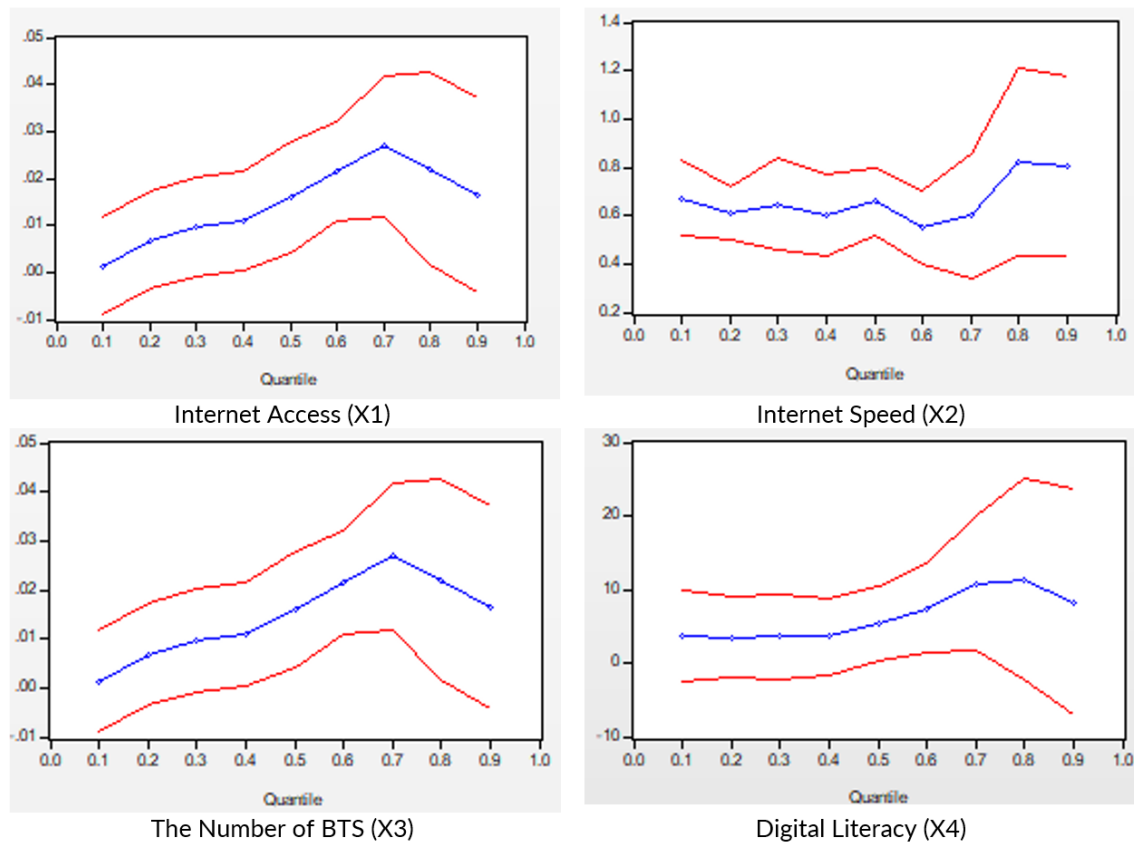
Internet Access (X1) had an increasingly positive effect at higher quantiles, indicating that internet access has a greater impact on inclusive growth in regions with

higher levels of digital financial inclusion. At lower quantiles, the effect remains relatively small and stable, while at medium to high quantiles, the coefficients increase significantly. The wider confidence intervals at higher quantiles suggest that the effect of internet access is more heterogeneous in areas with greater inclusion. This variation implies that regions with stronger initial digital conditions are better positioned to leverage the benefits of internet access (Li et al., 2025). Thus, the development of internet access appears to be more effective in regions that already possess well-established digital infrastructure.

These findings are in line with Manuel Castells' Network Society theory, which argues that individuals with internet access are easily integrated into social and economic networks. The internet functions as a central channel that connects communities to a variety of services, including digital financial services. Therefore, higher levels of internet access increase the opportunities for individuals to participate in the digital economy and access financial services more efficiently.

This result also supports the findings of Ahmed & Khatoon (2019), who demonstrated that internet connectivity, as proxied by the number of internet users, positively influenced financial inclusion. E-banking services heavily rely on internet availability. With internet access, individuals can easily open bank accounts and conduct financial transactions, facilitating integration into the formal financial system (Ahmed & Khatoon, 2019).

Figure 1. Quantile Process Estimates Results



Internet Speed (X2) showed a relatively stable pattern across all quantiles, with a slight increase at higher quantiles. This suggests that internet speed significantly influences digital financial inclusion across all levels of inclusion, although the effect is more pronounced in regions with higher levels of inclusion. Faster internet access facilitates engagement with a wide range of financial services, including banking, insurance, and digital payment systems (Bhosale, 2020). The stable coefficient across quantiles indicates that internet speed is a fundamental factor supporting access to digital financial services nationwide. Therefore, efforts to improve internet speed should be equitably distributed to ensure widespread digital financial inclusion.

The consistent effect of internet speed across low, medium, and high inclusion regions highlights its role as a universal enabler of digital finance. While its impact is evident at all levels, it is especially influential in areas with more advanced digital financial ecosystems. Thus, the government must ensure that improvements in internet speed are not solely concentrated in developed regions. Investments in broadband infrastructure, the optimization of 4G networks, the acceleration of 5G deployment, and strategic partnerships with internet service providers are essential to expand coverage and enhance connectivity quality throughout the country.

The number of Base Transceiver Stations (BTS) (X3) exhibited more variation compared to the other variables. From low to medium quantiles, its effect remained relatively stable, but there was a substantial increase at higher quantiles. This suggests that BTS infrastructure development has a more substantial impact in regions with higher levels of financial inclusion, while in areas with lower levels of inclusion, its effect is still limited. The wide confidence interval at the upper quantiles also implies greater uncertainty in the impact of BTS on digital financial inclusion in more developed regions. Therefore, while increasing the number of BTS is important for expanding digital service coverage, strategies must be tailored to the specific needs of each region. BTS infrastructure development significantly influences high-inclusion regions, contributing to economic growth and reducing inequality (Bhukta et al., 2024; Khoirunurrofik, 2023).

Digital Literacy (X4) showed a significant increase in its effect at higher quantiles, indicating that digital literacy plays a more prominent role in regions with higher levels of financial inclusion. At lower quantiles, its impact is relatively small and stable, but increases progressively at medium and higher levels. This suggests that digital literacy is a key factor in enhancing digital financial inclusion, particularly in regions that already have adequate digital infrastructure. Well-structured technological infrastructure forms the foundation for improving digital literacy (Sulianta et al., 2024). Therefore, digital literacy enhancement programs should focus on strengthening public understanding and utilization of digital financial services, especially in regions with reliable and high-speed internet access.

Interestingly, this finding contrasts with Castells' Network Society theory, which posited that access to and the ability to manipulate information networks were a primary source of power in the digital age. In the context of this study, individuals skilled in accessing, understanding, and utilizing digital technology are better able to capitalize on

opportunities within the digital economy, including digital financial inclusion. The findings also diverge from the study of Anindito & Faturohman, (2023) found a significant effect of digital literacy on digital financial inclusion. Digital literacy enables individuals, particularly those from vulnerable groups or those without access to traditional financial services, to use technology effectively and integrate into the financial system. (Anindito & Faturohman, 2023).

CONCLUSION

Indonesia must pursue the equitable development of digital infrastructure to foster inclusive digital financial growth. While baseline panel data analysis indicates that internet access does not have a statistically significant relationship with the growth of digital financial inclusion, quantile regression reveals a more nuanced picture. Specifically, the number of internet access points demonstrates an increasingly positive effect at higher quantiles, suggesting that internet access has a more substantial impact in regions with higher levels of financial inclusion. A similar pattern emerges with digital literacy. Although it is not statistically significant in the overall panel analysis, quantile regression reveals that its impact, while relatively small and stable in lower quantiles, increases progressively in middle to higher quantiles. These findings indicate that digital literacy becomes more influential in regions that already benefit from established digital infrastructure.

Internet speed, on the other hand, shows a consistently significant and positive relationship with digital financial inclusion across all quantiles, with a slight increase at the upper end. This reinforces the importance of fast and reliable internet connectivity as a foundational driver of inclusive access to digital financial services. The number of Base Transceiver Stations (BTS) also shows a significant relationship with digital financial inclusion. Its effect is relatively stable in the lower to middle quantiles but exhibits a substantial increase at higher quantiles. This suggests that BTS infrastructure development has a greater impact in regions with higher financial inclusion, while its effects are still limited in less developed areas.

Given these findings, the government must formulate targeted digital infrastructure policies that prioritize expanding internet access and digital literacy in regions with low levels of financial inclusion. This can be achieved through incentivizing BTS development in underserved areas, coupled with community-based digital literacy programs and efforts to ensure equitable improvements in internet speed nationwide. Since the effectiveness of digital infrastructure is more pronounced in high-inclusion regions, affirmative policy interventions are essential in lagging regions to accelerate convergence in digital financial inclusion across provinces, ensuring that such growth is both equitable and sustainable.

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What are the Spatial Linkage Patterns in East Kalimantan Region?

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ABSTRACT

Research Originality: This research is original research that examines the spatial linkage between regions in East Kalimantan Province comprehensively

Research Objectives: This study examines economic concentration and inter-regional connectivity and their impact on growth dynamics in East Kalimantan.

Research Methods: This research uses a Spatial Autocorrelation Analysis based on Moran's Index, Herfindahl-Hirschman Index, and Gravity Index. Data was analyzed from 10 regencies/cities in East Kalimantan from 2017 to 2023.

Empirical Results: The study results indicate weak spatial integration among regencies/cities in East Kalimantan. Moran's Index shows low positive spatial autocorrelation, suggesting limited economic spillover from high-GRDP regions. Market structure analysis reveals sectoral dominance, particularly in mining, leading to low diversification and oligopolistic tendencies. Gravity Index findings highlight strong spatial interaction between Kutai Kartanegara and Samarinda, while Mahakam Ulu remains isolated.

Implications: This study shows that spatial linkages between regions in East Kalimantan remain weak, with the dominance of extractive sectors leading to a concentrated market structure and regional disparities. To address this, strategic regional planning is needed through improved connectivity, economic diversification, and the strengthening of non-extractive sectors. An inclusive and integrative policy approach is essential to achieve equitable and sustainable growth across the region.

Keywords:

Spatial Autocorrelation Analysis, Spatial Linkage, Economic Concentration, Spatial Interaction

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INTRODUCTION

The development of a region cannot be separated from its geographical relations and interactions with other regions, considering the specific potential and needs of each area. Spatial interconnectedness (spatial linkage). It is important in regional economic analysis to determine the influence between geographically adjacent regions, both directly and indirectly, namely by identifying economic resources and activities in one region that can support each other to reduce inequality between more developed and less developed regions by optimizing the management of local resources and potentials (Rodriguez-Pose & von Berlepsch, 2023).

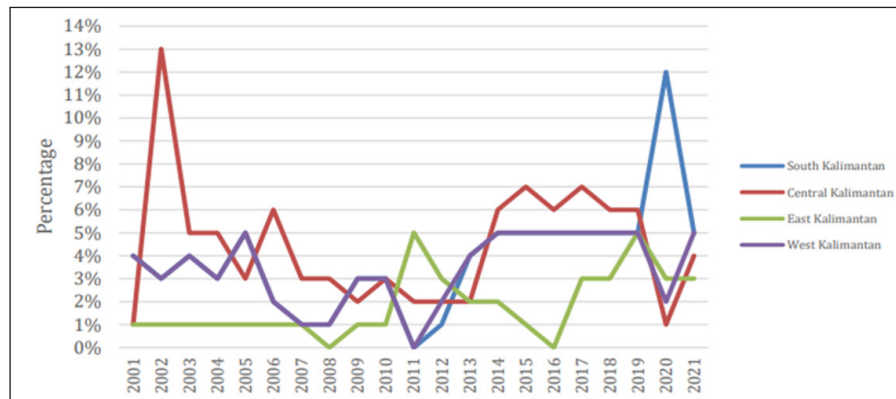
Various studies have examined spatial linkages in Indonesia, such as the analysis of the spatial linkage of economic growth between provinces (Fahmi, 2022), the linkages between metropolitan areas (Wijayanti et al, 2023), and the linkages of transportation infrastructure between regencies/cities (Fadhil et al, 2022). These studies generally use economic spatial model approaches such as the Spatial Autoregressive Model (SAR), the Spatial Durbin Model (SDM), or the Location Quotient (LQ) to statistically analyze the relationship between regions. Moreover, most of the research focuses more on the islands of Java and Sumatra, which historically have a high concentration of development.

Specifically, efforts to align Indonesia's economic growth focus on Kalimantan because, as part of Indonesia, each region's economic growth positively impacts the national economy. This fact is shown in Figure 1, which contributed an average of 9.46% to Indonesia's total GDP. The gross regional product (GRDP) of all provinces in Kalimantan has continued to make a considerable contribution to the national economy over the past ten years. Therefore, Kalimantan is a crucial region for the country's development and must be considered when integrating Indonesia's overall development. However, the difference in GRDP between 2000 and 2021 in each province in Kalimantan shows that there is income inequality on the island. Over the past 20 years, East Kalimantan's average GRDP per capita growth has been 8.48%, which is 1.12 times slower than South Kalimantan's average growth of 9.43%. In contrast, Central Kalimantan's growth rate is 1.15 times faster than South Kalimantan's. For this reason, it is necessary to examine the mechanism behind this economic gap, as shown by the variation in the GRDP per capita growth rate between provinces. (Imaduddin & Kharisma, 2024).

Kalimantan is a part of Indonesia with striking economic development in each region, which has different economic characteristics compared to Java and Sumatra. Kalimantan is a region that is highly dependent on the mining sector and natural resources, especially coal and petroleum. This dependence causes Kalimantan's economic structure to pay less attention to connectivity between regions, making it vulnerable to fluctuations in global commodity prices (Lasaiba, 2023). Although Kalimantan's economy is growing relatively fast (+5.43%), its share of contribution to the national economy remains small because Java and Sumatra still dominate the economic base, so regional growth in Kalimantan tends to be stagnant and uneven, as shown by income inequality between provinces (Imaduddin & Kharisma, 2024). Economic growth in Kalimantan is

closely linked to the influence of road infrastructure and private investment (Hermawan & Yunani, 2025), as well as the quality of human resources, which increases the region's contribution to the national economy (Fitrianiingtyas & Nuryadin, 2025).

Figure 1. Economic Growth in all Provinces in Kalimantan (percent)



Source: Central Statistics Agency, 2001-2021

One of the regions of Kalimantan, especially East Kalimantan, still receives relatively little attention despite having unique spatial characteristics, such as the dominance of the extractive sector, the spread of scattered settlements, and the plan to relocate the National Capital. East Kalimantan Province has a high GRDP, but its economic growth is still relatively low and uneven between regions. The economy still depends on the mining sector, and inequality between regions tends to decrease each year, driven by improvements in coal prices and strategic IKN projects that strengthen regional economic growth. (Permatasari et al, 2024).

In the last decade, geospatial studies in East Kalimantan have developed, mainly focusing on spatial distribution patterns. Moran's I and LISA identify the concentration of economic activity in big cities, showing inequality between regions. The results of the LISA cluster map show one new growth center in East Kalimantan Province, namely East Kutai Regency, which indicates a potential shift in regional economic dynamics (Pratiwi & Kuncoro, 2016). Likewise, research by Wijaya et al. (2020) on the mapping of spatial interactions between regions in East Kalimantan, using the gravity model and Klassen typology, shows a growth pattern centered in economic centers such as Kutai Kartanegara and Samarinda. This condition aligns with Hirschman's (1958) polarization theory and explains how economic growth tends to concentrate at the poles, drawing resources from surrounding regions and leading to widening regional gaps.

Therefore, a growth center-based development strategy requires policies that strengthen connectivity between regions, infrastructure development in buffer zones, and economic incentives for productive sectors outside the main centers (Rodríguez-Pose & Wilkie, 2018). The importance of the close relationship between spatial aspects and economic growth in East Kalimantan is evident, as areas with good transportation access,

such as toll roads and ports, have a higher GRDP than areas with limited infrastructure. Because they have connectivity, investment, and trade between regions, they can reduce regional disparities and encourage inclusive economic growth (Fahmi, 2022). Spatial linkages such as inter-regional connectivity play a role in shaping regional disparities and economic concentrations. To overcome this, efforts are needed to encourage the effect of spread, namely the spread of growth benefits to surrounding areas through strengthening connectivity, equitable distribution of infrastructure, and investment incentives for disadvantaged areas (Krugman, 1991; Combes & Gobillon, 2015; Rahayu & Febriaty, 2024).

However, previous studies are still focused on the interaction patterns or distribution of a single indicator (e.g., hotspots, GRDP, economic mobility), without explicitly examining the traces of multivariate spatial linkage between various economic components, infrastructure, and regional interactions in East Kalimantan. In addition, most previous studies are still based on traditional methods such as single-variable autocorrelation or static gravity models. Different spatial linkage analysis approaches have never been applied holistically in East Kalimantan. Consequently, there is no comprehensive analysis that integrates various variables, such as economic concentration, regional distance, and interaction between regions, to determine how regions in East Kalimantan are interconnected and impact regional economic growth.

Spatial dependence has an impact on economic growth between regions. Therefore, this study aims to reduce disparities by identifying spatial linkage patterns in East Kalimantan. It focuses on the distribution patterns, spatial concentrations, and interactions between regencies/cities regarding the distribution of GRDP, as well as effective economic interactions between developed and developing regions. Thus, this research is expected to expand the analytical discourse from focusing solely on the distribution or interaction of single indicators to a deeper understanding of the structural and functional connections between regions in East Kalimantan within the context of sustainable development.

METHODS

The research covers 10 regencies/cities in the province of East Kalimantan in Indonesia. In this study, a 6-year time series of data from 2017 to 2023 was used. This time frame provides a more comprehensive picture of changes in economic structure and the potential for the emergence of new economic patterns. The data used in this study are secondary, obtained from official publications by Statistics Indonesia (BPS) and other institutions related to the research topic.

The variables observed in this study in each region are economic growth, Gross Regional Domestic Product (GRDP), population (P), and distance between regions (d). The definition of variables is as follows: (1) Economic Growth is a change in economic conditions from time to time in percentage; (2) GRDP is defined as the total gross amount of all sectors in the region, both oil and gas and non-oil and gas, based on fixed prices in a given base year in units of millions of rupiah; (3) Total population (P)

is defined as the total number of persons residing in the area who are aged 15 years and above and are considered to be in the productive age group (on thousand); (4) The distance between regions (d) is defined as the distance from one city to another, i.e. the distance of several city from the city of Samarinda in km.

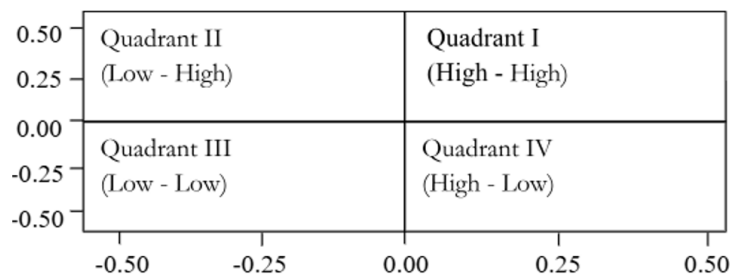
The analysis method in this study uses Spatial linkage, or spatial autocorrelation, which occurs due to inter-regional interactions and similarities in the characteristics of an object in space. Spatial patterns can be clustered, dispersed, or random. Positive spatial autocorrelation indicates that adjacent areas have similar characteristics and tend to form clusters, while negative spatial autocorrelation indicates differences in characteristics between adjacent areas, resulting in scattered patterns.

Moran's I is a method used to identify the characteristics of spatial patterns in three forms, namely clustered, random, and separated. Moran's I is used to see whether there is spatial autocorrelation in a region. Moran's I can be measured by the equation (Moran, 1950):

$$I = \frac{N \sum_i \sum_j w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{S_0 \sum_i (x_i - \bar{x})^2}$$

The Moran Index includes a Moran Scatterplot that displays the spatial influence distribution graph, divided into four quadrants (see Figure 2).

Figure 2. Morans Scaterplot



Source: (Marliani, 2021)

Quadrant I (High-High) reflects the concentration of high-value areas close to each other, while Quadrant II (Low-High) indicates the presence of low-value areas in the middle of high-value neighborhoods. Quadrant III (Low-Low) represents the interconnectedness of low-value areas close to each other, while Quadrant IV (High-Low) depicts high-value areas surrounded by low-value areas.

The Herfindahl Index is used to measure the degree of spatial concentration of a subsector within a region. The index indicates whether a subsector is evenly distributed or concentrated in a few locations. The value of the index ranges from 0 to 1, where a value close to 0 indicates even distribution, while a value close to 1 indicates high concentration in a region (Setiawan et al, 2021). The higher the value of this index, the greater the inequality of subsector distribution, which may indicate economic dominance in a particular region. Conversely, the lower the value of this index, the more evenly

distributed the subsectors are in the region being analyzed. The Herfindahl Index is widely used in regional economic analysis to understand spatial patterns and potential inequality between regions.

$$HHI_i = \sum_{i=1}^J (TK_i)^2$$

Description: *HHI_i* = The level of concentration of Large and Medium Industries for each Regency/City in East Kalimantan and *TK_i* = The total number of Large and Medium Industry workers in each Regency/City in East Kalimantan.

The Gravity Index measures economic linkages between regions based on economic attractiveness, population and distance. A high index value indicates close economic interaction, while a low value signifies a weak relationship. This concept assumes that regions with large GRDP or population tend to have stronger economic linkages. Conversely, the greater the distance between regions, the weaker the economic interaction due to increased transportation costs and geographical barriers. Gravity Index Formula (Sen & Smith, 1995):

$$i = \frac{P_1 \times P_2}{J}$$

The amount of inter-regional interaction (I) is influenced by the population in each region, namely *P₁* for region *i* and *P₂* for region *j* (in thousands). The larger the population, the higher the potential for economic interactions, such as trade and labor mobility. However, this interaction also depends on *J*, the distance between regions (in km). The longer the distance, the greater the barriers to interaction due to transportation costs and accessibility.

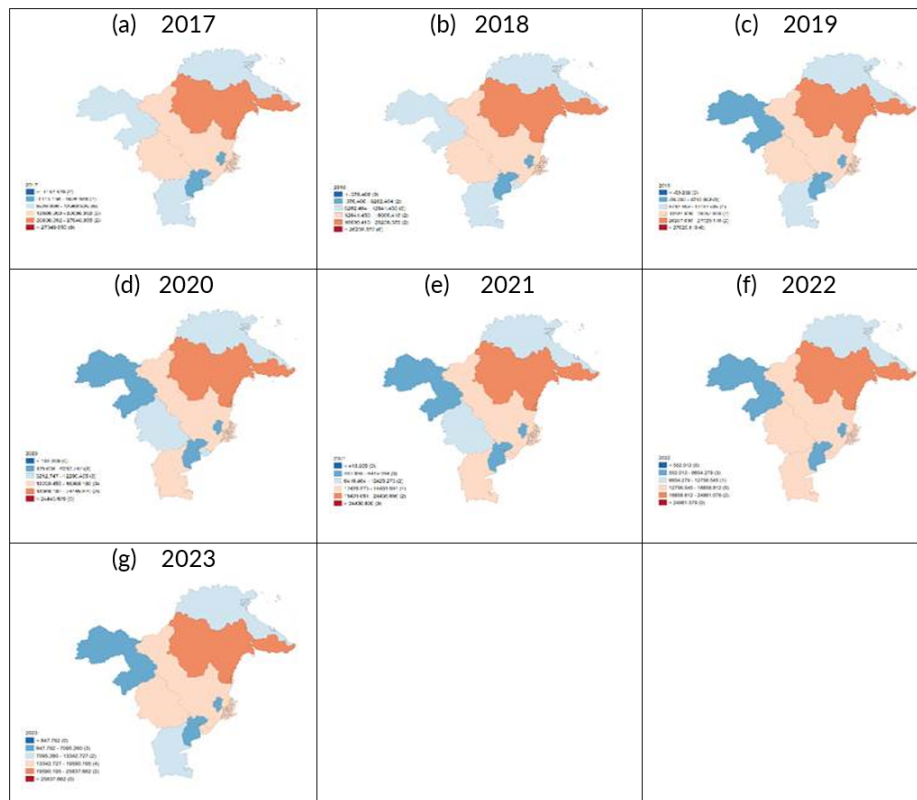
RESULTS AND DISCUSSION

The results of spatial autocorrelation analysis in East Kalimantan, which measures the level of spatial interdependence or inter-regional relationships, occur due to the interaction between regions and the similarity of regional characteristics. Using a spatial analysis approach, it is possible to identify patterns of clustering geographically (spatial clustering) or randomly dispersed. This can be seen from the results of the spatial autocorrelation analysis of each regency/city in East Kalimantan. The GRDP data description results for East Kalimantan from 2017 to 2023, based on 10 regencies/cities, are shown in Figure 3.

The results of the analysis show that East Kutai has the highest average GRDP per capita during the 2017-2023 period due to its large-scale coal mining sector, dominant exports, and relatively small population. Spatially, East Kutai has a stronger economic interaction with the global market (coal and CPO exports) than with the local region. This condition will create a potential regional spatial disparity, even though it is part of a strong economic cluster with regional spatial interactions dominated by the mining sector and its strategic position. East Kutai is in Quadrant I (high growth + high per capita GRDP) and is included in the advanced and fast-growing category, confirming the per capita disparity in East Kalimantan (Wijaya et al, 2020; Nur, 2021; Espinosa et al, 2024).

Furthermore, the groups with the second-highest GRDP per capita order are found in the Kutai Kartanegara, Balikpapan, and Paser areas due to their strategic position in the economic corridor and IKN development. Balikpapan has become a growth center, while Kutai Kartanegara and North Penajam Paser are the second-level growth centers in the IKN corridor based on the centrality index and scalography (Wahyudin, 2022), as well as the existence of spatial linkages dominated by extractive sectors such as mining and oil and gas, and supported by relatively better infrastructure (access to ports) and roles as distribution/logistics centers. This reflects the economic interaction between regions and the pattern of agglomeration in economic activities, namely by utilizing port and transportation infrastructure to create economic clusters. In line with the research of Kinanthi & Indrayati (2023), analyzing the distribution of the oil and gas sector in Kutai Kartanegara and proving the existence of a multiplier effect and clustered distribution that supports the role of this region as an extractive and regional distribution economic center, and with the analysis of Location Quotient and ShiftShare, this result also shows that the base sector in Balikpapan reaches the processing, electricity & gas, trade, transportation & communication that strengthens the strategic position of this city as a logistics center and economic agglomeration so that from the analysis of Klassen Balikpapan as "developing quickly but not advanced" and Kutai Kartanegara as "developed but depressed", reflects the dynamics of the economic agglomeration of extractive clusters in the IKN corridor (Sari et al, 2018; Espinosa et al, 2024).

Figure 3. Thematic Map of GRDP 2017-2023 Regency in East Kalimantan



Source: Geoda Data Processing Results

Meanwhile, the groups with the third-highest average GRDP per capita are West Kutai and Berau because their economic sectors are dominated by mines and plantations with high output, low population, and spatially geographical position as economically independent hinterland areas, which are rich in natural resources, even though they are separate from the growth center. Research by Wijaya et al. (2020) on spatial gravity analysis reveals a one-way relationship pattern from coastal growth (such as Berau) to inland areas, reflecting an economically independent hinterland pattern in resource-rich regions like West Kutai and Berau. This pattern creates a large concentration of economic added value because the impact of economic agglomeration and infrastructure connectivity that is not yet optimal will have the potential to form similar economic clusters in natural resource-based growth, namely from the results of the Location Quotient (LQ) analysis, it was found that the leading sector in West Kutai shows the dominance of the natural resources sector (mining and quarrying) and contributes significantly to GRDP (Karmini et al, 2022).

The regencies/cities with the lowest average GRDP per capita are Samarinda, North Penajam Paser, and Mahakam Ulu. Samarinda, despite being the provincial capital and having strategic geographical access, faces challenges due to its high population. These three regions have limited spatial linkages and function more as centers of government, distribution, or hinterland areas that have not been economically productive. It is shown that the highest inequality value is in Samarinda. However, the provincial capital has a low GRDP per capita due to the lack of integration of productive sectors and the absence of strong economic agglomeration. It shows a significant contribution from differences in regional investment and spending. This indicates that administrative functions are not encouraged by the productivity of the primary economic sector (Handoko, 2020). Spatially, they do not have a strong economic linkage with the surrounding productive areas, so they do not form economic growth clusters that strengthen each other due to weak infrastructure and connectivity, one of which is that the North Penajam Paser area is still a local logistics hub without optimal productive connectivity to the regional/export market so that there are local growth centers but the interaction is relatively limited. Reflects that this area has not been closely integrated with the surrounding productive economy (Harits et al, 2022; Vidriza, 2024).

To determine the presence of spatial autocorrelation between observation locations in a region, the Moran test is required. The value on the Moran index is between $-1 \leq I \leq 1$, where if the value $-1 \leq I < 0$, then it indicates the presence of negative spatial autocorrelation, while the value $0 < I \leq 1$ indicates the presence of positive spatial autocorrelation. In this study, the calculation of the Moran index uses distance weighting with the K-Nearest Neighbor approach. The Moran index value can be seen in Table 1.

Table 1. Moran's Index Value of GRDP 2017-2023

Year	Moran's Index	results
2017	0.211	positive spatial autocorrelation
2018	0.169	positive spatial autocorrelation
2019	0.144	positive spatial autocorrelation
2020	0.110	positive spatial autocorrelation
2021	0.079	positive spatial autocorrelation
2022	0.081	positive spatial autocorrelation
2023	0.093	positive spatial autocorrelation

Source: processed data

Table 1 shows that an analysis of the Moran's Index of Gross Regional Domestic Product (GRDP) per capita in East Kalimantan Province from 2017 to 2023 indicates significant spatial linkages between regions. These findings illustrate changes in economic distribution patterns that reflect non-static spatial relationships between regencies and cities in the region (Table 1). From 2017 to 2020, Moran's I values showed a positive spatial autocorrelation, with values that continued to decline: 0.211 in 2017, 0.169 in 2018, 0.144 in 2019, and 0.110 in 2020. Although Moran's Index tends to be low, its positive direction suggests that regions with high GRDP per capita are generally located near regions with high GRDP, and the same is true for regions with low GRDP. This reflects the existence of weak but still positively significant spatial linkages among regencies/cities in East Kalimantan. This research is in line with research from Jeleskovic & Loeber (2023), which analyzes the spatial dimension of the industrial sector that has an impact on local economic growth due to competition and synergy between regions, as well as spatial grouping to expand the scope of spatial interaction beyond adjacent areas and cover areas with similar characteristics (Fitriani et al, 2024).

From 2021 to 2023, there is a tendency to weaken spatial autocorrelation, although the value of Moran's Index still indicates a positive trend. It was recorded that the index value was 0.079 in 2021, slightly increased to 0.081 in 2022, and reached 0.093 in 2023. Despite the numerical increase, this trend actually reflects a decline in the strength of spatial linkages between regions. This result means that the level of GRDP per capita between regions is no longer geographically concentrated. This fact indicates that regions with high GDP per capita are beginning to coexist with those having lower GDP levels. This phenomenon indicates a weakening of spatial agglomeration and an increase in regional disparities.

Changes in the spatial pattern of GRDP per capita distribution in East Kalimantan during the 2017–2023 period can be attributed to some structural determinants, including high but uneven economic dependence on the mining sector, inequality in access and quality of infrastructure between regions, and the initial impact of the development of the new capital city of Indonesia (IKN) which began to trigger the relocation and

redistribution of economic activities in certain regions. The results of the Moran Scatterplot analysis and distribution map in Figure 4 reveal no dominant spatial cluster. The data distribution across the quadrants reflects the absence of a stable and integrated spatial pattern between regions.

Analysis of the Moran Scatterplot and the map of the distribution of GRDP per capita in East Kalimantan during the period 2017–2023 shows that the distribution of economic activities between regencies/cities is uneven and does not form a stable spatial pattern. The low but still positive value of Moran's Index, close to zero in some years, reflects the weak spatial linkage in the dynamics of regional economic growth. This result shows that the geographical proximity between regions has not been enough to create a significant economic spillover effect. The distribution of areas across the Moran Scatterplot quadrant reflects geographically adjacent areas, highlights similarities in development or economic growth levels, and indicates significant differences in economic dynamics between regions. According to Krugman (1991), in New Economic Geography, spatial concentration can produce increasing returns and encourage uneven regional growth, but they affect each other, and economic growth in a region is not entirely determined by internal factors alone, but also by its proximity to other developing regions.

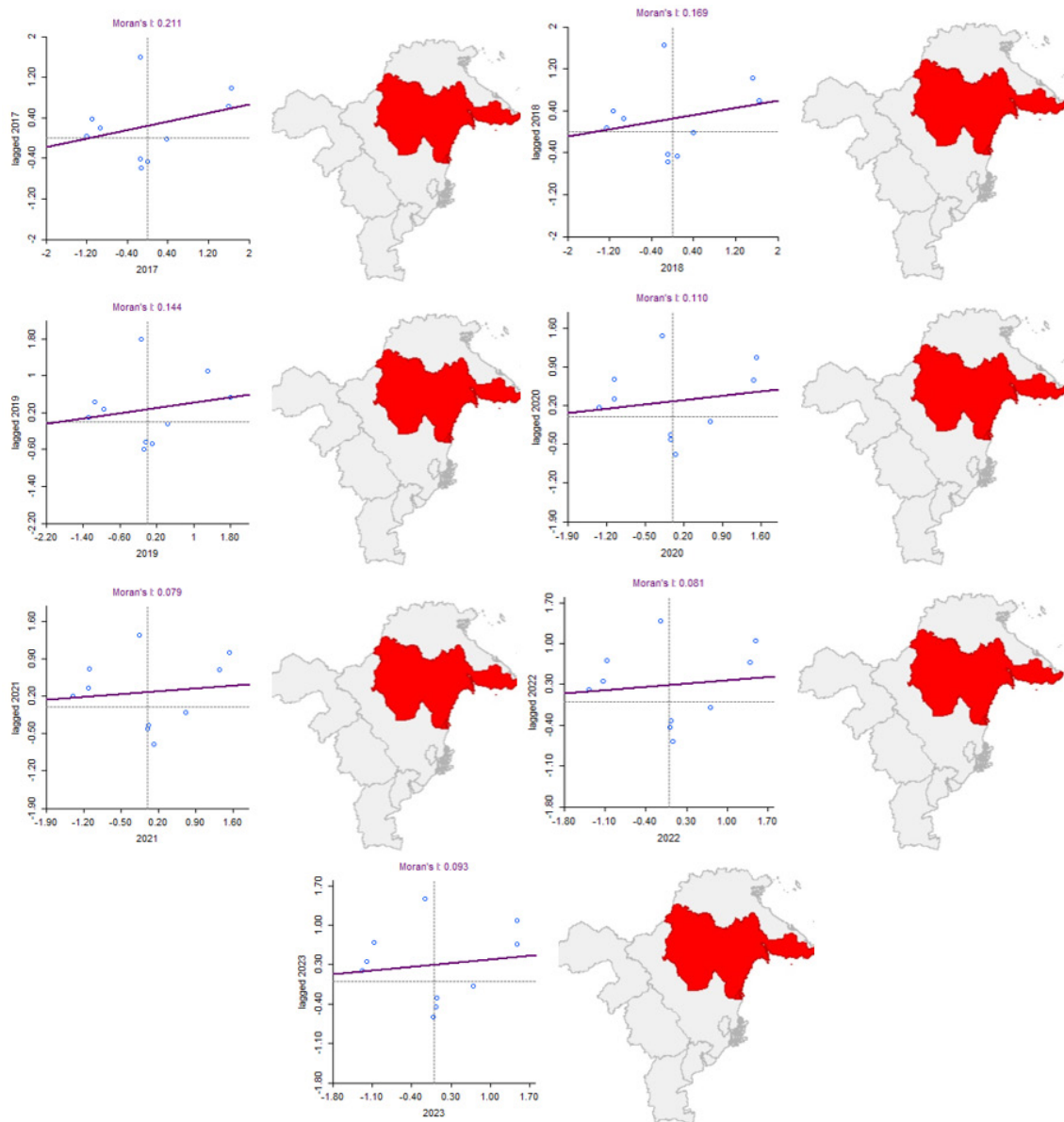
The results of the Moran Scatterplot analysis show that Bontang and East Kutai Regency occupy Quadrant I (High-High), which represents areas with high GRDP per capita levels and are surrounded by areas with similar economic characteristics. This reflects the significant contribution of their leading sectors to the establishment of economic growth centers in East Kalimantan.

Bontang demonstrates high economic performance due to the dominance of the processing industry sector, particularly the petrochemical and Liquefied Natural Gas (LNG) industries, which provide significant added value and attract national and international investment. Meanwhile, East Kutai regency relies on the large-scale coal mining sector and is the main coal production center in Indonesia. These extractive activities not only contribute significantly to local GRDP but also create a multiplier effect on economic activity in the surrounding region.

The geographical position of the two regions near other resource-rich areas will strengthen the spatial linkages in extractive-based economic clusters. This shows that the strength of the main sectors in Bontang and East Kutai is sustainable and highly competitive, enabling them to encourage stable and cohesive regional economic growth. The spatial interaction between these regions reflects the positive interconnectedness that supports the formation of an integrated economic cluster, particularly when natural resources are used as the main engine of economic growth. The same study from Wang et al (2019) shows significant spatial dependency and heterogeneity in economic growth between provinces in China, where the effects of natural resource spillovers tend to impact growth negatively.

The areas classified as Quadrant II (Low-High) in the Moran Scatterplot, namely Berau, Samarinda, Mahakam Ulu, and North Penajam Paser, show interesting spatial

Figure 4. Moran Scatterplot and GRDP distribution map 2017-2023



Source: Geoda Data Processing Results

characteristics. Although these regions have relatively low GRDP per capita rates, they are directly adjacent to regions with high GRDP. The results of this study align with the research of Khotiawan & Sakti (2023) on the existence of a positive spillover effect on per capita income between adjacent regions where the spatial pattern of growth is clustering. This pattern reflects the potential for local spatial inequality, where areas with weak economic performance are located around growth centers, or the occurrence of a backwash effect, as growth centers provide spillover to the surrounding areas. However, these effects are not always even (Richardson, 1978).

The city of Samarinda, as the capital of East Kalimantan province, has a diverse economic structure, covering the trade, service, and transportation sectors. However,

the phenomenon of overurbanization, characterized by a high population that is not balanced by adequate employment, results in the GRDP per capita being lower than in the surrounding areas. Meanwhile, North Penajam Paser, before the influence of the development of the new capital city of Indonesia (IKN), still relied on primary sectors such as agriculture and forestry, which have relatively low economic added value. Mahakam Ulu, as the youngest regency in the province, faces significant development challenges, particularly due to limitations in basic infrastructure and inter-regional accessibility. This condition hinders the optimization of local economic potential. Berau regency, despite having considerable natural resources, especially from the mining and plantation sectors, has not been able to encourage a significant increase in the per capita income of its people.

The inclusion of these four regions in the Low-High category reflects the opportunity for growth diffusion from areas with high GRDP to the surrounding areas. However, it also indicates the need for more targeted development policy interventions to optimally utilize the potential of existing spatial linkages, thereby reducing disparities between regions and designing more efficient strategies (Zhang & Gibson, 2024).

Furthermore, Quadrant III (Low-Low) is Balikpapan and Paser. These regions have low GDP per capita and are surrounded by other regions with similarly low GDP. This spatial pattern shows a low potential for positive linkages in economic growth and indicates a concentration of underdevelopment. This can reinforce development stagnation in the region, meaning that economically weak areas tend to be close together, reinforcing the pattern of spatial underdevelopment (Fitriani et al, 2024). In other words, there is a phenomenon of "spatial inertia" or "spatial poverty trap", which strengthens the poverty trap because the underdeveloped areas tend to form clusters and do not change without large-scale external intervention (Fitz & Gouri, 2021). Balikpapan, which was once one of the centers of the oil and gas industry, is now experiencing a decline in the sector's contribution and has not been entirely able to transform into other economic sectors, thereby hindering its economic growth and oil and gas dominance, creating a less inclusive and sustainable economic structure (Obeng-Odoom, 2024). Paser, although it has the potential of the mining and plantation sectors, faces challenges in maximizing the sector's contribution to sustainable per capita GRDP due to limited supporting infrastructure. This is strengthened by the theory of economic development, which emphasizes the importance of infrastructure in increasing economic growth by utilizing linkages between economic sectors (Hirschman, 1958). Affirmative policy interventions and local capacity building are the drivers of economic structural transformation in these areas with a Low-Low spatial pattern.

The areas of Kutai Kartanegara and West Kutai, identified as being in Quadrant IV (High-Low) in the Moran Scatterplot, exhibited contrasting spatial characteristics: they have a high level of Gross Regional Product per capita. However, they are surrounded by areas with low levels of GRDP per capita. This configuration reflects an isolated economic growth pattern or enclave, where the economic progress of the surrounding region does not mirror the achievements of the enclave itself. This is in

line with the phenomenon of "growth divergence": one region is self-developing, but the adjacent region is not developing or is declining (Evcim et al, 2023; Jayadevan et al, 2025).

Kutai Kartanegara has gained a strategic position in the economic map of East Kalimantan thanks to the dominance of leading sectors such as mining, oil and gas, and the processing industry, which contribute significantly to the creation of regional added value. This research is in line with (Jeleskovic & Loeber, 2023; Imaduddin & Kharisma, 2024) research that the existence of industrial sector clusters has a significant effect on local and national GRDP growth as well as the existence of relatively adequate industrial infrastructure, which has helped strengthen the region's economic position and become a center for knowledge spillovers, with technology, management, and innovation flowing to other sectors to support economic diversification (Khlystova & Kalyuzhnova, 2025). On the other hand, West Kutai, despite being geographically more remote, is still able to maintain a high GRDP per capita through the exploitation of the resources of the mining and forestry sectors. A similar empirical case in Africa that mining areas despite being remote and underpopulated show a surge in the local economy during the mining operation period (Asatryan et al, 2024), while the same empirical case in China shows that remote areas with high mining can maintain high GRDP when supported by green education and innovation, which turns the "resource curse" into sustainable development opportunities and forestry technology innovations can transform the primary sector in remote areas into more value-added, thereby keeping GRDP per capita high through productivity spillover and more advanced industrial structures (Ma & Chen, 2023; Li et al, 2024).

This spatial condition indicates a disconnect between the growth centers and the surrounding regions, reflecting the weak economic linkages between them. According to Krugman (1991), the absence of spatial integration reinforces the polarization between the center and the periphery, which will further widen the regional gap. In other words, only pockets of local growth/growth occur and the spillover effect or economic diffusion to the surrounding area has not occurred optimally (Myrdal, 1957; Hirschman, 1958) This emphasizes the importance of regional development policies that not only focus on increasing the output of the superior regions, but also encourage spatial integration and connectivity between regions with high GRDP and the surrounding regions that are underdeveloped as a strategic step to create more equitable and sustainable growth in East Kalimantan.

The Herfindahl-Hirschman Index (HHI) is a quantitative measure used to assess the level of market concentration and competition structure in an economy. This index is calculated by summing the square of the market share of each economic actor or sector in a region (Pepall et al, 2014). The calculation of the Herfindahl-Hirschman Index in East Kalimantan shows that the market structure in the area has different levels of concentration. This concentration is generally influenced by the dominance of one or two major sectors, especially the mining and processing industries. This phenomenon aligns with the characteristics of East Kalimantan's economy, which is highly dependent on

natural resources, particularly coal, oil, and gas, resulting in an undiversified economic structure. When one sector dominates a region's economy, market conditions become uneven, leading to decreased competition among economic actors and market structures that often result in oligopoly and even monopolies.

Using the top four concentration ratio (CR4) and Herfindahl-Hirschman Index (HHI) approaches, the market structure of East Kalimantan reveals a significant difference in economic competition between the regency and the city. If these two indicators are used together, they will provide a complete picture of the economy's concentration and the dominant direction of a particular sector in the local economy. Most regions, such as Paser, West Kutai, Kutai Kartanegara, East Kutai, Berau, Mahakam Ulu, Balikpapan, and Bontang, showed a CR4 value > 0.70 and an HHI ranged between 0.25 and 1.00. Based on market structure theory (Schmalensee, 1989), CR4 values above 0.60 and HHI above 0.25 indicate a high level of concentration, which can lead to oligopoly or monopoly structures. In East Kalimantan, the dominance of the mining and quarrying industry, along with the agricultural or processing industries in some other regions, leads to limited market access for other companies, decreases competition, and increases economic dependence on global changes. In contrast to these conditions, areas such as North Penajam Paser have a CR4 value of ≈ 0.17 and an HHI $\approx$ of 0.18, indicating a moderate oligopoly structure with the dominance of several sectors but greater opportunities for competition. With a CR4 ≈ 0.46 and an HHI ≈ 0.11 , the provincial capital of Samarinda shows competitive market conditions. This value shows that the market is very open and that no single sector really dominates the economy. This is in accordance with the fact that Samarinda has many service, trade, and government sectors scattered throughout the city, which results in a more balanced economic structure and more advanced infrastructure, showing a more competitive and sustainable market structure in East Kalimantan.

According to structure behavior performance theory, non-competitive market forces are more likely to form if the market is more concentrated (Bain, 1951). When economic sectors are not diversified, there is an inequality of opportunity. As a result, the market becomes less able to absorb labor and innovate (Pepall & Norman, 2014). As a result, if an economic transformation that results in sector diversification is not carried out, areas with high concentration values, such as Mahakam Ulu or Kutai Kartanegara, have the potential to experience structural vulnerability in the long term because the economic structure that is not inclusive and minimal diversification makes it difficult for regions to transition. After all, the linkages with other sectors are weak and show dominance that limits competition (Irawan et al, 2021; Bruno, 2022; Dira et al, 2023; Banurea & Benardin, 2024). Highly concentrated economic structures in regions tend to increase regional disparities, reduce the efficiency of resource distribution, and decrease the resilience of local economies to external changes. Regencies with high concentrations should be encouraged by sector diversification and pro-competition policies to increase market efficiency (e.g., through small business subsidies, new investor incentives, deregulation). Meanwhile, in regions such as North Penajam Paser and Samarinda, which are more competitive, the focus is

on improving the quality of human resources and infrastructure to support sustainable growth.

Understanding the patterns of spatial interaction between the growth center and the surrounding area is crucial in the study of regional economics and spatial planning, as it helps identify the dynamics of regional interconnectedness in terms of population mobility, flow of goods, and services. The gravitational model, which is based on the analogy of Newton's law of gravity, states that the force of attraction between two objects is directly proportional to the size of their mass and inversely proportional to the square of the distance between them (Isard, 1960; Anderson, 2011).

In this study, a gravity model was used to calculate the strength of spatial interaction between Samarinda City, the regional growth center in East Kalimantan, and nine other regencies or cities that have economic, social, and geographical relationships. In this model, two main variables are used: the number of people aged 15 years and older as indicators of mobility and market potential, and distance between regions as an obstacle to interaction. According to the theory of spatial interaction, which emphasizes the importance of complementarity, transferability, and intervention opportunities in explaining patterns of interlocation relationships, serves as the basis for selecting these variables. Based on the results of the gravity index calculation for the period 2017 to 2023 (Table 3), it is evident that there is a variation in the level of interaction between the city of Samarinda and other regions.

Table 3. Results of the Gravity Index of Samarinda City as the Center of Annual Growth 2017-2023

Regency	Rank	Interaction Value
Kutai Kartanegara	1	2565966683
Balikpapan	2	549117852
East Kutai	3	212095841
Bontang	4	172388343
North Penajam Paser	5	84934862
Paser	6	83977162
West Kutai	7	51607736
Berau	8	48867763
Mahakam Ulu	9	5074764

Source: processed data

Kutai Kartanegara Regency showed the highest interaction value, followed sequentially by Balikpapan City, East Kutai Regency, Bontang City, North Penajam Paser Regency, Paser Regency, Berau Regency, West Kutai Regency, and Mahakam Ulu Regency. Samarinda and Kutai Kartanegara have a high interaction value because they are geographically close and have a large, productive population. This data indicates the high intensity of labor movements, distribution of goods, and economic activity

across regions. As an industrial city and regional logistics hub, Balikpapan also shows strong interconnectedness. This finding aligns with the growth pole theory by Perroux (1955), who argued that growth centers attract and influence the surrounding region through the spillover effect. However, areas such as Mahakam Ulu and West Kutai have low interaction values. Geographical barriers, limited transportation infrastructure, and a small population cause this condition. This fact suggests that differences in spatial connectivity can influence variations in development between regions (Myrdal, 1957; Hirschman, 1958).

Table 3 presents the analysis of spatial interaction using the gravity model, indicating that Kutai Kartanegara Regency has the highest level of interaction with Samarinda City, which serves as the center of growth in East Kalimantan. Geographical proximity (± 17 km) is the main factor that drives the high mobility of the population, the flow of goods, and services between the two regions. This condition creates a strong economic synergy, where Kutai Kartanegara serves as a production area and supplier of raw materials, while Samarinda acts as a regional distribution and trade center. These findings are in line with the theory of spatial interaction, which states that complementarity, transferability, and intervention opportunities are the main prerequisites for inter-regional interaction. The study by Wijaya et al (2020) reinforces this by showing the highest gravitational interaction value (606.77) between the two regions. In addition, population growth in Kutai Kartanegara contributes to increased labor absorption and shifts in economic structure from primary to secondary sectors. Improved infrastructure connectivity also strengthens regional supply chains and encourages more inclusive economic growth.

On the other hand, Mahakam Ulu Regency is recorded to have the lowest level of spatial interaction with Samarinda, due to its remote location (about 250 km) and lack of basic infrastructure. Geographical conditions dominated by forests and hills, and dependence on river transportation routes, limit the accessibility and mobility of goods and people. As a result, economic development, education, and regional connectivity have become very limited. Higang & Liestiawati (2025) noted that the travel time to Mahakam Ulu can reach 25 hours via the river route. This is reinforced by Purwadi et al (2019), who found that limited infrastructure is the main obstacle in the development of logistics between regions, despite the potential for natural resources. David et al (2024) and Kaiser & Barstow (2022) also emphasized that the lack of physical connectivity has a direct impact on low access to education, health, and economic growth in rural areas. In the education sector, the limitation of qualified teachers and educational facilities is a significant challenge, as revealed by Nurjanana et. al (2025). Therefore, improving functional relations with Samarinda is important in encouraging inclusive growth and Mahakam Ulu's contribution to East Kalimantan's GRDP.

CONCLUSION

This study concludes that the spatial linkage pattern between regencies/cities in East Kalimantan Province still shows a weak level of integration. Measurements using Moran's Index indicate a positive but weak spatial autocorrelation, suggesting that regions with high GRDP per capita rates have not yet fully formed strong growth clusters around them. This reflects the absence of a significant economic spillover effect between regions. Analysis of market structure shows that most of the region is dominated by one or two major sectors, particularly the mining and processing industries. This dominance tends to create an oligopolistic market structure, which can even lead to monopolies. This high dependence on the extractive sector has implications for weak economic diversification and risks widening the gap between regions.

Furthermore, the results of the Gravity Index analysis reveal an uneven pattern of spatial interaction. Kutai Kartanegara and Samarinda are the growth centers with the highest level of interaction, whereas Mahakam Ulu exhibits the lowest interaction due to geographical and infrastructure barriers. This underscores the importance of policy interventions to strengthen regional connectivity, encourage basic infrastructure investment, and facilitate integration between economic sectors to reduce spatial fragmentation. Conceptually, the findings of this study align with the theory of New Economic Geography and the Polarization Hypothesis, which state that without proper intervention policies, economic growth tends to concentrate in the core region, thereby widening the gap with the periphery. This condition is clearly reflected in East Kalimantan; a spatially integrative policy approach is needed, which is not only oriented towards strengthening growth centers but also creating functional connectivity and equitable distribution of investment between regions to form an inclusive and sustainable regional economic system.

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How Macroeconomic Indicators Drive Food Production in OIC Countries?

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ABSTRACT

Research Originality: This research prioritizes a more in-depth analysis of OIC member countries with different income categories. The research also focuses on developing a more robust and integrated modeling framework that can capture the dynamic interactions between inflation, economic growth, and food production.

Research Objectives: This study investigates the impact of economic growth and inflation on food production in both the short and long term.

Research Methods: This study uses panel data from 40 OIC member countries from 1992 to 2021. This study employs Panel Autoregressive Distributed Lag (PARDL) and categorizes OIC member countries based on income classifications: High-Income, upper-middle, lower-middle, and Low-Income countries.

Empirical Results: The findings indicate that economic growth and inflation substantially impact food production over the long term. Certain countries exhibit a beneficial impact, whereas others demonstrate a detrimental effect.

Implications: This research can provide new insights into the complex relationship between macroeconomic indicators and food availability, and it can be used to inform policymaking recommendations. In addition, the findings can support policymakers in formulating more effective strategies to shift policy towards sustainability.

Keywords:

food production; inflation; economic growth; panel autoregressive distributed lag

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INTRODUCTION

Understanding the complex dynamics between inflation, economic growth, and food production is crucial in the context of effective economic policy planning and implementation, especially in countries that depend on the agricultural sector as the backbone of their economy (Destiningsih et al., 2019; Latif & Mustani, 2020; Liszbinski et al., 2020; Shkliarevsky, 2023). Furthermore, understanding the dynamics of this relationship will also play a crucial role in global policies, particularly those related to zero hunger (Sustainable Development Goal 2). Inflation, defined as a general increase in the prices of goods and services in an economy over a period of time, can undermine consumer purchasing power and increase production costs for producers, including farmers (Widagdo et al., 2020). Economic growth, on the other hand, reflects an increase in a country's capacity to produce goods and services over time, which can lead to rising incomes and living standards (Wajeetongratana, 2020; Zainurossalamia et al., 2021). Its implications for food production are far-reaching, affecting the availability, accessibility, and stability of food supply. A comprehensive understanding of the relationship between inflation, economic growth, and food production is therefore vital for maintaining food security and sustainable economic development.

Numerous academics have produced empirical data about the dynamic impact of macroeconomic conditions on food production. Several significant research gaps hinder a comprehensive understanding of the complex relationship between inflation, economic growth, and food production. Specific research yields conflicting outcomes, with some indicating a positive correlation and others demonstrating a negative effect. Positive economic expansion typically results in an augmentation of disposable income, fostering heightened demand for food, both quantitatively and qualitatively (Khayer et al., 2023; Mustafa et al., 2022). Moreover, economic expansion frequently stimulates investment in agricultural research and development, resulting in advancements in crop yields, pest management, and irrigation methods (Pathak, 2023), thus increasing food production.

Empirical evidence on inflation also suggests different results. Some studies show that inflation has a positive effect, while others show a negative effect. Inflation itself is one of the significant challenges for the agricultural sector as it affects production costs, market mechanisms, and long-term viability (Eslami & Baghestany, 2020; Mekonen, 2020). Research by Headey & Hirvonen (2023) explains that in the short term, inflation causes food prices to increase due to the absorption of food crop production into the market. When food prices increase, farmers' profits increase, allowing them to increase food production. Another result explained that elevated inflation rates can destabilize agricultural production by increasing the costs of essential inputs such as fertilizers, pesticides, fuel, and labor, thereby reducing food production (Girdzijauskas et al., 2022; Iddrisu & Alagidede, 2020). Similarly, inflation can lower consumers' purchasing power and raise farmers' input costs, which can lead to lower food production and greater food insecurity (Panda et al., 2020).

In certain countries of the Organization of Islamic Cooperation (OIC), the correlation among economic growth, inflation, and food production frequently lacks coherence. The agricultural industry, a pillar of the food sector, is not the cornerstone of the economy. Regarding the economy, some countries, especially OIC member countries in the Middle East, still rely on the oil and gas sector (Yusof & Bahlous, 2013). Excessive dependence on oil revenues in many OIC countries, especially in the Middle East, can lead to the emergence of unsustainable economic models. Therefore, it is necessary to diversify the economy to reduce reliance on oil revenues, with one potential area for diversification being food production (Tuama, 2018).

The inconsistency of the empirical evidence presented makes studies on the influence of macroeconomic indicators on food production relevant for further investigation. This study is conducted in OIC member countries because some of them still rely on oil-based economic sectors and have not focused on the food sector, even though food availability is fundamental for sustainability. Therefore, the purpose of this study is to analyze macroeconomic indicators, namely inflation and economic growth, in relation to food production in OIC member countries. The research stands out from previous studies by focusing more deeply on OIC member countries with various income categories and by developing a more robust and integrated modeling framework capable of capturing the dynamic interactions between inflation, economic growth, and food production. This research can provide new insights into the complexity of the relationship between macroeconomic indicators and food availability and can be used as recommendations for policy making. In addition, the findings can support policymakers in formulating more effective strategies to shift policy towards sustainability.

METHODS

This research uses a quantitative approach. This approach will comprehensively analyze the influence of variables (Mohajan, 2020). A more detailed explanation of the operational variables used in this study is shown in Table 1.

This study uses panel data available for all countries that are members of the OIC. This study will analyze data from 57 countries for the period from 1992 to 2021. The OIC member countries consist of Afghanistan, Albania, Azerbaijan, Bahrain, Bangladesh, Benin, the United Arab Emirates, Brunei Darussalam, Burkina Faso, Algeria, Djibouti, Chad, Indonesia, Morocco, Ivory Coast, Palestine, Gabon, Gambia, Guinea, Guinea-Bissau, Guyana, Iraq, Iran, Cameroon, Qatar, Kazakhstan, Kyrgyzstan, Comoros, Kuwait, Libya, Lebanon, Maldives, Malaysia, Mali, Egypt, Mauritania, Mozambique, Niger, Nigeria, Uzbekistan, Pakistan, Senegal, Sierra Leone, Somalia, Sudan, Suriname, Syria, Saudi Arabia, Tajikistan, Togo, Tunisia, Türkiye, Turkmenistan, Uganda, Oman, Jordan, and Yemen.

Table 1. Operational Variables

Variables	Proxy	Code	Unit	Description	Data Source
Food	Food Production Index	fpi	Index	The Food and Agriculture Organization of the United Nations (FAO) defines the Food Production Index as the index of edible food crops that possess nutritional value. Coffee and tea are omitted due to their lack of nutritional benefit.	SESRIC
Economic Growth	Gross Domestic Product Growth	gg	Percent	Economic growth is defined as a rise in the production of products and services within a region's economy. Economic growth is calculated as follows: $\frac{(GDP_t - GDP_t)}{GDP_t} \times 100$	
Inflation	Consumer Price Index	cpi	Index	Inflation generally uses an indicator called the Consumer Price Index (CPI). The change in the CPI reflects the price movement of a package of goods and services used by the people.	

Due to the availability of data, filtering was necessary, which resulted in the elimination of some countries' data. This brings the total number of OIC member countries that are the object of research to 40 countries, which is a reasonably representative number for this study. This data (from 40 countries and spanning 1992 to 2021) was chosen for its completeness to ensure the data obtained forms a balanced panel category. The completeness of the data is considered sufficient to see the dynamics of changes and data patterns. In addition, the completeness of this data is also part of the balanced panel data formulation. Teal & Eberhardt (2010) emphasize the use of panel ARDL when $T > 10$, particularly for detecting long-run cointegration. Balanced panel data, where observations are available for each cross-sectional unit across all time periods, offer significant advantages over unbalanced panel data, where some observations are missing (Gutiérrez et al., 2024). While unbalanced panels are more common in practice due to attrition, missing data, or staggered entry into the study, balanced panels provide a more straightforward and robust framework for many econometric techniques (Fitzmaurice & Ravichandran, 2008).

In more detail, the sample is analyzed into several groups in specific models as shown in Table 2. Panel data is employed because it examines effects in groups rather than individual units; therefore, very little information is lost (Moufidi & Mansouri, 2021; Shanti et al., 2023). Moreover, panel data analysis mitigates the disruptions arising from individual time series, and heteroscedasticity is not a concern (Lillo & Torrecillas, 2018). Panel data is most appropriate when data availability is an issue, especially in poor countries with limited temporal variables (Ahn et al., 2013; Hidhiir et al., 2024).

Table 2. Research Model

Model (Group)	Observation
Model I: High-Income Countries (Bahrain, Brunei, Guyana, Oman, Qatar, Saudi Arabia, United Arab Emirates)	N=7, T=29 N*T = 203
Model II: Upper Middle-Income Countries (Albania, Algeria, Gabon, Indonesia, Iran, Libya, Malaysia, Maldives, Türkiye)	N=9, T=29 N*T = 261
Model III: Lower Middle-Income Countries (Bangladesh, Benin, Cameroon, Comoros, Cote d'Ivoire, Djibouti, Egypt, Jordan, Lebanon, Morocco, Pakistan, Senegal, Tunisia)	N=13, T=29 N*T = 377
Model IV: Low-Income Countries (Burkina Faso, Chad, Gambia, Guinea-Bissau, Mali, Mozambique, Niger, Sierra Leone, Togo, Uganda, Yemen)	N=11, T=29 N*T = 319
Total	1160

It can be written simply as follows:

$$fpi_{it} = \alpha_{it} + \beta_1 gg_{it} + \beta_1 cpi_{it} + \varepsilon_{it} \quad 1$$

Where *fpi* is the food production index, which is a proxy for the agricultural sector. *Fpi* is the dependent variable that will be influenced by the independent variables of economic growth and inflation.

This research uses Panel Autoregressive Distributed Lag (PARDL) analysis. When examining each model that has been formed, the four models indicate that $N < T$, making the PARDL model appropriate for use in this study. In addition, the PARDL model allows generating a combination of integrated variables with various orders after the stationarity test (Boateng & Lew, 2025). The PARDL model can provide short-run and long-run coefficients for inference (Bentzen & Engsted, 2001; Mcnown et al., 2018; Ngoma & Yang, 2024; Nkoro & Uko, 2016; Ramos-Herrera, 2024; Zardoub, 2023).

Autoregressive Distributed Lag models have become a mainstay in econometrics for analyzing time series data, particularly when investigating the relationships between variables with mixed orders of integration (Sheikh et al., 2020). Within the ARDL framework, two prominent variations exist: Panel ARDL (PARDL) and Nonlinear ARDL (NARDL), each designed to address specific data characteristics and research questions (Shanti et al., 2023). PARDL models extend the traditional ARDL approach to panel data settings, accommodating cross-sectional dimensions and allowing for the examination of both short-run and long-run relationships across multiple entities, while NARDL models, on the other hand, relax the linearity assumption inherent in standard ARDL models, enabling the capture of asymmetric effects and nonlinear dynamics within a single time series or panel data context. This study uses the PARDL model instead of NARDL because of the linearity assumption. Linearity indicates the strength of the theory that is the basis for analyzing the relationship between variables.

In general, the PARDL model for High-Income, Upper Middle-Income, Lower Middle-Income and Low-Income countries is as follows:

$$fpi_{it} = \alpha_{it} + \sum_{j=1}^p \beta_j fpi_{i,t-j} + \sum_{j=0}^p \gamma_j gg_{i,t-j} + \sum_{j=0}^p \gamma_j cpi_{i,t-j} + \varepsilon_{it} \quad 2$$

Description:

$fpi_{i,t}$: Food Production Index for country i at time t

$gg_{i,t}$: Economic Growth for country i at time t

$cpi_{i,t}$: Inflation for country i at time t

α_{it} : Individual fixed effects

β_j, γ_j : Lag coefficient of each variable

ε_{it} : Error Term

RESULTS AND DISCUSSION

The final results of extensive research efforts often yield several complex findings, each of which contributes uniquely to a comprehensive understanding of the topic under study. These findings, which are carefully collected and rigorously analyzed, form the basis for interpretations, conclusions, and subsequent recommendations. The initial phase of this empirical investigation involves examining the data, necessitating the application of descriptive statistical analysis. The purpose of presenting descriptive statistics is to provide a summary of the data set, including measures such as mean, variability, and the shape of the distribution.

Table 3. Descriptive Statistics

Model	Var	Mean	Max	Min	SD
Model I	FPI	82.76638	185.23	25.87	31.84269
	GG	4.493095	43.48	-4.96	5.591884
	CPI	98.27438	266.12	31.83	47.10341
Model II	FPI	86.78096	169.04	34.79	22.50247
	GG	3.828667	86.83	-50.34	8.963176
	CPI	100.9321	561.61	0.35	77.78331
Model III	FPI	82.53454	181.33	33.19	24.78141
	GG	4.295385	16.21	-25.91	3.893032
	CPI	93.05744	516.84	9.4	54.5255
Model IV	FPI	79.325	147.47	27.2	27.87232
	GG	4.722364	37.23	-36.06	6.804404
	CPI	123.7203	2123.49	2.92	193.8958

Table 3 elucidates that the outcomes of descriptive statistical analyses indicate that the mean score of the food production index ranges from 79.32 to 86.78 across all models in High-Income, upper-middle, lower-middle, and Low-Income Countries.

The average economic growth ranges from 3 to 4 percent, indicating a stable growth rate. Upper Middle-Income and Low-Income countries exhibit inflation, as their average Consumer Price Index is above 100, whereas High-Income and Lower Middle-Income countries demonstrate deflation, with indices below 100. The most significant changes in economic growth, as indicated by the data, occurred in higher middle-income countries, with a peak growth of 86.83 percent and a trough of -50.34 percent. In High-Income countries, economic growth was robust, with a maximum rate of 43.48 percent and a minimum of -4.96 percent.

Stationarity tests show consistent mean, variance, and covariance structures across time periods. This result indicates that the probability distribution of the data does not change over time. This property is critical to enable proper forecasting, modeling, and inference, as it allows past observations to predict future behavior with a reasonable degree of confidence (Milly et al., 2015; Omosehin et al., 2021). Table 4 shows the result of the unit root test.

Table 4 explains that stationarity tests using the Im, Pesaran, and Shin W-stat, the Augmented Dickey-Fuller (ADF) - Fisher Chi-square, and the Phillips-Perron (PP) - Fisher Chi-square tests show stationary data at different levels. The agricultural sector and inflation variables are at *first difference*, while economic growth is at the level. For this reason, the ARDL panel model is appropriate because the stationarity level is at a different order.

The cointegration test is used to analyze the presence or absence of long-run effects. Cointegration analysis is a subset of modern time series econometrics that offers rigorous analyses to investigate long-run equilibrium relationships among non-stationary variables. Unlike traditional regression methods, which can produce spurious results when applied to trending data, cointegration techniques explicitly take into account the non-stationary nature of economic time series, thus providing a more reliable basis for inference (Usman et al., 2022).

Table 4. Unit Root Test

Variables	Model I			Model II			Model III			Model IV			Remarks
	Intercept	Intercept & Trend		Intercept	Intercept & Trend		Intercept	Intercept & Trend		Intercept	Intercept & Trend		
Δfpi	Im, Pesaran and Shin W-stat	-6.13128*** (0.0000)	-5.96802*** (0.0000)	-7.57576*** (0.0000)	-6.29133*** (0.0000)		-11.2990*** (0.0000)	-9.99281*** (0.0000)		-8.68324*** (0.0000)	-7.03751*** (0.0000)	I(0)	
	ADF - Fisher Chi-square	63.6048*** (0.0000)	59.1880*** (0.0000)	90.3559*** (0.0000)	72.1496*** (0.0000)		164.891*** (0.0000)	137.718*** (0.0000)		115.586*** (0.0000)	89.4801*** (0.0000)		
	PP - Fisher Chi-square	159.662*** (0.0000)	200.073*** (0.0000)	182.780*** (0.0000)	416.456*** (0.0000)		300.520*** (0.0000)	1222.50*** (0.0000)		244.227*** (0.0000)	736.314*** (0.0000)		
gg	Im, Pesaran and Shin W-stat	-4.21181*** (0.0000)	-3.61497*** (0.0002)	-8.54884*** (0.0000)	-7.38391*** (0.0000)		-3.76804*** (0.0001)	-1.67590** (0.0469)		-8.15646*** (0.0000)	-7.65845*** (0.0000)	I(0)	
	ADF - Fisher Chi-square	45.2032*** (0.0000)	41.5240*** (0.0001)	103.905*** (0.0000)	84.3828*** (0.0000)		62.4924*** (0.0001)	42.0651** (0.0242)		108.723*** (0.0000)	95.4612*** (0.0000)		
	PP - Fisher Chi-square	74.1574*** (0.0000)	72.4324*** (0.0000)	154.416*** (0.0000)	857.105*** (0.0000)		136.942*** (0.0000)	121.244*** (0.0000)		198.746*** (0.0000)	488.631*** (0.0000)		
Δcpi	Im, Pesaran and Shin W-stat	-2.46718*** (0.0068)	-0.52230 (0.3007)	-2.54687*** (0.0054)	-1.73222** (0.0416)		-4.50201*** (0.0000)	-3.68412*** (0.0001)		-5.28087*** (0.0000)	-5.13077*** (0.0000)	I(0)	
	ADF - Fisher Chi-square	27.0046** (0.0192)	14.0259 (0.4478)	67.4060*** (0.0000)	55.6187*** (0.0000)		96.3575*** (0.0000)	74.4034*** (0.0000)		98.5698*** (0.0000)	82.8542*** (0.0000)		
	PP - Fisher Chi-square	47.3467*** (0.0000)	31.1008*** (0.0054)	67.6668*** (0.0000)	53.8708*** (0.0000)		100.381*** (0.0000)	97.1639*** (0.0000)		104.907*** (0.0000)	110.504*** (0.0000)		

Notes: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
Source: The results of the author's data processing

Table 5. Cointegration Test

	Hypothesized No. of CE(s)	No. of CE(s)	None	At most 1	At most 2
Model I	Fisher Stat.*	(from trace test)	58.47 (0.0000***)	24.01 (0.0457**)	19.30 (0.1539)
		(from max-eigen test)	48.37 (0.0000***)	21.24 (0.0956*)	19.30 (0.1539)
Model II	Fisher Stat.*	(from trace test)	86.18 (0.0000***)	26.87 (0.0815*)	11.53 (0.8707)
		(from max-eigen test)	79.3 (0.0000***)	29.24 (0.0455**)	11.53 (0.8707)
Model III	Fisher Stat.*	(from trace test)	116 (0.0000***)	49.59 (0.0035***)	40.16 (0.0376**)
		(from max-eigen test)	93.06 (0.0000***)	42.24 (0.0232**)	40.16 (0.0376**)
Model IV	Fisher Stat.*	(from trace test)	155.5 (0.0000***)	59.67 (0.0000***)	23.30 (0.385)
		(from max-eigen test)	124.4 (0.0000***)	60.98 (0.0000***)	23.30 (0.385)

Notes: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Source: The results of the author's data processing

Table 5 explains the results of the cointegration panel test using the Johansen Fisher Test, where all models are significant at the 1%, 5%, and 10% levels. This indicates that there is a long-term influence between the variables studied in models I, II, III, and IV. These results only explain the presence or absence of long-term influence but do not provide a detailed estimate of its magnitude on the models formed.

The estimation outcomes of the PARDL model are presented in Table 6. Table 6 presents the coefficients and probability values for each variable across all models: Model I (High-Income Countries), Model II (Upper Middle-Income Countries), Model III (Lower Middle-Income Countries), and Model IV (Low-Income Countries).

Model I: In the long term, economic expansion exerts a substantial adverse impact on food production, although inflation has a negligible negative effect. In the medium run, neither economic growth nor inflation significantly impacts food production.

Model II: Over the long term, economic growth and inflation exert a substantial positive impact on food production. In the short term, inflation is the sole factor exerting a major negative impact on food production.

Model III: Over the long term, economic growth and inflation exert a substantial positive influence on food production. In the short run, economic growth and inflation exert a negligible influence on food production.

Model IV: In the long term, economic growth exerts an insignificant beneficial influence on food production, whereas inflation has a considerable positive impact. In the medium run, neither economic growth nor inflation significantly impacts food production.

Table 6. PARDL

Variables	Model I		Model II		Model III		Model IV	
	Coeff	Prob	Coeff	Prob	Coeff	Prob	Coeff	Prob
Long-Run								
gg	-4.883723	0.0643*	5.099422	0.0338**	0.989478	0.0048***	1.806976	0.1151
cpi	-0.288972	0.1061	0.418931	0.0103**	0.609495	0.0000***	1.624271	0.0000***
C	193.4962	0.0000	94.17356	0.0000	37.77922	0.0000	22.58913	0.0939
Short-Run								
COINTEQ	-0.103509	0.1359	-0.040261	0.0002	-0.170416	0.0405	-0.046176	0.0028
D(fpi(-1))	-0.090031	0.4669	-0.132512	0.1878			-0.132262	0.2662
D(fpi(-2))	0.129607	0.0992*						
D(fpi(-3))	0.184837	0.1482						
D(gg)	0.560678	0.1412	-0.063047	0.5021	0.089603	0.5405	0.315368	0.2516
D(gg(-1))							0.076307	0.7078
D(gg(-2))							0.187194	0.2755
D(cpi)			-0.288361	0.0843*				
D(cpi(-1))			-0.029513	0.6756				

Notes: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Source: The results of the author's data processing

The estimation results indicate that economic expansion positively influences food production in the long term among Upper-Middle, Lower-Middle, and Low-Income Countries. This outcome aligns with the studies conducted by (Khayer et al., 2023; Mustafa et al., 2022; Pathak, 2023). Positive economic growth will undoubtedly result in a rise in individuals' income. The rise in wealth stimulates heightened demand for food, both quantitatively and qualitatively (Khayer et al., 2023; Mustafa et al., 2022). This increase in demand can boost food production by enhancing agricultural output, prompting farmers to implement more efficient technology to meet the needs of an expanding market. Moreover, economic expansion frequently stimulates investment in agricultural research and development, resulting in advancements in crop yields, pest management, and irrigation methods (Pathak, 2023). The results indicate a long-term influence due to the involvement of technology investment in this process. As farmers' income rises, they require time to advance the agricultural industry in alignment with market demand. The integration of technology in agriculture and the short timeframe from planting to harvest necessitate quick decisions.

In High-Income Countries, economic growth diminishes the productivity of the agriculture sector. Over time, agriculture's significance as the primary catalyst for economic growth diminishes in tandem with economic progress (Poláčková, 2020; Sulasni et al., 2022). This result is consistent with the findings of Sulasni et al. (2022), which elucidate a long-term transition in the economic sector from agriculture to industry. Gollin (2023) asserts in his research that this behavior is natural.

The estimation results indicate that inflation has a positive influence on food production. Inflation works as a double-edged sword for agricultural output, yielding both detrimental and beneficial effects. The effect of inflation will be detrimental when the

costs of production goods or input materials, such as fertilizers, agricultural implements, seeds, and similar items, rise. This results in a decrease in agricultural sector productivity. Inflation can have a positive influence when price increases affect production goods or harvested products. This can enhance farmers' income, enabling them to advance their agricultural practices in both quality and quantity. This analysis reveals a beneficial effect prevalent across most countries, including Upper-Middle, Lower-Middle, and Low-Income Countries. This finding is consistent with the results of Headey & Hirvonen (2023), which indicate that inflation prompts an agricultural supply response. Inflation drives up food costs, leading to the transfer of food crop production from the agricultural sector to the market. The increase in food prices increases farmers' income, thereby encouraging agricultural development and consequently increasing food production.

In High-Income countries, inflation has a negative relationship, although it is not significant. Inflation increases the price of output goods, resulting in a gap between the price received by farmers and the price paid for inputs, which in turn affects real incomes and potentially losses (Girdzijauskas et al., 2022; Iddrisu & Alagidede, 2020; Panda et al., 2020). Furthermore, the observed insignificant relationship may be attributed to the transition of the economic sector from agriculture to manufacturing.

CONCLUSION

This study contributes to the literature by illustrating the impact of inflation and economic growth on food production. The findings indicate that economic growth and inflation significantly influence food production. In low- to middle-income countries, these factors tend to increase food production through agricultural output, but in High-Income countries, they tend to decrease it. Furthermore, the study examines how economic expansion can increase people's incomes. This growth in income drives up demand for food, both in quantity and quality. Farmers will respond to increased food demand by boosting the agricultural industry. This result also agrees with the Solow-Swan neoclassical theory of economic growth. Similarly, inflation influences food production. Although inflation has both a negative and a positive impact on agricultural output, this study found that it is positive in many countries. Inflation raises food prices, absorbing food crop production from the agricultural sector into the market. When food prices rise, farmers' earnings rise. This farmer's profit drives the development of the agriculture sector and its impact on increasing food production.

There are recommendations from the research conducted. First, policymakers should consider the complexity of the relationship between macroeconomic indicators and food production to construct effective strategy formulations. Second, policymakers (especially OIC countries) should also formulate more effective strategies to shift policies towards sustainability.

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Undesirable Output in Environmental Efficiency: Evidence from ASEAN Countries

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ABSTRACT

Research Originality: This study enriches the environmental efficiency literature by applying a DEA model that considers undesirable outputs, to produce more comprehensive and accurate efficiency estimates, especially in the context of the ASEAN region.

Research Objectives: To evaluate and compare the relative environmental efficiency of ASEAN countries using the Data Envelopment Analysis (DEA) method.

Research Methods: This study applies the DEA approach to measure environmental efficiency in ASEAN countries from 2000 to 2022, using population and industry as inputs, and GDP and CO2 emissions as outputs.

Empirical Results: The findings indicate variations in environmental efficiency among ASEAN countries, reflecting differences in industrial policies and levels of economic development. Singapore emerges as the most efficient country, while Indonesia is identified as one of the ASEAN countries that needs to focus on improving its environmental efficiency.

Implications: The research results show significant variation in environmental efficiency across ASEAN countries. This finding emphasizes the importance of formulating development policies that are not solely oriented toward economic growth but also address resource efficiency and emission reduction. Countries with low efficiency, such as Indonesia, need to develop more comprehensive, data-driven green transition strategies.

Keywords:

environmental efficiency; data envelopment analysis; undesirable output; sustainable development; environmental economics

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INTRODUCTION

Environmental efficiency in developing countries is crucial in achieving sustainable development. The SDGs emphasize the need for inclusive and sustainable economic growth (SDGs Goal 8) (Kreinin & Aigner, 2022; Rai et al., 2019). In developing countries, economic growth often risks increasing the overexploitation of natural resources (Lampert, 2019). The steadily growing population is applying pressure on natural resources, land, and economic activities. This has resulted in various social and environmental issues for countries, threatening their future survival and development (Galkina & Sorokin, 2020; Sadiq et al., 2022). Energy utilization refers to the increased energy consumption during industrialization and urbanization. Members of the ASEAN countries prioritize energy utilization (Chen & Jia, 2017). The booming economy in the ASEAN region prompts governments to consider social and environmental challenges, as most current development models in the area depend on natural resources (Khoa et al., 2025).

The ecological economy is one of the most studied topics right now. As a result, states focus their recovery plans on improving the economy and quality of life, supporting the economy, and increasing energy use and efficiency (Lacko et al., 2023). Energy consumption is a crucial component in advancing any industry or economy. Sustainable development is a worldwide movement that requires nations to balance environmental effectiveness and economic advancement (Feng et al., 2024). The issue of sustainable energy development has gained prominence due to ASEAN's economic expansion during the past two decades. (Karki, Mann, & Salehfar, 2005) Consequently, economic growth has become an important measure of a nation's progress. Rapid economic progress has generated numerous concerns in various countries in recent years. This is necessitated by balancing economic advancement and environmental protection. Consequently, economic growth has emerged as a significant indicator of a nation's performance. However, the rapid economic expansion has generated considerable concern in certain countries in recent years. This is due to the necessity of balancing environmental safety with economic growth. (Grossman & Krueger, 1995)

While most ASEAN nations empirically witness declining economic growth, environmental challenges have escalated markedly. This is demonstrated by amounts of carbon dioxide (CO₂) emissions (Haseeb et al., 2019). The implementation of the fourth industry, along with innovation development and technology utilization, facilitates the economic advancement of ASEAN countries. ASEAN is experiencing growth in industry and population, leading to an increase in GDP. However, this growth is also accompanied by increased CO₂ emissions from industrial activities (Feriansyah et al., 2023). Energy consumption and environmental issues are becoming increasingly significant globally as the public becomes more aware and concerned. Numerous methodologies have been implemented to resolve environmental and energy-related concerns. The Data Envelopment Analysis (DEA) method is a non-parametric approach to efficiency evaluation that has garnered significant attention. (Zhou et al., 2008a). DEA, developed by Charnes et al. (1978), is a well-known tool for determining the relative efficiency of a group of comparable entities, commonly known as decision-making units

(DMUs), each with many inputs and outputs. Since the work of Charnes et al. (1978), Data Envelopment Analysis (DEA) has been extensively studied and gained significant recognition across several application domains. The review by Cook and Seiford (2009) presents an overview of significant methodological advancements in DEA. In the realm of energy and the environment, Meng conducted a study on the application of Data Envelopment Analysis (DEA), identifying environmental performance monitoring as a significant application area. The utilization of DEA to assess ecological performance is predicated on the classification of outputs into desirable and undesirable outputs (Meng et al., 2013; Scheel, 2001).

ASEAN countries face significant pressure to balance economic growth with environmental sustainability. However, conventional approaches often ignore negative impacts such as CO₂ emissions. By including undesirable outputs, this study more fully captures this reality. Several previous studies have discussed how efficiency is related to various factors. Although several studies have examined environmental efficiency using the DEA approach, there is still limited research on environmental efficiency within a country and its comparison (Hosseini et al., 2020; Wang et al., 2021; Zhang et al., 2011), primarily focused on developed countries (Hermoso-Orzáez et al., 2020; Lacko & Hajduová, 2018) or large developing countries such as China, India, or Latin American countries (Anser et al., 2020; Chen & Jia, 2017; Jiang & Xie, 2024).

The research conducted by Yasin (2023) on, this study examined the performance of technical efficiency convergence (Beta and Sigma convergence) in 10 ASEAN countries as well as three main partners from East Asia, namely China, South Korea, and Japan, during the period 1990–2021 using the Stochastic Frontier Analysis approach to estimate technical efficiency, and the research results showed that there was a difference in efficiency among ASEAN countries. While this research measures environmental efficiency by adopting the DEA and time series.

Zhang et al. (2011) studied 23 developing countries from 1980 to 2005, focusing on labor, Capital, and Energy consumption in relation to GDP output. This study uses a time span to see the difference in efficiency levels between developing countries from year to year. Empirical results show that efficiencies vary among the 23 countries; for example, China has experienced the most rapid improvement. Practice in China shows that effective energy policies play an important role in improving energy efficiency. In Zhang's research, undesirable outputs were not considered, and only GDP was used as the measure of efficiency.

The research conducted by Xie et al. (2014) focused on analyzing the environmental efficiency of the electricity industry in 26 OECD and BRIC countries (1996–2010). It used the SBM-DEA-based Environmental Malmquist Index, which considers electricity as a desired output and carbon emissions as an undesirable output, with CO₂ emissions. The results show that changes in fuel structure and technological advancements are the main drivers of improving the efficiency of dynamic environments. Economic conditions and energy prices also have a significant effect.

The novelty of this research lies in its consideration of undesirable outputs, in addition to desired outputs, for environmental efficiency. Furthermore, it examines all the newest ASEAN countries, including Timor-Leste, in the analysis. Furthermore, this research offers A long-term panel analysis (2000–2022) on ASEAN countries, with environmental DEA being rarely conducted. This research fills this gap by conducting a comprehensive and longitudinal evaluation of environmental efficiency among ASEAN countries and providing relevant policy implications for sustainable development decision-making in the region. Moreover, the Data Envelopment Analysis (DEA) method has been widely used to measure energy and environmental efficiency (Zhou et al., 2008a). Several studies have developed DEA approaches that consider desirable and undesirable outputs (Cámara-Aceituno et al., 2024; Shim & Eo, 2010; Zhou et al., 2008b). However, studies applying this approach in the context of developing countries, particularly in ASEAN, remain limited. Therefore, further analysis is needed to understand how differences in industrial sectors and national policies in ASEAN countries influence the balance between desirable and undesirable outputs in environmental efficiency.

This study aims to evaluate and compare the relative eco-efficiency of ASEAN countries. This method offers a more comprehensive evaluation of environmental efficiency by incorporating both desirable and undesirable outputs, thereby providing valuable insights for sustainable development policies in the region. The unique aspect of our research is the implementation of Data Envelopment Analysis (DEA) to evaluate the eco-efficiency of ASEAN countries from 2000 to 2022. This approach utilizes environmental efficiency indicators derived from various input variables and distinguishes between desirable outputs (maximized) and undesirable outputs (minimized). Furthermore, our investigation improves objectivity by employing graphical analysis to present the findings, which enables a more thorough and data-driven classification of eco-efficiency in ASEAN countries.

METHODS

We found that the most used method for evaluating environmental efficiency is the data envelopment analysis (DEA) (Mardani et al., 2017). The data source used in this research consists of secondary data obtained from the World Development Indicators from 2000 to 2022., Due to the absence of recently reported data from certain governments, particularly regarding CO2 emissions. The selection of inputs and outputs is a crucial aspect in evaluating environmental efficiency (Cooper et al., 2006; C. Feng & Wang, 2017; Wu et al., 2016).

The data in this research includes several variables grouped into input, desired output, and undesirable output variables, as shown in Table 2. The data in Table 1 are extracted from reliable resources, namely the World Bank's online database (World Bank, 2023) and "Our World in Data".

Table 1. Names of Countries and Decision-Making Units (Dmus)

No.	DMUs	Country	GDP Average (2000 - 2022)	GDP 2022
1	DMU1	Indonesia	6.97776E+11	1.32E+12
2	DMU2	Malaysia	2.49935E+11	4.08E+11
3	DMU3	Filipina	2.30474E+11	4.04E+11
4	DMU4	Singapore	2.51266E+11	4.98E+11
5	DMU5	Thailand	3.35415E+11	4.96E+11
6	DMU6	Laos	9576140334	1.55E+10
7	DMU7	Vietnam	1.782E+11	4.1E+11
8	DMU8	Brunei	12691798246	1.67E+10
9	DMU9	Myanmar	43190500236	6.23E+10
10	DMU10	Cambodia	18457818875	4E+10
11	DMU11	Timor Leste	1235125235	3.21E+09

Source: World Bank processed, 2025

Table 2. Input Variable, Desirable Output, and Undesirable Output

Input	Desirable Output	Undesirable Output
- Population (People)	GDP	CO ₂ Emission
- Industry (Constan)	(current US\$)	(Million Ton)

The study was divided into four parts to reach our objectives, as illustrated in Figure 1. This research adopts the Seiford and Zhu (2002) DEA undesirable model to evaluate countries' productivity in Asia:

$$\begin{bmatrix} Y \\ -X \end{bmatrix} = \begin{bmatrix} Y^g \\ Y^b \\ -X \end{bmatrix}$$

Y^g : Desirable output, Y^b : Undesirable Output, $Y = Y^g + Y^b$

The DEA model assumes that $Y(Y^g + Y^b)$ increases, indicating improved efficiency, but the increase in undesirable output Y^b causes efficiency to decrease. Here, $-x$ is the input. Therefore, after putting a minus sign on the undesirable production and finding out a proper transaction vector ω , the minus undesirable will become a plus sign, such as $\bar{Y}_j^b = -Y_j^b + \omega > 0$, and $\omega = \max \{Y_j^b\} + 1$, such that model becomes

$$\begin{aligned} \max \quad & h \\ \text{s.t.} \quad & \sum_{j=1}^n Z_j Y_j^g \\ & \geq h Y_0^g \\ & \sum_{j=1}^n Z_j \bar{Y}_j^b \geq h \bar{Y}_0^b \\ & \sum_{j=1}^n Z_j X_j \leq X_0 \\ & \sum_{j=1}^n Z_j = 1 \\ & Z_j \geq 0 \end{aligned}$$

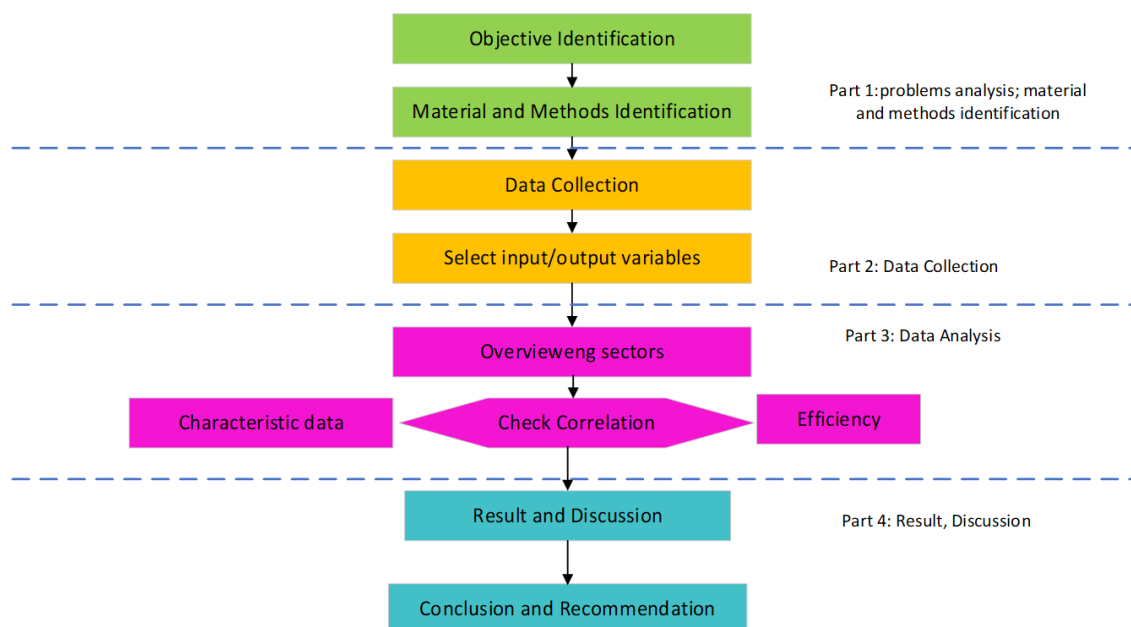
Here, inputs X_j ($j = 1, \dots, m$), $\sum_{j=1}^n Z_j = 1$ indicates that the DMU must represent the effective elasticity set of the production function, h denotes the relative efficiency value, and Z_j signifies the input and output weights.

We assume that there are 11 DMUs Where they are the 11 ASEAN countries. The value of k ranges from 1 to 11. For each of the DMU_k , this research has N inputs $X_k = (X_{1k}, X_{2k}, X_{3k}, \dots, X_{nk})$, M desirable outputs $Y_k = (Y_{1k}, Y_{2k}, Y_{3k}, \dots, Y_{mk})$, and J undesirable outputs $U_k = (U_{1k}, U_{2k}, U_{3k}, \dots, U_{jk})$. With the data, we proceed to operate by Tyteca's process (1997) :

$$\begin{aligned} EEI &= \text{Min } \lambda \\ s.t. \quad &\sum_{k=1}^K Z_k X_{nk} \leq X_n, n = 1, 2, \dots, N \\ &\sum_{k=1}^K Z_k X_{mk} \geq y_m, m = 1, 2, \dots, M \\ &\sum_{k=1}^K Z_k U_{jk} = \lambda u_j, j = 1, 2, \dots, J \\ &Z_k \geq 0, k = 1, 2, \dots, K \end{aligned}$$

Where k = number of DMUs (ASEAN countries), n = number of inputs, x = inputs, y = desirable outputs, M = number of desirable outputs, z = undesirable outputs, and j = number of outputs.

Figure 1. Step of Research Process



RESULT AND DISCUSSION

This research's main results explain that environmental efficiency levels vary widely across ASEAN countries. Singapore and Brunei show consistently high efficiency, whereas Myanmar and Cambodia have low efficiency due to high emission intensity and low economic output. Another finding is that average environmental efficiency in the ASEAN region increased slowly throughout 2000–2022, but with uneven progress across countries. It was also found that industrial and population growth are negatively correlated with environmental efficiency, especially in countries that have not widely adopted clean technologies or strict environmental policies. The use of a DEA approach with undesirable outputs (CO₂ emissions) significantly changes the country efficiency rankings, compared to traditional DEA models, and reveals hidden inefficiencies in high-emission countries.

To improve the precision of the final evaluation process, a comprehensive statistical description was employed, as illustrated in Table 3. Concurrently, environmental efficiency is assessed for each country annually. This is the case with the energy from the industry process during the period 2000–2022. When reviewed based on population, Indonesia had the highest average population from 2000 to 2022, including 2022. Meanwhile, the country with the lowest average population in ASEAN in 2022 is Brunei. Indonesia occupies the highest position in industry compared to 10 other Southeast Asian countries (ASEAN). In Hamilton and Waters' research (Hamilton & Waters, 2018), it is stated that the Indonesian industry is one of the highest in the ASEAN region.

Regarding CO₂ emissions, it can be seen that the country with the highest CO₂ emissions in 2022 is Vietnam, but when considering the average emissions from 2000 to 2022, the highest is Indonesia. Chairiawan (2019) and data from IEA (2018) indicate that Indonesia contributed 1.41% of global CO₂ emissions and was the largest emitter in the ASEAN region, with 454.9 MtCO₂ in 2016. The research of Kusumawardhani et al. (2022) also strengthens this by discussing the relationship between economic growth and energy consumption. Meanwhile, Timor-Leste is the country with the average CO₂ emissions in 2022 in ASEAN.

Table 3. Maximum, Minimum, and Average Values for Input and Output.

	Indicator	Unit	Maximum	Minimum	Average
Inputs	Population	People	278830529	326424	55449532
	Industry	Constant	4.51E+15	44213900	3.97E+14
Desirable output	GDP	(current US\$)	1.32E+12	3.67E+08	1.84E+11
Undesirable output	CO ₂ Emission	Million Tons	54.619	0.002	11.374

Source: Data processed (2025)

Pearson correlation is a statistical method used to measure linear relationships between variables. A positive correlation value indicates a positive and unidirectional relationship, whereas a negative correlation value indicates an opposite relationship. Currently, this

investigation employs a straightforward Pearson correlation test to assess the correlation between input and output. The coefficient value is between -1 (perfect negative) and 1 (perfect positive). A crucial requirement of applying DEA analysis is a positive correlation. The Pearson correlation calculation based on data with the variables Population, Industry, GDP, and CO₂ emissions from industry is shown in Table 4.

Table 4. Pearson Correlation Value between Input & Output

Input & Output	Population	Industry	GDP	CO ₂ Emission
Population	1			
Industry	0.885	1		
GDP	0.768	0.755	1	
CO ₂ Emission	0.782	0.764	0.81	1

Source: Data processed (2025)

Pearson's correlation value is 0.71 – 0.90, which shows a strong correlation (Akoglu, 2018). For example, we pay attention to the Pearson correlation value between population and CO₂, which is 0.782; this shows a strong direct proportional relationship, indicating that as the population increases, CO₂ emissions will rise accordingly. There have been several previous studies that have discussed this connection further. One of the research findings is that population density impedes CO₂ emissions in high and lower-middle-income countries but enhances them in lower-income nations (Pickson et al., 2024). However, an empirical investigation by Cahyo et al. (2023) found that CO₂ and population have a negative relationship.

The results of DEA modeling produce efficiency values. Efficiency values are divided into four categories based on the Environmental Efficiency Indicator (EEI) value grouping method by Hermoso-Orzáez et al. (Hermoso-Orzáez et al., 2020).

1. Excellent Environmental Efficiency (0.99 to 1 Value)
2. Good Environmental Efficiency (0.80 to 0.98 Value)
3. Average Environmental Efficiency (0.5 to 0.79 Value)
4. Environmental Efficiency Can Be Improved (0.0 to 0.49 Value)

The efficiency value for each Decision-Making Unit (*DMU*), specifically 11 ASEAN countries from 2000 to 2022, is shown in Table 5.

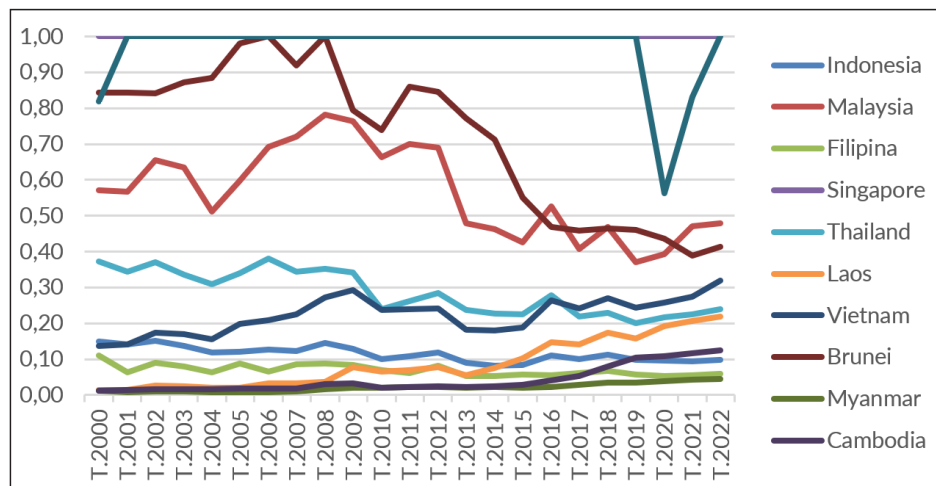
Table 5 and Figure 2 show that from year to year (2000 to 2022), the environmental efficiency value for each DMU (11 ASEAN countries) fluctuates significantly from year to year. It can be seen that Singapore is the only country with a stable and superior efficiency value compared to other countries, with a value of 1 from 2000 to 2022. The results from Table 5 and Figure 2 are then calculated on average from 2000 to 2022, as shown in Table 6.

Based on Table 6, Singapore is noted to have excellent environmental efficiency. Meanwhile, Timor-Leste is included in the category of countries with good environmental

efficiency. Malaysia and Brunei are classified as countries with average environmental efficiency. Countries such as Indonesia, the Philippines, Thailand, Laos, Vietnam, Myanmar, and Cambodia show improvements in environmental efficiency compared to the previous period, although they are still in the suboptimal category. These findings reflect the diverse dynamics and developments in environmental management in the ASEAN region.

The more advanced a country is, the more efficient its environment will be (Barra & Falcone, 2023; Chiu et al., 2012). The Environmental Kuznets Curve (EKC) theory posits an inverted U-shaped relationship between economic growth and environmental degradation (Adhikary & Hajra, 2021; Hoang et al., 2024; Zilio, 2012). The research conducted on ASEAN countries is related to the EKC theory, which suggests that more developed countries aim to be more efficient in resource use and environmental management. This condition occurs because they have moved beyond the phase of high resource exploitation and have adopted more environmentally friendly policies and technologies. Additionally, a factor is that Singapore is a small country, whereas Indonesia has low efficiency in certain areas. The countries that have average efficiency are Malaysia and Brunei.

Figure 2. Line Chart *Visualization of Efficiency Values of Decision-Making Units (DMUs) in 2000 – 2022*



Source: Data processed (2025)

Table 5. Efficiency Value of Decision-Making Units (DMUs) in 2000 – 2022

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Indonesia	0.15	0.14	0.15	0.14	0.12	0.12	0.13	0.12	0.14	0.13	0.10	0.11	0.12	0.09	0.08	0.08	0.11	0.10	0.11	0.10	0.10	0.09	0.10
Malaysia	0.57	0.57	0.66	0.64	0.51	0.60	0.69	0.72	0.78	0.76	0.66	0.70	0.69	0.48	0.46	0.43	0.53	0.41	0.47	0.37	0.39	0.47	0.48
Philippines	0.11	0.06	0.09	0.08	0.06	0.09	0.07	0.09	0.09	0.08	0.07	0.06	0.08	0.05	0.05	0.06	0.06	0.06	0.07	0.06	0.05	0.05	0.06
Singapore	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Thailand	0.37	0.34	0.37	0.34	0.31	0.34	0.38	0.34	0.35	0.34	0.24	0.26	0.28	0.24	0.23	0.23	0.28	0.22	0.23	0.20	0.22	0.22	0.24
Laos	0.01	0.01	0.03	0.02	0.02	0.02	0.03	0.03	0.04	0.08	0.07	0.07	0.08	0.06	0.08	0.10	0.15	0.14	0.17	0.16	0.19	0.21	0.22
Vietnam	0.14	0.14	0.17	0.17	0.16	0.20	0.21	0.22	0.27	0.29	0.24	0.24	0.24	0.18	0.18	0.19	0.26	0.24	0.27	0.24	0.26	0.27	0.32
Brunei	0.84	0.84	0.84	0.87	0.88	0.98	1.00	0.92	1.00	0.79	0.74	0.86	0.85	0.77	0.71	0.55	0.47	0.46	0.46	0.46	0.44	0.39	0.41
Myanmar	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.04	0.03	0.04	0.04	0.04
Cambodia	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.04	0.05	0.08	0.10	0.11	0.12	0.12
Timor Leste	0.82	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.83	1.00

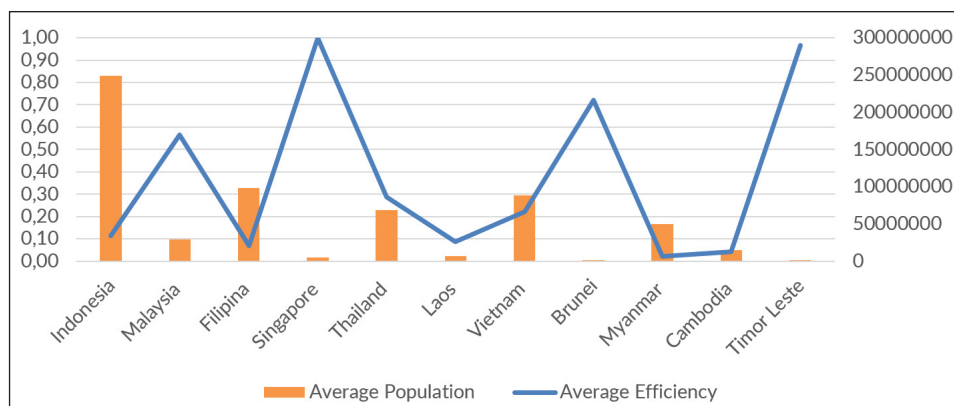
Table 6. Average Efficiency of Each DMU

DMU Name	Average Efficiency
Indonesia	0.11
Malaysia	0.57
Filipina	0.07
Singapore	1.00
Thailand	0.29
Laos	0.09
Vietnam	0.22
Brunei	0.72
Myanmar	0.02
Cambodia	0.04
Timor Leste	0.97

Source: Data processed, 2025

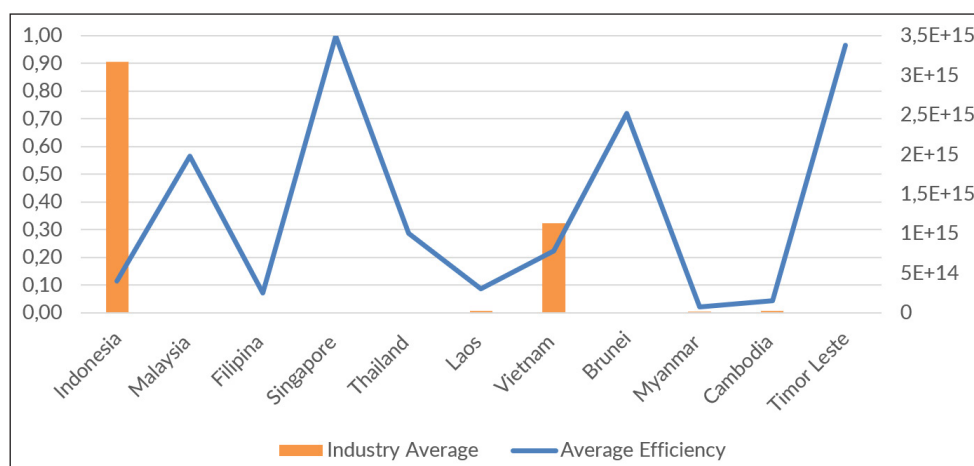
Research related to DEA, as explained earlier, explains that inputs in the form of Population and Industry are used. In this case, a deeper review of the relationship between each input and the average efficiency value is provided in Figures 3 and 4. Figure 3 shows the results, indicating that the country with the highest average population, Indonesia, has the lowest average efficiency compared to other ASEAN countries. On the contrary, countries with low average populations, such as Singapore, Timor-Leste, and Brunei, have a relatively high average efficiency. Indonesia has the largest population in ASEAN, which means that domestic energy demand is significantly higher to support economic activities and household consumption (Prasetyanto et al., 2025; Pattiruhu & Kriekhoff, 2022). Singapore, Malaysia, and Brunei have significantly smaller populations, which means that the pressure on the environment is relatively lower in terms of energy consumption and CO2 emissions (Islam & Ghani, 2018).

Figure 3. Comparison Chart of Input (Average Population) and Average Efficiency



Source: Data processed (2025)

Figure 4. Comparison Chart of Inputs (Industry Average) and Average Efficiency

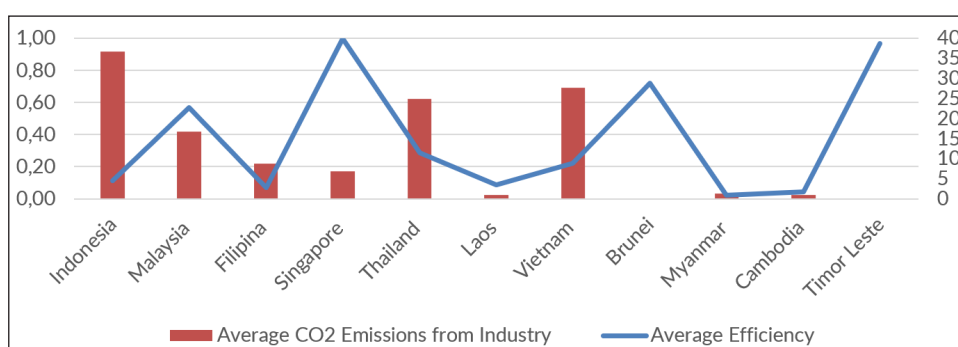


Source: Data processed (2025)

Based on Figure 4, the country with the highest industrial average is Indonesia, which has a low average efficiency. However, other countries, such as Myanmar and Cambodia, have low average efficiency despite a fairly low average industrial input. Indonesia has a relatively large industrial sector within its national economic structure; however, this sector still heavily relies on environmentally unfriendly energy sources (e.g., coal-based industries and energy-intensive manufacturing) (Hariyanto, 2021; Ramadanti et al., 2024; Yohanes Handoko & Loisa, 2023). Meanwhile, Singapore and Brunei have industrial sectors that are more focused on high-value-added industries such as technology, finance, and service-based industries, which are more energy-efficient compared to heavy manufacturing sectors (Asgari et al., 2024; Holloway, 1971; Shi, 2015; Su et al., 2021).

This study uses outputs in the form of Gross Domestic Product (GDP) and CO2 emissions. In this, the relationship between each output and the average efficiency values depicted in Figures 5 and 6 is reviewed in depth. The results of Figure 5 show that Singapore, the country with the highest efficiency in ASEAN, has a GDP that is not significantly higher than that of its nearest country, Indonesia. However, in terms of GDP, Singapore can be far superior to Timor-Leste, which has the lowest GDP despite having a high average efficiency value.

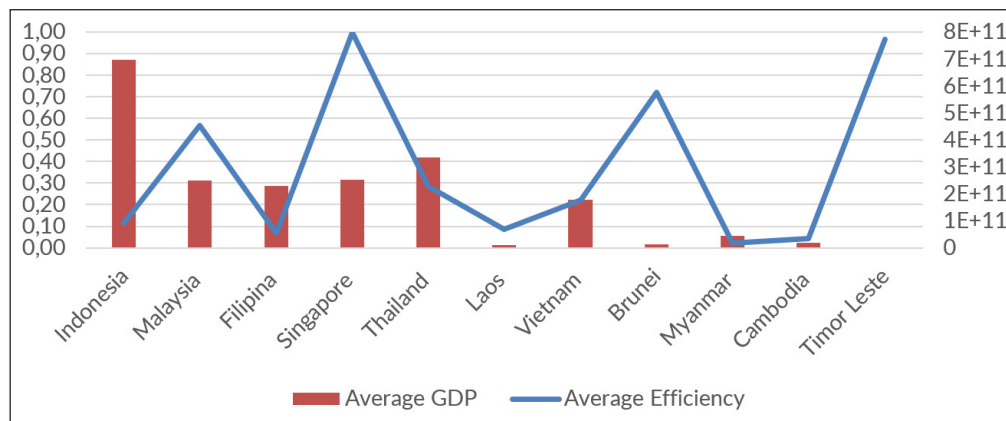
Figure 5. Comparison Chart of Output (Average CO2 emissions) and Average Efficiency



Source: Data processed (2025)

Indonesia produces greater CO₂ emissions due to its reliance on fossil fuels and the ongoing large-scale deforestation (Chairiawan, 2019). Countries like Singapore, despite having large-scale economic activities, apply much higher energy efficiency and utilize more modern technology, resulting in lower CO₂ emissions per unit of output (Koh et al., 2012; Meirun et al., 2021). For example, Singapore's power generation sector emphasizes high energy efficiency (Ali & Weller, 2014). Emphasizing efficiency is also important to reduce the "decoupling gap" between economic growth and environmental pressures, which remains a challenge in many developing countries (Zhang et al., 2019).

Figure 6. Comparison Chart of Output (Average GDP) and Average Efficiency



Source: Data processed (2025)

Based on Figure 6, the results show that the three countries with low average CO₂ emissions and low average efficiency are Singapore, Timor-Leste, and Brunei. When compared, Indonesia's economic output (GDP per capita) is still lower than that of Singapore and Brunei. These results are in line with research conducted by Hill (2018), which suggests that an equivalent level of economic output does not match the high CO₂ emissions. Singapore and Brunei have a much higher GDP per capita with relatively more controlled CO₂ emissions, making them technically more efficient in generating GDP per ton of CO₂.

The closeness of the relationship between the average efficiency value generated by Data Envelopment Analysis (DEA) and Input and Output can be measured using Pearson correlation. The results of Pearson's correlation calculation show that overall, the average input and output (population, industry, GDP, and CO₂ emissions) have a negative correlation with the average efficiency value. Negative correlation values indicate opposite relationships. Some studies show a negative correlation between specific inputs (such as population, industry, and GDP) and efficiency. For example, higher population density and energy consumption per unit of GDP negatively impact environmental efficiency (Wang et al., 2013). CO₂ emissions are often used as an undesirable output in efficiency models. According to studies, higher CO₂ emissions correlate with poorer efficiency ratings. For example, increasing CO₂ emissions has a detrimental influence on regions' environmental efficiency (Iqbal et al., 2019; Wang et al., 2012).

Table 7. Pearson Efficiency Value Average Correlation Value between Input & Output

Input & Output	Average Efficiency	Population Average	Industry average	GDP Average	Average CO2 Emissions
Average Efficiency	1				
Population Average	-0.463	1			
Industry average	-0.275	0.903	1		
GDP Average	-0.15	0.869	0.785	1	
Average CO2 Emissions	-0.241	0.814	0.765	0.869	1

Source: Data processed (2025)

Based on the results of the previously carried out Data Envelopment Analysis (DEA), an efficiency value is obtained. In this case, these efficiency values can be optimized by reviewing Slack results in the DEA. Slack in Data Envelopment Analysis is an indicator that shows inefficiencies in the use of inputs or outputs in a Decision-Making Unit (DMU). Slack describes how much input can be reduced or how much output can be increased without changing overall efficiency. Table 8 shows information indicating that countries such as Singapore and Timor-Leste have input and output slack values of 0. This result suggests that the inputs and outputs in these two countries do not need optimization by adding or decreasing values, as their conditions are efficient and ideal. It is different from Indonesia, where there is still a value of 446169818783442 for input slacks and 1122749409806.93000 for output slacks. Therefore, to optimize efficiency in the future, the Government of Indonesia is advised to reduce industrial inputs or increase output.

Table 8. Slacks Values for Input & Output for Each DMU in 2022

DMU Name	Input Slacks		Output Slacks	
	Population	Industry	GDP	CO2
Indonesia	0.00000	446169818783442.00000	1122749409806.93000	0.00000
Malaysia	5889664.40154	0.00000	538431530439.88300	0.00000
Filipina	0.00000	0.00000	185702654968.65600	0.00000
Singapore	0.00000	0.00000	0.00000	0.00000
Thailand	0.00000	0.00000	1024847736778.44000	0.00000
Laos	0.00000	0.00000	81798578513.44700	0.00000
Vietnam	0.00000	645630941652965.00000	2395110493642.80000	0.00000
Brunei	0.00000	5412223.93229	0.00000	0.22087
Myanmar	0.00000	0.00000	145604856805.31300	0.00000
Cambodia	0.00000	0.00000	119071948772.07800	0.00000
Timor Leste	0.00000	0.00000	0.00000	0.00000

Source: Data processed (2025)

CONCLUSION

This study evaluates and compares the relative environmental efficiency levels of 11 ASEAN countries over the period 2000–2022. The results show significant variations in environmental efficiency across the region. Singapore and Brunei consistently rank among the highest environmentally efficient countries, driven by their high economic output and relatively low emissions intensity. In contrast, Myanmar, Cambodia, and Laos show lower environmental efficiency scores, primarily due to their high emissions relative to their economic performance and low adoption of clean technologies. Some countries, such as Vietnam and Indonesia, show step-by-step improvements in environmental efficiency over time, reflecting the positive impacts of economic restructuring and the implementation of environmental regulations. Meanwhile, countries that rely heavily on extractive industries and coal, such as Thailand and the Philippines, show fluctuating efficiency levels. This comparison emphasizes the importance of sustainable industrial policies, energy diversification, and investment in environmentally friendly technologies as key factors influencing environmental efficiency performance in the ASEAN region.

The study focuses only on ASEAN countries, so its findings may not be generalized to other developing countries outside the region. In future research, it is expected to calculate economic efficiency with a broader coverage of countries in Asia, or conduct comparative studies with developing countries in the Americas or Africa. This study also supports Sustainable Development by providing data-driven analysis that can be used to design policies balancing economic growth with environmental protection. These findings emphasize the importance of formulating development policies that focus not only on economic growth but also on resource efficiency and emissions reduction. Countries with low efficiency levels, such as Indonesia, need to develop more comprehensive, data-driven green transition strategies.

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Gen Z's Work Paradigm Shift: Determinants of Gig Economy Choice in Surakarta

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ABSTRACT

Research Originality: The mixed-method approach combines quantitative and qualitative data, thereby providing a more comprehensive view of work preferences among the younger generation.

Research Objectives: This research examines Generation Z's work preferences about the gig economy in Surakarta.

Research Methods: A mixed method was used, employing Atlas.ti for qualitative analysis and logistic regression for quantitative analysis.

Empirical Results: Atlas.ti mapping identified five main categories in the gig economy: type of work, purpose of work, legal guarantees, barriers, and advantages and disadvantages. Logistic regression results revealed that income, reduced work stress, flexible arrangements, and work environment significantly influence Generation Z's decision to engage in gig work. In contrast, age, gender, and education level showed no significant influence on the choice to work in this sector.

Implications: These results highlight the need for legal frameworks that ensure fair protection and social benefits for gig workers, including health insurance, pension schemes, and fair wage standards.

Keywords:

generation Z; gig economy; job interest; logistic regression

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INTRODUCTION

In recent years, the gig economy has become an increasingly prevalent labor model (Li et al., 2025). Characterized by temporary, flexible, and platform-based work, the gig economy provides an opportunity for workers, particularly young people, to generate income through various activities, free from traditional employment constraints (Woodcock & Graham, 2020; Tan et al., 2021). Currently, the gig economy in Indonesia includes 4 million workers and contributes US\$7 billion to GDP, demonstrating its direct impact on the national economy. The gig economy continues to grow annually, and Indonesia is considered one of the most favorable environments for recruiting gig workers.

The gig economy is a combination of economic progress and shifting socioeconomic preferences. Workers can adjust their working hours to suit personal needs. This flexibility allows income generation from various sources. Furthermore, workers can utilize their existing skills in ways that align with their preferences.

The accelerated growth of the gig economy can be attributed to the emergence of disruptive technologies, which have triggered a 76.54% decline in conventional employment and a shift of a large portion of the workforce to the informal sector. The number of informal workers has steadily increased, reaching 83.83 million in 2024, or approximately 57.95% of the total working population. The majority of these informal workers are engaged in trade and service sectors. The increasing number of informal workers reflects the ongoing expansion of the gig economy in Indonesia.

Several studies have examined the factors that attract Generation Z to gig work, with Kamarudin & Arif (2024) explaining that income is the primary motivator for Generation Z to enter the gig economy. However, income in the gig economy is relatively small compared to that in the conventional sector. Gig workers are commonly found in tourist-based cities. Research in Malang shows that their average monthly income is between IDR1-3 million (55.3%), with 18.8% earning below IDR1 million and 25.9% above IDR3 million (Darmawan & Muttaqin, 2023). However, income can fluctuate depending on the volume of work performed.

Generation Z is generally considered to be more tech-savvy than previous generations (Buzzetto-Hollywood & Quinn, 2024). The term 'digital native' refers to individuals who have grown up with digital technologies in their daily lives since the advent of the digital age (Mertala et al., 2024). The digital age has made technology ubiquitous, thus enabling Generation Z to enter the gig economy regardless of gender (Permana et al., 2022).

In the workforce, men constitute the majority, and women consistently earn less across various types of work. Research shows that the gender income gap in Indonesia is 42.82%, meaning that on average, men's income is significantly higher than women's (Hundley, 2001). This is closely related to traditional perceptions of women as not being the primary breadwinners in the family. In addition, rigid working hours in conventional employment often prevent married women from participating in the labor market due to household responsibilities that require flexible time. However, the gig economy has

gradually addressed these barriers by offering flexible job opportunities, enabling many women to work full-time or part-time.

The gig economy is divided into two sectors: location-based and online-based. The online-based gig economy requires higher educational levels due to the technical skills needed to perform the work (Herrmann et al., 2023). However, the location-based gig economy shows inclusivity across diverse educational backgrounds (Prakoso & Anggraeni, 2023). This research supports the rationale for including education level as a variable to explain Gen Z's interest in the gig economy.

Today's workforce presents challenges for Generation Z, who are more prone to anxiety and stress, especially under pressure. Their work-related concerns are driven by uncertain futures, educational and career pressures, and rising living costs. According to Hamdali & Liswandi (2023), Generation Z requires a leadership style that suits their characteristics. However, in formal workplaces, Generation Z often works alongside older generations with differing leadership styles. This generational gap may lead Generation Z to switch companies in search of a more comfortable work environment (Ehsan & Ali, 2019). Job stress significantly contributes to burnout among Generation Z (Hartono et al., 2024) and is a key factor influencing their decision to pursue gig work.

Generation Z prefers a flexible environment with a warm, familial atmosphere and low pressure, as they value tranquility. This flexibility includes location, atmosphere, and work hours (T. Putri et al., 2023). The benefits of flexible work include reduced stress, improved physical and mental health, and increased work motivation (Aura & Desiana, 2023). Research shows that gig workers prioritize value flexibility, as it allows them to complete tasks at any time and allocate more time for personal needs, supporting work-life balance (Hartono et al., 2024).

The work environment plays an important role in shaping employee performance in a company. A positive work environment can reduce fatigue and boredom while improving work quality (Meijerink et al., 2024). Unlike the rigid and fixed structure of formal work environments, the gig economy offers greater flexibility. Research shows that the work environment is the sole significant factor influencing Gen Z employee performance (Hendratmoko & Mutiarawati, 2024). Variations in the physical environment of the workplace can affect comfort and productivity, thereby positively impacting the company. Gig workers can work from home, cafes, or coworking spaces, depending on their needs and convenience.

The gig economy is also growing in Surakarta, where the Gen Z population totals 168,038 people, accounting for approximately 29.92% of the city's total population (BPS, 2024). Approximately 59.32% of the population is employed in the formal sector, a 1.70% decrease from August 2022 (61.02%) (BPS, 2024). This data shows a growing preference for the informal sector among workers in Surakarta. In addition, the growth of the informal sector in Surakarta creates promising opportunities for various jobs and activities in the gig economy.

Although research on Generation Z's participation in the gig economy has expanded, most studies have primarily focused on macro-level motivations or urban populations, leaving a gap in understanding the micro-level determinants that influence young people's job preferences in smaller cities like Surakarta. In particular, empirical studies that distinguish between Generation Z individuals interested in gig work and those interested in formal employment remain limited, despite potentially differing motivational factors.

This context raises ongoing debates about gig work: while it offers flexibility, critics argue that it often comes at the expense of income stability, health benefits, legal protections, and long-term career opportunities, making it a precarious form of employment (Alauddin et al., 2025; Lauren & Anandan, 2024). A noteworthy gap in the literature lies in inconsistent findings on the relationship between work stress and job preference. Several studies, such as Fatima and Srivastava (2024) and Hartono and Prapunoto (2024), argue that high levels of work stress in formal employment encourage individuals to seek more flexible alternatives, including gig work, indicating a positive relationship. However, Hendratmoko and Mutiarawati (2024) present a contradictory perspective, suggesting that work stress has a negative influence, meaning that individuals experiencing high stress may avoid uncertain environments like the gig economy.

This study addresses this gap by separately analyzing groups interested and not interested in gig work. It quantitatively evaluates how income, age, gender, education level, job stress, flexibility, and work environment influence interest in the gig economy using binary logistic regression. It also employs a mixed-methods approach to identify the determinants of gig economy interest among Generation Z in Surakarta. The novelty of this study lies in the mixed-method design, which offers a more comprehensive understanding of how economic, psychological, and demographic factors influence employment preferences. The results are expected to contribute not only to academic discourse but also to the formulation of labor market policies that match the aspirations of the evolving young workforce.

METHODS

This research uses a mixed-methods approach, combining quantitative and qualitative techniques to gain a comprehensive understanding of the determinants that influence Generation Z's interest in the gig economy in Surakarta. This research uses both primary and secondary data. In this study, an α -value of 0.1 (10%) was applied, and a sample of 100 respondents was obtained. Purposive sampling was used to ensure that the selected respondents aligned with the research objectives.

The model used in this research is as follows:

$$L_i = L_N = \frac{P_i}{(1-P_i)} = \alpha + \beta_1 \text{Inc}_1 + \beta_2 \text{Age}_1 + \beta_3 \text{Gender}_1 + \beta_4 \text{Edu}_1 + \beta_5 \text{WS}_1 + \beta_6 \text{FW}_1 + \beta_7 \text{WE}_1 + e_i$$

Logistic regression analysis was conducted using EViews 12 to determine the statistical significance of each variable and the overall model fit. Complementing the quantitative findings, qualitative data were analyzed using ATLAS.ti 25, a software tool

designed to identify patterns, codes, and thematic categories in interview transcripts. The qualitative component strengthens the interpretation of the statistical results by capturing respondents' motivations, perceptions, and experiences related to gig work. Five main themes emerged from the qualitative coding: types of jobs, purposes of work, legal guarantee, perceived barriers, and the pros and cons. The operational variables from this research are shown in Table 1.

Table 1. Operational Variables

Variable	Definitions	Measurement	References
Work in options	Someone interested in, has worked in, or is currently working in the gig economy	0 = no interest in working in the gig economy 1 = interested in working in the gig economy	Permana et al (2023)
Income	The amount of money or income that respondents get from various sources (salary for those who are already working and pocket money for those who are not working)	Indonesian rupiah	Anggraini (2023)
Age	The number of years counted from the respondent's birth year to the time of completing the interview survey.	Years old	Izza et al (2024).
Gender	The biological classification of respondents is divided into two, namely male and female.	0 = man 1 = woman	Lusiyanti (2020)' Fatmawati (2020)
Education	The highest formal level completed by the respondent.	Years of schooling Junior high school = 9 Senior high school = 12 Undergraduate = 16	Hermann et al (2023)
Work stress reduction	Work stress refers to the level of pressure or stress experienced by respondents in terms of job demands, work environment, and individual psychological condition.	This variable is measured using Likert scale perception: 1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree	Prapunoto (2024); Srivastava (2024)
Flexible working	Flexible working refers to the extent to which respondents have control over when, where, and how they work.		Anggraini (2023); Muttaqin (2023)
Work environment	Work environment refers to the physical, social, and psychological conditions in which work is done and how the environment affects individual performance, well-being, and interest in work		Srivastava (2024)

RESULTS AND DISCUSSION

This study aims to identify the factors influencing Generation Z’s participation in the gig economy. The analysis combines descriptive statistics, qualitative mapping, and binary logistic regression. This section presents the main empirical findings and discusses them in relation to the existing literature. Qualitative mapping using ATLAS.ti found five main categories related to the gig economy: type of work, purpose of working, legal guarantees, barriers, and advantages and disadvantages of gig work. The main finding of this study is that income, work stress reduction, work flexibility, and work environment significantly affect Generation Z's interest in gig work.

In contrast, age, gender, and education level do not have a statistically significant influence. Before conducting the regression analysis, descriptive statistics were used to summarize respondents’ characteristics and perceptions. The summary of all research variables is presented in Table 2.

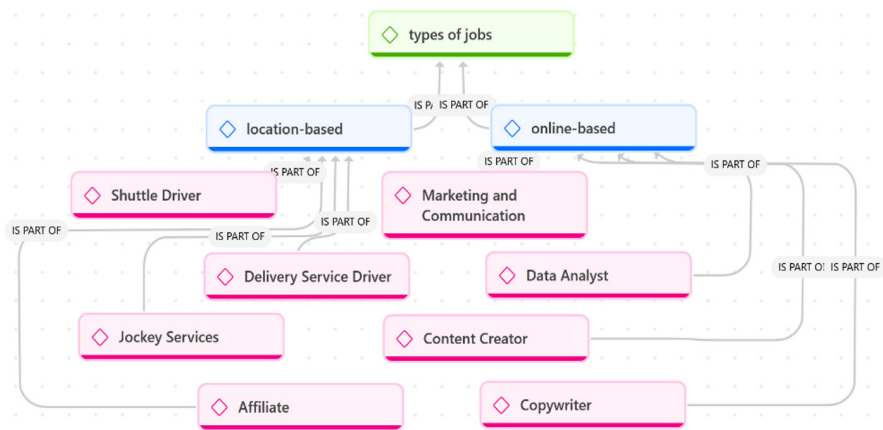
Table 2. Description of Research Variables

	Intention	Income	Age	Gender	Education	Work Stress	Flexibility	Work Environment
Mean	0.850000	1.61400	21.06000	0.550000	12.76000	4.030000	4.220000	4.240000
Std. Dev	0.358870	0.95843	2.210261	0.500000	1.875520	0.593823	0.628932	0.621500
Maximum	1.000000	6.00000	28.00000	1.000000	16.00000	5.000000	5.000000	5.000000
Minimum	0.000000	0.20000	13.00000	0.000000	6.000000	2.000000	2.000000	3.000000

Source: Data Processed (2024)

Table 1 shows Generation Z's average interest in the gig economy as 0.85, indicating that 85% of respondents are interested in this sector. Their average income ranges from IDR 1,614,000 to 6,000,000, with most respondents being students. The average age of respondents is 21 years, ranging from 13 to 28 years. The gender distribution shows that 55% of respondents are female and 45% are male. The average education level is 12 years, equivalent to senior high school.

Figure 1. Types of Jobs



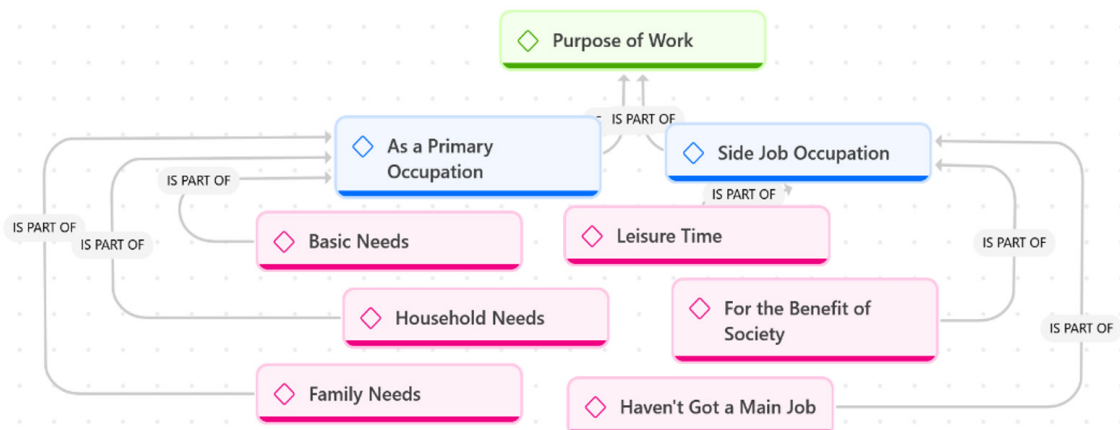
Sources: Data Processed (2024)

Other variables were measured on a Likert scale of 1-5. The average work stress score of 4.03 indicates that respondents perceive gig work as less stressful than formal jobs. The flexibility variable has an average of 4.22, indicating that respondents view the gig economy as highly flexible. The work environment variable has an average of 4.24, which means the majority of respondents find gig work environments comfortable.

Generation Z, defined here as those aged 15-28 years, represents a phase where individuals begin making career decisions following their studies. Generation Z, often perceived as less suited to high-stress environments, increasingly views the gig economy as an alternative career path. Based on the concept map generated, five thematic categories represent Generation Z's engagement with the gig economy.

The gig economy is divided into two types of work: location-based and online-based (see Figure 1). Location-based gigs typically involve tasks that do not require specific skills or educational qualifications, such as delivery drivers operating through Telegram bots, personal shopping, freelance errands, and affiliate marketing that earns commissions from product promotions. These jobs offer high flexibility and easy access for Gen Z who want to earn an income without special skills. Meanwhile, online freelance work requires specific skills or education, such as marketing, communication, digital marketing strategies, data analysis, content creation, and copywriting. These professions are increasingly in demand due to their flexibility and competitive earning potential in the digital age.

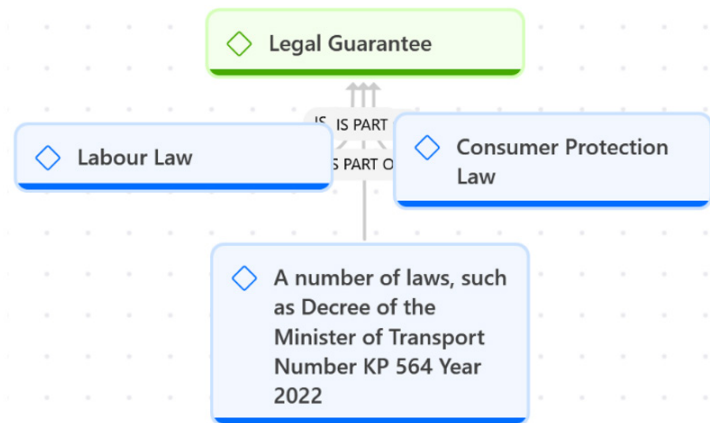
Figure 2. Purpose of Work



Sources: Data Processed (2024)

Generation Z engages in the gig economy primarily either as a primary source of income or as supplementary work. As a primary source of income, they rely on this work to meet basic needs like food and shelter, household necessities such as utilities and furnishings, and family expenses like education and healthcare costs. The economic flexibility of the gig economy allows them to adjust their work schedules with both daily expenses and long-term financial planning. Alternatively, many utilize the gig economy as a side income to productively fill free time, fund social activities, or serve as a temporary solution before securing full-time employment.

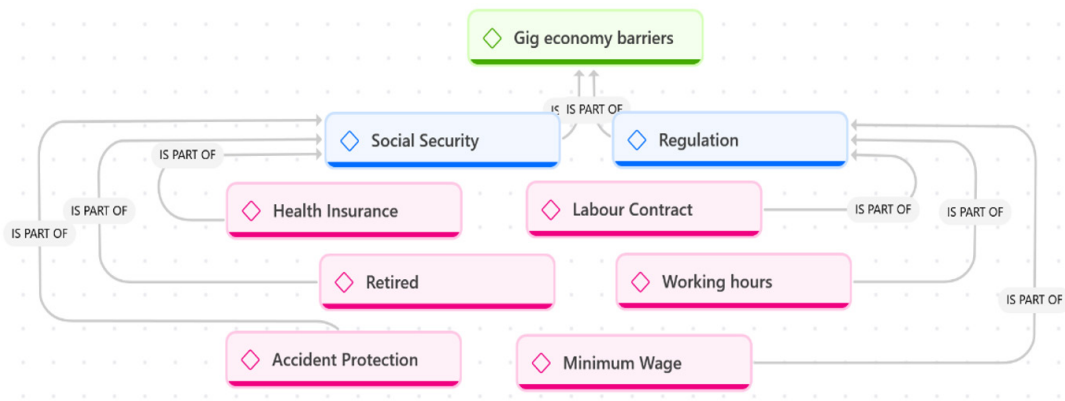
Figure 3. Legal Guarantee



Sources: Data Processed (2024)

Legal guarantee for gig economy workers in Indonesia still faces challenges due to the absence of specific regulations that provide full protection (see Figure 3). Protection for gig workers is partially provided under the Labor Law, which should guarantee the right to a living wage, social security, and a safe working environment. However, their classification status as partners often limits the scope of such protection. In addition, the Consumer Protection Law indirectly pressures platform providers to ensure safe and quality services for both workers and customers. The government has also issued special regulations, such as the Decree of the Minister of Transportation Number KP 564 of 2022, which regulates tariffs and operational costs for gig workers in the transportation sector. However, this protection is still limited and excludes other sectors. Therefore, more comprehensive regulations are needed to provide gig workers with legal certainty equivalent to that of formal employees.

Figure 4. Gig Economy Barriers

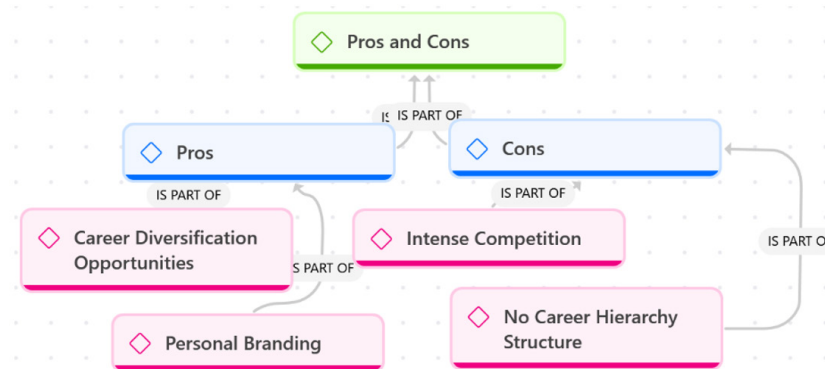


Sources: Data Processed (2024)

The gig economy faces various obstacles, particularly in terms of social security and regulation (see Figure 4). Unlike formal employees, freelance workers lack automatic access

to health insurance, pension funds, or accident insurance. They must pay their own health insurance premiums and save for retirement, which is difficult due to unstable income. In terms of regulation, freelancers generally lack formal employment contracts, which makes their relationship with platform providers flexible but uncertain regarding continued work. Additionally, the lack of working hour limitations makes them vulnerable to fatigue and health risks (see Figure 5).

Figure 5. Strengths and weaknesses



Sources: Data Processed, 2024.

Table 3. Binary Logistic Regression Test

Variable	Coefficient	z-Statistic	Probability	Odds Ratio
Constanta (C)	-42.22374	-2.957226	0.0031	0.000000
Income**	-1.350081	-2.134488	0.0328	0.258998
Age	0.231789	0.915615	0.3599	1.261038
Gender	0.914841	0.951245	0.3415	2.497822
Education Level	-0.108137	-0.297363	0.7662	0.897443
Work Stress**	2.120946	2.456640	0.0140	8.350206
Flexible Working**	5.444389	3.170964	0.0015	232.2534
Work Environment**	3.319098	2.504531	0.0123	27.69343
McFadden R-squared		0.584933		
LR Statistic		49.45127		
Prob(LR Statistic)		0.000000		

Sources: Data Processed (2024)

In addition to the phenomenon mapping, binary logistic regression test results were used to examine the effects of independent variables on Generation Z's interest in the gig economy. The results of the binary logistic regression are presented in Table 2. In the binary logistic regression test, the income variable significantly influenced Generation Z's choice to work in the gig economy, with a significance level of 0.0328 (less than 0.05) and an odds ratio of 0.2589. This result means that the higher a person's income,

the less likely they are to choose the gig economy. This result aligns with the findings of Prakoso et al. (2023), who state that the gig economy is more attractive to those with low incomes or those who need additional income due to its flexibility. The reason is that the gig economy often offers flexibility in earnings, allowing individuals to earn income based on the number of completed tasks.

Individuals with higher incomes tend to prefer jobs that offer more stability, clearer career paths, and social security, such as those in the formal sector. Higher income is often associated with shifts in job preferences. Generation Z, with their dynamic lifestyles and high aspirations, may be more drawn to jobs that not only provide income but also social status and more structured career development. Jobs in the formal sector often provide access to clear career paths, training programs, and recognition that can enhance professional reputation. This condition offers more appeal than the financial flexibility of the gig economy, which typically lacks hierarchical career structures (Novianti & Chandra, 2022).

Age showed no significant effect on Generation Z's choice to work in the gig economy. This condition is likely due to the relatively homogeneous characteristics of Generation Z in values, preferences, and mindsets, especially regarding flexibility, technology, and work freedom. As a generation raised in the digital age, age differences such as being under or over 21 years old did not result in significant variations in their interest in the gig economy.

Gender has also shown no significant effect on Generation Z's choice to work in the gig economy. This condition may be attributed to the skill-based nature of work in the gig economy and prevailing market needs, rather than individual characteristics such as gender (Rani et al., 2022). The flexibility of work in this sector allows individuals of any gender to customize their work to suit their needs. In addition, equal access to technology for all genders in Generation Z further reinforces that gender is not a determining factor in interest in the gig economy.

In addition, the gig economy offers flexibility that accommodates the needs of individuals of different genders (Sarker et al., 2024). For example, women who want to balance work and domestic responsibilities, or men who want to pursue freelance projects, can equally take advantage of the flexibility of the gig economy. As such, there is no specific pattern that suggests that one gender is more interested than the other in working in this sector. Furthermore, digital technology, as a key driver of the gig economy, is equally accessible to all genders. Generation Z, regardless of gender, shows high levels of digital literacy, resulting in no significant difference in their ability to access and capitalize on opportunities in the gig economy.

Education level showed no significant influence on Generation Z's choice to work in the gig economy. This result aligns with Herrmann et al. (2023), who found that education level does not play a significant role in determining freelance workers' choices. In the gig economy ecosystem, work is more dependent on technical skills and practical experience than on formal educational background (Herrmann et al., 2023). Many gig

economy platforms prioritize task efficiency and quality of output. This characteristic makes the gig economy accessible to individuals across educational backgrounds.

Work stress had a strong positive effect (OR = 8.35) in this study and significantly influenced Generation Z's choice to work in the gig economy. This data illustrates that as work stress levels increase, the likelihood of choosing gig work increases by a factor of 8.35 compared to individuals with lower stress levels. This finding supports Hartono et al (2024), who identified work stress as a significant predictor of fatigue. Additionally, Generation Z, as the youngest cohort in today's workforce, tends to prefer a more positive, flexible work environment that supports physical and mental well-being.

The main factor contributing to reduced work stress is the flexibility and freedom offered by this sector, which is difficult to find in formal employment. Generation Z often feels pressured by strict work targets, restrictive rules, and rigid hierarchies in formal work environments. The gig economy offers a more appealing alternative because it allows individuals to set their own work hours, choose projects that align with their interests, and take breaks as needed without pressure from a direct supervisor. Additionally, gig jobs often involve lower emotional stress due to their independent and results-based nature, unlike the stress of absenteeism or adherence to rigid company rules. With greater flexibility, Gen Z feels more capable of managing their workloads, maintaining a balance between personal and professional life, and reducing the risk of work-related stress. This condition makes the gig economy a more appealing option than more stressful conventional employment. This result aligns with Hartono & Prapunoto (2024), who emphasized Generation Z's tendency to avoid high-pressure environments and prefer mentally sustainable work models.

Work flexibility showed a significant influence on Generation Z's choice to work in the gig economy, with an odds ratio of 232.2534. This result indicates that greater flexibility substantially increases the likelihood of respondents choosing gig work. This finding aligns with Prakoso & Anggraeni (2023) and Darmawan & Muttaqin (2023), who also found that work flexibility positively influences one's decision to pursue freelance work. The main factor for this positive influence is Generation Z's strong emphasis on work-life balance. Generation Z values the freedom to determine work hours, location, and type of work, allowing them to align their work with their personal preferences and needs. Such flexibility perfectly suits the dynamic lifestyle of Generation Z, who often prioritize time for family, hobbies, and self-development. Additionally, the gig economy allows them to avoid the monotonous routines typically found in formal employment. Flexibility allows Gen Z to achieve work-life balance, explore self-development, and maintain autonomy—values they deeply care about (Li et al., 2025).

This study found that the work environment significantly influences Generation Z's interest in the gig economy. It indicates that the better the work environment, the more likely Generation Z is to choose to work in the gig economy. These findings align with Fatima & Srivastava (2024) and Osorio & Madero (2025), who revealed that Generation Z highly values positive work environments that align with their preferences. In the gig

economy, Generation Z can choose jobs that encourage creativity and productivity, such as working from home or in co-working spaces. They also prefer environments free from hierarchical pressure, employee conflict, and toxic work cultures. With the freedom to choose clients and projects, Gen Z can work in a more relaxed atmosphere and feel more comfortable, making the gig economy a more appealing career choice. Gig workers often choose to work from home, cafés, or co-working spaces, reflecting their preference for comfort and psychological well-being.

CONCLUSION

Based on the Atlas.ti mapping results, the gig economy emerged as a growing employment option in Indonesia. The purpose of gig work varies, serving either as a primary or supplementary income source. Gig workers still lack legal protections, which remains a critical issue, especially regarding social security and regulatory frameworks. The gig economy offers not only advantages like career diversification and increased personal branding but also disadvantages such as fierce competition and unclear career paths. The findings indicate that income, reduced work stress, flexible working arrangements, and a supportive work environment significantly influence Generation Z's decision to engage in gig work. In contrast, demographic variables such as age, gender, and education level did not show significant influence, as skillsets and digital literacy are more decisive than demographic background in the gig economy.

Based on these findings, policy recommendations emphasize the need for legal protections and social security reforms. Policymakers should prioritize developing a legal framework that provides casual workers with fair protection and social benefits, including health insurance, pension schemes, and fair wage standards. Inclusive skills development programs are also needed. Governments and educational institutions should collaborate to provide accessible training programs that equip young workers with the digital and entrepreneurial skills required for online and location-based jobs. Workplace innovation in the formal sector is necessary: employers should consider adopting more flexible working arrangements and fostering psychologically safe environments to retain and attract Generation Z talent.

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Food Security Outcomes of Indonesia's Non-Cash Food Assistance Program (BPNT) among Lowest-Expenditure Households

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ABSTRACT

Research Originality: This study provides the first scientific analysis of the effect of the Non-Cash Food Assistance (BPNT) Program on household food security among Indonesia's lowest 20% expenditure group.

Research Objectives: This study investigates how the Non-Cash Food Assistance Program (BPNT) influences household food security in Indonesia, specifically among households in the lowest 20% expenditure group.

Research Methods: This research utilizes a multinomial logistic regression model to examine the key determinants of food security among households.

Empirical Results: The Non-Cash Food Assistance Program (BPNT) plays a significant role in improving the food security of recipient households. Social assistance programs like BPNT can help low-income families by mitigating the negative effects of food price shocks, specifically by promoting dietary diversity.

Implications: The government should keep updating data to make BPNT distribution more effective, especially for the poorest 20% of households, who are most vulnerable to food insecurity. It also needs to conduct regular outreach and monitoring to ensure beneficiaries use BPNT properly.

Keywords:

non-cash food assistance (BPNT); household food security; multinomial logistic regression

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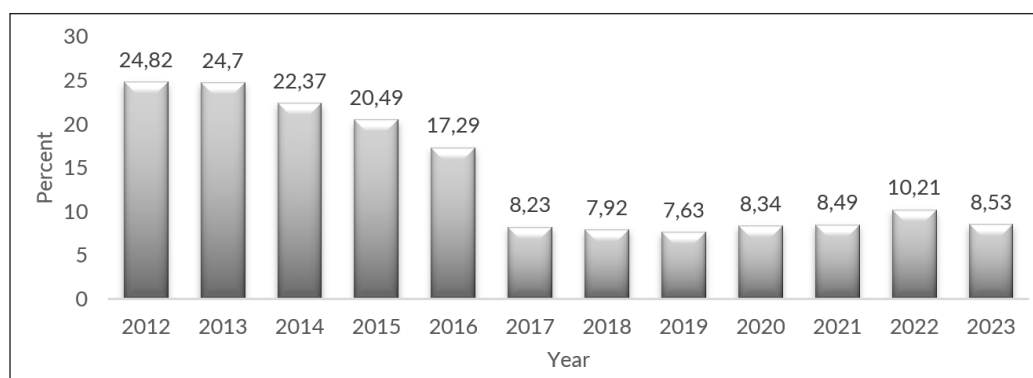
INTRODUCTION

Poverty remains a persistent challenge in Indonesia. In response, the government implemented the Non-Cash Food Assistance (BPNT) Program, which allocates IDR 200,000 monthly per family for food purchases. As of the 2022 fiscal year, the program achieved 99.25% performance and 98.15% budget realization (Mabruk & Prasojo, 2024). BPNT aims to enhance the welfare and survival of impoverished and marginalized groups by improving food accessibility, thereby addressing the fundamental rights and welfare of the families receiving the aid (KPM).

Initiated in 2017 as a transformation of the Rastha (Prosperous Rice) program, BPNT continues to receive substantial budget allocations. In 2023, it received the largest share of Indonesia's social protection budget, reaching IDR 45.1 trillion and targeting 18.8 million beneficiary families. Although the government has implemented the BPNT program to strengthen the food security of poor and vulnerable households, around 8-9 people out of every 100 Indonesians cannot consume enough food to supply the necessary energy for individuals to function normally and stay physically well.

The COVID-19 pandemic has led to heightened economic unpredictability worldwide, posing challenges to food security in Indonesia. Government interventions like BPNT and PKH have reduced the prevalence of inadequate food consumption from 10.21% in 2022 to 8.53% in 2023, especially in low-income communities. In other words, 8–9 out of every 100 Indonesians consume food but still fail to meet the daily energy requirement of 2,100 kcal necessary to function normally and stay physically well. Although this figure has declined, it remains above the government's 2024 National Medium-Term Development Plan (RPJMN) target of 5.7% (Bappenas, 2020). More intensive efforts are needed to achieve this target. For more details, see Figure 1.

Figure 1. Prevalence of Undernourishment (PoU), 2012-2023



Source: Central Bureau of Statistics (2024)

Poverty significantly limits economic access to food, as most low-income individuals in Indonesia face food insecurity due to difficulties in ensuring the availability of healthy food that complies with standard dietary norms (Zakiah, 2018). One of the key challenges to improving household-level food security is the high proportion of people with limited

purchasing power. In this context, insufficient income is a significant barrier for many households in accessing adequate quantities of quality food (Rachman, 2010). Food consumption is inherently linked to poverty, as poor households prioritize food over non-food expenditures. Consequently, poverty and food insecurity are closely intertwined, with poverty as a primary driver of food insecurity (Ainistikmalia et al., 2022). With a score of 60.2, Indonesia ranks 63rd out of 113 countries in the 2022 Global Food Security Index (GFSI), below the global average of 62.1. Within ASEAN, Indonesia ranks fourth, behind Singapore, Malaysia, and Vietnam. The GFSI assesses food security across several dimensions: affordability, availability, quality, safety, sustainability, and adaptation. Indonesia scored well in affordability (81.4), but lags in availability (50.9) and sustainability and adaptation (46.3). While the country has made progress in ensuring affordable food through robust protection systems, it continues to face challenges in guaranteeing food quality, safety, and long-term resilience (The Economist Group, 2022).

In 2022, domestic strategic food availability increased to 6.40%, surpassing the target of 3.64%, which placed it in the “very successful” category. Production of several key commodities also saw notable gains compared to 2021: rice increased by 2.31%, corn by 9.29%, chili by 10.88%, meat (in yield) by 14.50%, milk by 2.39%, and eggs by 7.28%, although shallots declined by 1.51% (Bappenas, 2024). Despite these improvements in national-level food availability, challenges persist in ensuring food diversity and equitable access across the population (Arif et al., 2020). The abundance of food at the national level is not always matched by household-level access, particularly among low-income groups.

Ariningsih & Rachman (2016) emphasize that most poor households in Indonesia struggle with food insecurity due to limited access to food, hindering their ability to obtain healthy, safe, and nutritious meals. Arif, Isdijoso, Fatah, & Tamyis (2020) identify poverty and the high cost of food relative to income as the primary barriers to food access. Although poverty rates have declined recently, approximately 25.9 million people, equivalent to 9.36% of the population, remained below the poverty line in 2023 (Central Bureau of Statistics, 2023).

Indonesia also faces challenges related to food utilization at the household level. Effective food management is critical, yet issues such as low consumption levels, poor dietary quality, and limited variety remain prevalent. Beyond availability and affordability, food security is also influenced by households' knowledge and awareness of the importance of balanced and diverse nutrition (Saputri et al., 2016). Therefore, this study adopts a comprehensive definition of food security, encompassing four key dimensions at the household level: availability, affordability, accessibility, and utilization.

Household food security can be assessed through a classification that links per capita daily calorie adequacy with the proportion of household expenditure allocated to food (Yuliana et al., 2020). Based on Permenkes RI No. 28 of 2019, Indonesia's recommended daily energy intake is 2,100 kcal per capita. A household is deemed calorie sufficient if it consumes more than 80% of this target (i.e., >1,680 kcal/capita/day), and calorie-deficient if consumption is equal to or less than 80% ($\leq 1,680$ kcal/capita/day). The food expenditure share is considered high if it is 60% or greater, and low if it is below 60%.

Cross-classifying these two indicators yields four household food security categories: food secure, food vulnerable, food less secure, and food insecure.

The Indonesian population is divided into five equal-sized expenditure quintiles, ranked from lowest to highest, which serve as a proxy for welfare status (BPS, 2023). As shown in Table 1, the lower the quintile, the greater the share of food expenditure. This trend reflects the limited income available for non-food needs in poorer households, resulting in a disproportionate allocation of resources toward food. Low-income households' high share of food expenditure indicates constrained financial capacity and purchasing power, signaling that food security has not been adequately achieved (Sundari & Nachrowi, 2016).

Table 1. Food Expenditure Share and Calorie Adequacy by Expenditure Quintile in 2023

Expenditure Quintile	Average Monthly Per Capita Expenditure (IDR)	Share of Food Expenditure (% per month)	Calorie Adequacy (kcal/capita/day)
(1)	(2)	(3)	(4)
Quintile 1	522,942	63.37	1,663.05
Quintile 2	786,662	59.98	1,919.42
Quintile 3	1,067,196	57.56	2,082.67
Quintile 4	1,491,891	54.13	2,268.17
Quintile 5	3,390,657	39.42	2,504.91
Total	1,451,870	48.99	2,087.64

Source: Central Bureau of Statistics (2023)

Nationally, the share of food expenditure among the Indonesian population stood at 48.99% in 2023. Among the lowest expenditure quintile (Quintile 1), with an average monthly per capita expenditure of IDR 522,942, the food expenditure share was 63.37%. In Quintiles 2 through 4, the share remained above 50%. Only Quintile 5, the highest expenditure group, had a food expenditure share below 50%, at 39.42%. These figures reflect a clear trend: the lower the income group, the higher the expenditure allocated to food. This pattern suggests that lower-income households must dedicate most of their income to meet basic nutritional needs, leaving little room for non-food expenditures. The high food expenditure share among the poorest households highlights their limited financial capacity and purchasing power, signaling that food security remains unachieved for a significant population segment (Sundari & Nachrowi, 2016).

Calorie adequacy data further reinforces these disparities. In 2023, the average calorie consumption across the Indonesian population was 2,087.64 kcal per capita per day. While Quintile 4 and 5 households consumed 2,268.17 and 2,504.91 kcal, respectively, exceeding the national adequacy threshold of 2,100 kcal, the lower three quintiles fell short. Notably, the lowest quintile recorded an average intake of only 1,663.05 kcal per capita per day, well below the adequacy standard. These findings confirm that the

poorest households cannot access sufficient nutritious food to meet their basic energy needs, primarily due to income constraints (Siddiqui et al., 2020).

Considering how food security fundamentally supports well-being and quality of life, both the private sector and policymakers have a vested interest in influencing consumer behavior and protecting vulnerable groups. The Non-Cash Food Assistance Program (BPNT) is an intervention to improve food access among Beneficiary Families (KPM), households within the lowest 25% of socio-economic conditions. However, program implementation has not been optimal. Only 28.46% of food-insecure households received BPNT in 2022, and its utilization stood at just 86.9%. Moreover, recipients are disproportionately concentrated in higher expenditure groups. BPNT has the lowest absorption rate among poor households compared to other social assistance schemes, just 40% (Arfandi & Sumiyarti, 2022).

Similar programs in other countries offer instructive comparisons. In the United States, the Supplemental Nutrition Assistance Program (SNAP), formerly known as the food stamp program, has existed since 1939. Mousa & Freeland-Graves (2019) found that programs offering supplementary food support, such as pantries and kitchens, positively affect the nutritional quality of household food and overall food security. Ogundari et al. (2022) revealed that compared to non-recipients, SNAP recipient households are more likely to achieve food security. Thus, by improving access to nutritious food, government food assistance programs improve household food security (Ssekate, 2024).

Furthermore, Gundersen et al. (2017) state that the SNAP program helps lower food insecurity rates among families with children. Schmidt et al. (2016) found that participation in key safety net programs—such as TANF, SNAP, or Medicaid/SCHIP—helped reduce both the number of economic hardships and instances of food insecurity among low-income households with children, particularly within non-immigrant, single-parent families. Their study revealed that receiving food or cash assistance was associated with a four percentage point decline in food insecurity. Similarly, Tiwari et al. (2016) investigated government-led cash transfer initiatives in Ghana, Kenya, Lesotho, and Zambia. Their findings indicated that consistent and sufficiently large cash transfers improved the quantity and quality of food consumed and significantly reduced household food insecurity. While climate and weather-related shocks tend to worsen food insecurity, interventions such as Ethiopia's Productive Safety Net Program have shown that cash support can help alleviate these impacts—though food aid alone proved less effective. Households that had savings or opted to sell their harvests at higher prices, rather than consuming them, tended to fare better. However, such strategies remain less accessible for the poorest households, who are also the most vulnerable to food insecurity (Dasgupta & Robinson, 2021).

Meanwhile, several studies in Indonesia, including Syamola and Nurwahyuni (2019) and (2022), found that Raskin receipt does not affect household food security. Mutiah and Istiqomah (2017) found that Raskin significantly increased households' chances of food security, but this research was only conducted in urban areas. Meanwhile, Sundari and Nachrowi (2015) showed that participation in the Raskin program positively influenced

household food security in Indonesia, but did not specifically look at its impact on poor households.

Given the inconsistent findings and the absence of research examining the BPNT program's impact on the lowest-income group, this study seeks to fill that gap. By leveraging 2023 Susenas data, this research aims to evaluate the effectiveness of BPNT in improving food security among households in the bottom 20% expenditure group. This study aspires to make a meaningful empirical contribution to the literature on food assistance and poverty alleviation. As BPNT commanded the most significant budget among social protection programs in 2023, ensuring its effectiveness is essential. The findings will provide important policy insights for better targeting and delivering food assistance to Indonesia's most vulnerable households.

METHODS

This study utilizes secondary data from the March 2023 National Socio-Economic Survey (Susenar) and its associated Consumption Module, provided by Indonesia's Central Statistics Agency (BPS). Susenas is conducted biannually, in March and September; the March round was selected for this analysis because it provides detailed data at the household level, ensuring comprehensive coverage across the country. The choice of the 2023 dataset reflects a post-pandemic context, offering an up-to-date and relevant snapshot of household conditions following Indonesia's recovery from COVID-19.

The March 2023 Susenas survey surveyed approximately 345,000 households across 34 provinces and 514 districts/cities, achieving a response rate of 99.98%. After data cleaning to ensure completeness and consistency, 341,802 households were retained for analysis in this study. The dependent variable in this study is household food security status. This is determined using a classification framework based on Jonsson & Toole (1991) in Widada et al. (2017), which cross-tabulates two indicators: (1) per capita daily calorie adequacy and (2) the share of food expenditure relative to total household expenditure. Calorie adequacy reflects the household's ability to meet nutritional needs, measured by the number of calories consumed per person per day. According to Indonesia's Ministry of Health Regulation No. 28 of 2019, the recommended daily energy intake is 2,100 kcal per capita. Households are considered calorie-sufficient if their per capita calorie intake exceeds 80% of this threshold ($>1,680$ kcal/capita/day), and calorie-deficient if intake is equal to or less than 80% ($\leq 1,680$ kcal/capita/day).

Table 2. Degree of Household Food Security

Calorie Sufficiency	Proportion of Food Expenditure	
	Low (<60%)	High ($\geq 60\%$)
Sufficient ($>80\%$)	Food Secure	Food Vulnerable
Lacking ($\leq 80\%$)	Food Less Secure	Food Insecurity

Source: Jonsson & Toole (1991) in Widada et al. (2017)

Based on Table 2, household food security status is grouped into four categories, as follows: Category 0 = Food Insecurity; Category 1 = Food Less Secure; Category 2 = Food Vulnerable; Category 3 = Food Security.

The share of food expenditure refers to the proportion of total monthly household spending allocated to food needs. Total household expenditure comprises food and non-food consumption, calculated based on goods and services received, used, or purchased for household purposes within a month, excluding expenses related to business operations or transfers to others. The consumption approach measures the quantity of food consumed during the survey. For non-food consumption, the delivery approach captures goods and services acquired (either purchased or received) and utilized by the household. The share of food expenditure is classified as low if it is less than 60% and high if it is 60% or more. This variable is one of two key indicators in determining household food security status. The study's independent variables capture several dimensions of food security, including food availability, affordability, utilization, and the impact of government interventions. All variables were constructed using responses from the March 2023 Susenas Core Questionnaire (VSEN23.K) and the Consumption Module (VSEN23.KP). Further details are provided in Table 3.

Table 3. Operationalization of Variables

Variables	Information
Food Security Status (Dependent Variable)	0 = Food Insecurity 1 = Food Less Secure 2 = Food Vulnerable 3 = Food Security
Business Field (Occupation)	0 = Non-agriculture 1 = Agriculture
Residential Area Classification	0 = Rural 1 = Urban
Per Capita Expenditure	1. First 20% (lowest) 2. Second 20% 3. Third 20% 4. 20% fourth 5. 20% fifth (highest)
Ownership Status of Residential Building	0 = Not Owned 1 = Owned
Credit Access	0 = No Credit Access 1 = With Credit Access
Gender of Head of Household	0 = Female 1 = Male
Education level of household head	1. Elementary School 2. Junior High School 3. High School 4. College
Age of household head	Age of household head
Total number of household members	Total number of household members
Non-cash Food Assistance	0. Non-recipient 1. Recipient

Source: Various studies

This study employs multinomial logistic regression to examine the impact of the BPNT program and other influencing factors on household food security status and estimate the likelihood of these variables affecting that status. This statistical method is suitable when the dependent variable is categorical with more than two possible outcomes, and multiple independent variables are involved.

According to Sundari & Nachrowi (2015), ordinal logistic regression is unsuitable for analyzing food security levels because the categories of the dependent variable do not exhibit a strictly sequential relationship. While “food secure” may be considered better than “food insecure,” the distinctions between intermediate categories—such as “food less secure” and “food vulnerable”—are not necessarily ordinal in nature. Furthermore, this study did not use the ordered logit model because the data did not meet the proportional odds assumption, also known as the parallel lines assumption. In contrast, multinomial logistic regression does not require this assumption and allows for separate coefficients across all dependent variable categories (Amrullah et al., 2019).

This research model modifies the model used by Sundari & Nachrowi (2015) focusing on the households in the lowest expenditure group. Food security status serves as the dependent variable and is categorized as follows: $Y = 0$ food insecure, $Y = 1$ food secure, $Y = 2$ food vulnerable, $Y = 3$ food secure. Thus, a logistic model with four categories of food security status would have a logit function for $Y=i$ compared to $Y=0$ (reference category), as follows:

$$\ln\left[\frac{\pi(Y=i|x)}{\pi(Y=0|x)}\right] = \beta_{i0} + \beta_{i1}BPNT + \beta_{i2}occupation + \beta_{i3}location + \beta_{i4}logincome + \beta_{i5}home + \beta_{i6}loan + \beta_{i7}gender + \beta_{i8}educ_1 + \beta_{i9}educ_2 + \beta_{i10}educ_3 + \beta_{i11}age + \beta_{i12}size + \varepsilon_i, i = 1,2,3 \quad (1)$$

Where β is the logit parameter value, and ε is the error term. The probability for each category in the multinomial logistic regression model with four categories is:

$$\pi_i = \pi(Y=i | x) = \frac{e^{z_i}}{1 + e^{z_1} + e^{z_2} + e^{z_3}} \quad (2)$$

With the probability of a household being food insecure ($i=0$ and $e^{z_0}=1$), food less secure ($i=1$), food vulnerable ($i=2$), or food security ($i=3$). The estimation results of the β coefficient cannot be interpreted directly. To provide a more meaningful interpretation, an interpretation is needed based on the coefficient results of the marginal effect estimation, which refers to the change in probability due to changes in the independent variable. The marginal effect in the multinomial model is calculated differently for each category. The marginal effect can be formulated as:

$$ME_{ij} = \frac{\partial \pi(Y=i|X)}{\partial x_j} = \pi(Y=i|X) \cdot (\beta_{ij} - \sum_{k=0}^I \pi(Y=k|X) \beta_{kj}) \quad (3)$$

RESULTS AND DISCUSSION

Table 4 shows that in 2023, only 14.49% of households in the lowest expenditure group in Indonesia were classified as food secure, while the remaining 85.51% were not. The most significant proportion of food-insecure categories—36.45%—falls into the food

vulnerable group. This category includes households that meet calorie adequacy standards but must allocate 60% or more of their income toward food. In contrast, 26.13% of households were classified as food insecure, characterized by low food expenditure share but insufficient calorie intake. Meanwhile, 22.93% of households were categorized as food insecure, meaning they fail to meet both calorie adequacy and exhibit a high share of food expenditure. These figures underscore the challenges the lowest-income households face in achieving food security.

Table 4. Summary Statistics

Variables	Food Insecurity % or Mean [SD]	Food Less Secure % or Mean [SD]	Food Vulnerability % or Mean [SD]	Food Security % or Mean [SD]
<i>Status of Food Security</i>	22.93	26.13	36.45	14.49
<i>Employment of Head of Household</i>				
Non-Agriculture	21.52	31.19	32.38	14.91
Agriculture	24.11	21.92	39.83	14.14
<i>Area</i>				
Rural	24.19	23.98	37.98	13.85
Urban	19.88	31.37	32.71	16.03
<i>Ownership of Residential Building</i>				
Not Owned	26.88	30.66	31.61	10.85
Owned	22.39	25.50	37.12	14.99
<i>Access to Credit</i>				
Without Access to Credit	23.48	26.01	36.30	14.21
With Credit Access	20.57	26.65	37.09	15.69
<i>Gender of household head</i>				
Female	16.80	25.60	38.31	19.30
Male	23.77	26.20	36.20	13.83
<i>Education Level of Head of Household</i>				
Elementary school or below	23.27	22.02	40.39	14.32
Junior High School	23.74	28.29	33.78	14.20
High School	21.82	34.78	28.31	15.08
Higher Education	19.08	39.99	25.20	15.73
<i>Non-cash food assistance (BPNT)</i>				
Non-recipient	23.50	28.03	34.28	14.18
Recipients	21.23	20.39	42.98	15.40
Age	47.12	47.41	50.39	50.82
Size	5.07	4.67	4.14	3.84
N	68.361			

Source: National Socio-Economic Survey (2023)

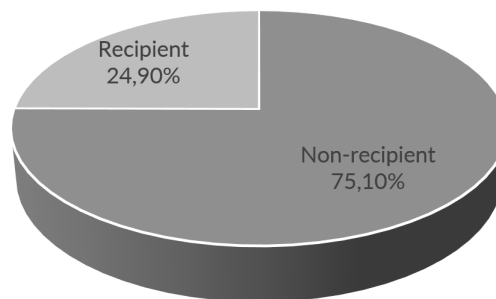
Table 4 summarises how household characteristics relate to food security status. Households categorized as food secure tend to have higher per capita income. In terms

of age, households headed by older individuals are generally more food secure. Similarly, a smaller household size is associated with greater food security, suggesting that fewer dependents reduce the burden on available resources. Concerning occupation, there is no notable difference in food security outcomes between households whose heads work in the agricultural sector and those in non-agricultural employment.

However, other factors influence food security. Households residing in urban areas, owning their homes, having access to credit, and being led by male heads of household with university-level education are more likely to be food secure. Additionally, households that receive BPNT assistance are more likely to attain food security, further emphasizing the importance of targeted government interventions for vulnerable populations.

Meanwhile, Figure 2 illustrates that only 17,025 households, or 24.90% of those in the lowest 20% expenditure group, received BPNT assistance in 2023. This result indicates a relatively low coverage rate, with approximately 75.10% of households in this group remaining unreached by the program. Given that the BPNT program is specifically designed to support households facing the greatest vulnerability to food insecurity, this limited coverage is a critical concern. Ideally, all households in the lowest expenditure quintile should be prioritized as BPNT beneficiaries. The current gap in coverage highlights the need for improved targeting and distribution mechanisms to ensure that the assistance reaches those most in need and effectively contributes to reducing food insecurity among Indonesia's poorest households.

Figure 2. Distribution of Non-Cash Food Assistance (BPNT) to Households in the 20% Lowest Expenditure Group in Indonesia in 2023



Source: National Socio-Economic Survey (2023)

The analysis results are presented in Table 5, showing the multinomial logistic regression estimation. In the first logit function equation $\ln(\frac{\pi_1}{\pi_0})$, the category of food Less Secure ($Y=1$) relative to food insecurity ($Y=0$), each of the independent variables is significant at the 99% confidence interval ($\alpha = 0.01$). The gender and education dummy variables (*educ*) are not significant in the second logit function equation. $\ln(\frac{\pi_2}{\pi_0})$, the category of food vulnerability ($Y=2$) relative to food insecurity ($Y=0$). Meanwhile, in the third logit function equation $\ln(\frac{\pi_3}{\pi_0})$, the category of food security ($Y=3$) relative to food insecurity ($Y=0$), almost all independent variables are significant, except for the field of business/occupation of the head of the household.

The marginal effect results presented in Table 6 indicate that Non-Cash Food Assistance (BPNT) and most other independent variables—except for the employment sector of the head of household (KRT)—are significant at the 99% confidence level ($\alpha = 0.01$). Specifically, receiving BPNT increases the probability of a household being food secure by 1.07% and decreases the likelihood of being food insecure by 1.62%. As a targeted program aimed at strengthening food security among Beneficiary Families (KPM)—those within the lowest 25% of socio-economic status—BPNT demonstrates a clear, positive impact on improving food security outcomes for its recipients.

Table 5. Multinomial Logistic Regression

Variables	Food Less secure $\ln(\frac{\pi_1}{\pi_0})$	Food Vulnerable $\ln(\frac{\pi_2}{\pi_0})$	Food Security $\ln(\frac{\pi_3}{\pi_0})$
Occupation of Head of Household (1=Agriculture)	-0.281	0.135	0.005
Area Classification (1=Urban)	0.299	0.073	0.298
Ownership Status of Residential Building (1=Owned)	0.242	0.288	0.627
Credit Access (1=With Credit Access)	0.162	0.302	0.428
Gender of Head of Household (1=Male)	-0.202	-0.021	-0.177
Junior High School	0.224	-0.018	0.205
Senior High School	0.506	-0.035	0.435
University	0.762	0.030	0.638
Age of Head of Household	0.004	0.011	0.011
Number of Household Members	-0.129	-0.326	-0.473
Non-Cash Food Assistance (1=Recipient)	-0.191	0.297	0.170
Constant	0.415	0.995	0.357

$p < 0,01$, $p < 0,05$, $p < 0,1$

Source: National Socio-Economic Survey 2023, processed from sample data

These findings align with previous research by Sundari and Nachrowi (2015), who found that food assistance programs like Raskin helped reduce household spending burdens, increasing the likelihood of food security among beneficiaries. Similar evidence has emerged from studies in the United States. For example, Ogundari et al. (2022), McKernan et al. (2021) and Swann (2017) observed that participation in the Supplemental Nutrition Assistance Program (SNAP) significantly improved household food security, as reflected in reduced levels of food insecurity and hunger among recipient families.

When examining the food-insecure and food-vulnerable groups, the marginal effect analysis reveals that BPNT leads to a 6.78% decrease in the probability of food insecurity, while increasing the probability of being food vulnerable by 7.33%. This suggests that although BPNT may help households avoid the most severe forms of food insecurity, it may not be sufficient to move them into complete food security. One possible explanation is that BPNT allows recipients to reallocate limited income away from food to cover

other urgent needs—such as debt repayment or non-food expenses—thereby leaving them vulnerable despite some improvement. In addition, the assistance amount may not be adequate to meet all nutritional needs. Nevertheless, an increase in the food vulnerable group could indicate a positive transition from food insecurity to complete security. This aligns with the findings of Deb & Gregory (2018), who argue that food assistance programs may have a limited impact on food security at the extensive margin but can meaningfully reduce food insecurity at the intensive margin.

Regarding residential classification, households in urban areas were 2.09% more likely to be food secure than those in rural areas. This suggests that despite lower levels of food production, urban households benefit from greater diversity and accessibility in food supply, contributing to improved dietary quality. Similar patterns were observed by Amrullah et al. (2019) in Indonesia and Fadol et al. (2024) in Sudan. In contrast, Awoyemi et al. (2023) and Grimaccia & Naccarato (2019) noted that rural households may be more food secure due to lower food prices and local availability. However, Abebe (2024) highlighted that urbanization can also contribute to rising food insecurity in densely populated areas, as seen in urban Ethiopia.

Table 6. Marginal Effect on Households in the Lowest 20% Expenditure Group

Variables	Marginal Effect			
	Food Insecurity	Food Less Secure	Food Vulnerable	Food Security
(1)	(2)	(3)	(4)	(5)
Occupation of Head of Household (1=Agriculture)	0.0067	-0.0643	0.0544	0.0032
Area Classification (1=Urban)	-0.0325	0.0384	-0.0268	0.0209
Ownership Status of Residential Building (1=Owned)	-0.0550	-0.0030	0.0075	0.0505
Credit Access (1=With Credit Access)	-0.0455	-0.0120	0.0288	0.0287
Gender of Head of Household (1=Male)	0.0191	-0.0292	0.0230	-0.0128
Junior High School	-0.0182	0.0359	-0.0352	0.0175
Senior High School	-0.0407	0.0816	-0.0769	0.0359
University	-0.0672	0.1160	-0.0963	0.0475
Age of Head of Household	-0.0014	-0.0005	0.0014	0.0005
Number of Household Members	0.0467	0.0219	-0.0347	-0.0339
Non-Cash Food Assistance (1=Recipient)	-0.0162	-0.0678	0.0733	0.0107

p < 0,01, p < 0,05, p < 0,1

Source: National Socio-Economic Survey 2023, processed from sample data

Homeownership is another significant factor. Households residing in owned homes were 5.05% more likely to be food secure than those in rented or non-owned dwellings. This finding is consistent with the results of Indrawan et al. (2024), Kharisma & Abe (2020) and Guo (2011). Similarly, access to credit increases the probability of food security by 2.87% and reduces food insecurity by 4.55%. These results support prior findings by

Hassen et al. (2016) and Gebre (2012) in Ethiopia, who noted that access to credit facilitates income-generating activities and helps stabilize household consumption during periods of food stress. This relationship is further reinforced by Bahiru, Senapathy, & Bojago (2023).

Surprisingly, having a male head of household is associated with a 1.28% lower probability of food security and a 1.91% higher probability of food insecurity. This finding contrasts with some expectations and reflects a broader debate in the literature. For instance, Hassen et al. (2016) in Ethiopia, Wiranthi et al. (2014), and Heryanah (2016) found that households headed by women are more likely to achieve food security, possibly due to women's better management of limited resources and stronger prioritization of household nutrition. These findings are supported by the FAO (2014), which emphasized women's critical role in ensuring household food security. However, studies by Ganpule et al. (2023) in India and Swann (2017) in the United States reported that women-headed households may also face greater food insecurity, suggesting that the relationship is context-dependent.

The education level of the household head also plays a crucial role. Compared to those with only primary education or less, households led by individuals with junior high school education are 1.75% more likely to be food secure. This probability increases to 3.59% for senior high school graduates and 4.75% for university graduates. These findings are consistent with prior research from Abdullah et al. (2019) in Pakistan, and Cahyono & Tokuda (2024) found that higher education levels enhance knowledge, income opportunities, and access to nutritious food in Indonesia. Similar conclusions were drawn by Feyisa et al. (2023) in Ethiopia, Adjei-Mantey et al. (2023) in Ghana and Amrullah et al. (2023) in Indonesia.

Although the marginal effect of age is small, it is statistically significant. Each additional year in the age of the household head increases the probability of food security by 0.05%. This suggests that experience and stability associated with older age may contribute positively to food access and decision-making. Similar findings were reported by Megbowon & Mushunje (2018) in South Africa, Ogundari et al. (2022) in the United States, Abdullah et al. (2019) and M. Akbar et al. (2020) in Pakistan.

Finally, the number of household members is inversely related to food security. Each additional household member reduces the probability of being food secure by 3.39% and increases the probability of food insecurity by 4.67%. Larger households are more burdened by limited resources, making it more challenging to meet adequate nutritional needs. This pattern is consistent with the findings of Mutiah & Istiqomah (2017). Similar results were obtained by Beyene & Muche (2010) in Ethiopia and Ogundari et al. (2022) in the United States.

Robustness Check

Robustness checks were conducted using alternative model specifications to ensure that the results are not solely dependent on the multinomial logistic regression model, following the approach of Cabral et al. (2025). As an alternative, multinomial probit regression was employed, given its structural and conceptual similarity to the multinomial logit model. Both models can handle dependent variables with more than two nominal (non-ordinal) outcome

categories and allow for multiple independent variables. Using the probit model validates the consistency and reliability of the findings obtained from the multinomial logit model.

Table 7 demonstrates that the effect of the Non-Cash Food Assistance Program (BPNT) remains consistent across both the multinomial logit and probit models. In both specifications, BPNT has a statistically significant positive impact on household food security at the 99% confidence level ($\alpha = 0.01$). The marginal effect values are highly comparable across the two models, indicating that differences in estimation techniques do not materially alter the findings. This consistency confirms the robustness of the relationship between BPNT participation and household food security outcomes, reinforcing the validity of the results regardless of the model specification employed.

Table 7. A Comparison of Multinomial Logistic and Multinomial Probit Regression

Variables	Logit	Probit
Non-cash Food Assistance (1: Recipient. 0: Non-recipient)		
Coefficient β	0.170***	0.116***
Marginal Effect		
Food Insecurity	-0.0162***	-0.0182***
Food Less Secure	-0.0678***	-0.0653***
Food Vulnerable	0.0733***	0.0734***
Food Security	0.0107***	-0.0101***

$p < 0,01$, $p < 0,05$, $p < 0,1$

Source: National Socio-Economic Survey 2023, processed from sample data

CONCLUSION

In addition to BPNT, various socio-economic and demographic factors influence household food security. Households headed by females, those with higher education levels, older heads, fewer members, access to credit, urban residence, and homeownership are more likely to be food secure. These findings emphasize the multifaceted nature of food security and the importance of a targeted, evidence-based approach to social assistance.

To enhance the effectiveness of the BPNT program, it is essential to conduct continuous data updates to improve targeting, especially for the poorest 20% of households, who remain the most food insecure. Furthermore, program socialization and routine monitoring are critical to ensure that beneficiaries are aware of and can utilize the assistance optimally. Priority should be given to households with the highest vulnerability: those in rural areas, with larger household sizes, and whose heads have only primary education or less.

This study also acknowledges its limitations. The analysis focuses primarily on internal household factors, due to the constraints of the available dataset. Future research could incorporate external variables, such as regional food availability, price fluctuations, market access, and health service infrastructure, all of which play essential roles in shaping household food security. Additionally, applying multilevel logistic regression may provide deeper insights by accounting for household-level and contextual-level influences.

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Spending More, Fewer Casualties? Leveraging Governance in Local Disaster Management

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ABSTRACT

Research Originality: This research introduces a quantitative framework for evaluating the effectiveness of local government disaster management strategies in Indonesia, specifically during the pre-disaster and emergency response stages—an area previously underexplored in existing qualitative-focused literature.

Research Objectives: This study evaluates the effectiveness of disaster management in reducing losses from natural disasters, focusing on two main stages: the pre-disaster and emergency response stages. Pre-disaster is measured by the documented availability of the Disaster Management Plan and the emergency response aspect through emergency spending.

Research Methods: This study employs fixed-effect estimation using panel data from districts and cities across Indonesia spanning 15 years, from 2008 to 2022.

Empirical Results: The study's results indicate that RPB effectively reduces the death rate from natural disasters, whereas the realization of BT'T shows the opposite result.

Implications: These findings indicate that local governments should improve the quality of their RPBs and regularly prepare them to mitigate disaster risk effectively. Additionally, the government needs to assess and improve the flexibility of the BT'T implementation mechanism, enabling its immediate use during the initial emergency response stage and thereby reducing death rates from natural disasters.

Keywords:

emergency spending; disaster management plan; death rate; natural disaster; local government policy

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INTRODUCTION

Natural disasters represent a critical challenge, leading to substantial casualties, affecting a significant portion of the population, and generating significant social, economic, and long-term development losses. Meanwhile, Indonesia is the country with the second-highest disaster risk based on the report (Institute for International Law of Peace and Armed Conflict (IFHV), 2023). These disaster risks encompass the occurrence of extreme natural disasters and the negative impacts of climate change. Due to Indonesia's location and topography, earthquakes, tsunamis, and volcanic eruptions are inevitable.

Casualties, especially those who died, are the most detrimental impact of natural disasters because the loss of life not only has a direct effect on the victims' families but also shakes the social and economic stability of the community. The death of a relative can cause deep grief and temporary cognitive disorganization, which can potentially damage family structure and reduce labor productivity (Bonanno et al., 2010). Elevated mortality rates often reflect inadequate disaster mitigation, underscoring the need for enhanced planning and response to reduce risks and equip communities to withstand disasters. Preparedness and mitigation measures, along with effective evacuation, can reduce deaths due to natural disasters (Paul, 2011). Accordingly, disaster deaths are widely regarded as a key indicator to assess the efficacy of disaster risk management strategies in mitigating the impact of natural disasters (Green et al., 2019).

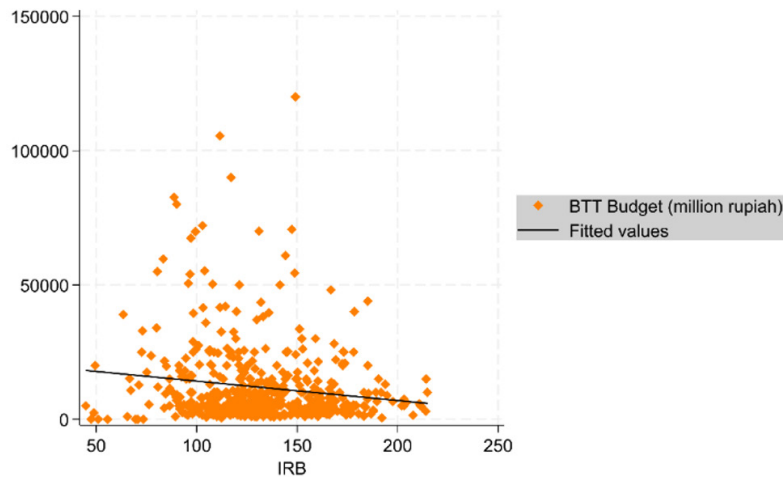
The effectiveness of disaster management plays a critical role in addressing the elevated risk of natural disasters. In the Indonesian context, disaster risk can be mitigated by reducing vulnerability levels and enhancing people's ability to cope with potential hazards. For instance, we can implement this by improving infrastructure and early warning systems, offering disaster education, and promoting active community involvement in disaster planning and mitigation. Although natural hazards such as earthquakes or volcanic eruptions cannot be entirely avoided, their impacts can be mitigated by reducing vulnerability and increasing capacity.

Pre-disaster activities within the disaster management implementation framework include risk reduction through vulnerability reduction and capacity building. In accordance with Law No. 24/2007, the Government of Indonesia mandates that the pre-disaster stage of disaster management begins with the preparation of a disaster management plan (RPB). The matters listed in the RPB include threat assessment, understanding community vulnerability, disaster impact analysis, selection of risk reduction actions, determination of preparedness mechanisms, and allocation of tasks, authority, and resources. Subsequently, central and local governments incorporate elements of the RPB into their development planning. However, despite the mandate established under Law 24/2007, only 247 districts, or around 48% of Indonesia's 514 districts, had RPB documents as of 2023.

District governments contribute to preparing RPB and play a crucial role during the emergency response stage following natural disasters. In emergency response, district governments coordinate among parties to assess needs, organize communication, allocate resources, and coordinate activities during response/evacuation in disasters. District

governments hold jurisdiction over the allocation of disaster management budgets within their respective regions. As the coordinator of regional disaster management, the Regional Disaster Management Agency allocates a portion of its budget to routine expenditures, which remain substantially lower than the local government's total budget (Oktari et al., 2017). Notably, up to 50% of local governments in Indonesia allocate disaster mitigation budgets that fall short of the actual needs, highlighting this condition (Dartanto et al., 2017).

Figure 1. Relationship between the BTT budget and the IRB at the district government in 2023



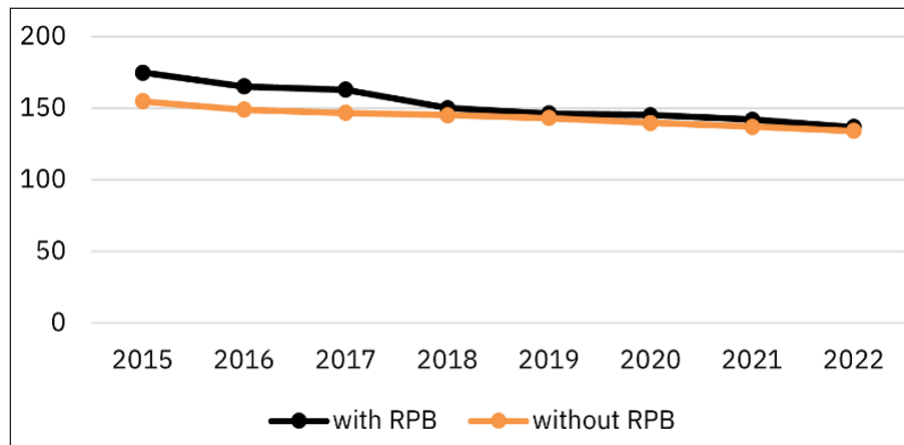
Source: BNPB and Ministry of Finance (processed by authors)

In the emergency response stage, district governments allocate emergency spending (BTT) within the Regional Revenue and Expenditure Budget (APBD). According to the Ministry of Internal Affairs Regulation (Permendagri 77/ 2020), BTT is designated to finance urgent disaster response activities, including search and rescue of disaster victims, emergency response assistance, evacuation of disaster victims, clean water and sanitation needs, food, clothing, health services, shelters, and temporary houses. Dartanto et al. (2017a) observed that as disaster risk intensifies, budget allocations for disaster mitigation tend to decline, reflecting perceived uncertainty and the limited effectiveness of such investments in reducing damage and losses. Under these conditions, ideally, areas with a high disaster risk index (IRB) should focus on the emergency response stage by increasing BTT allocations to reduce disaster impact. However, empirical findings from 2023 reveal a negative relationship between the BTT budgets and IRB (Figure 1). This data shows that the district government has not allocated BTT in accordance with the regional IRB's provisions. The BTT budget continues to decline as the regional IRB grows.

Furthermore, when examining compliance with disaster management governance during the pre-disaster stage, an additional noteworthy finding emerges. Figure 2 revealed that regions with RPB documents, on average, scored higher on IRB than those without. These findings suggest that areas with a high IRB exhibit greater awareness of the risks in their areas and commitment to managing disaster risk through systematic planning. Figure 3 indicates that areas with RPB have comparatively lower budgets than those without

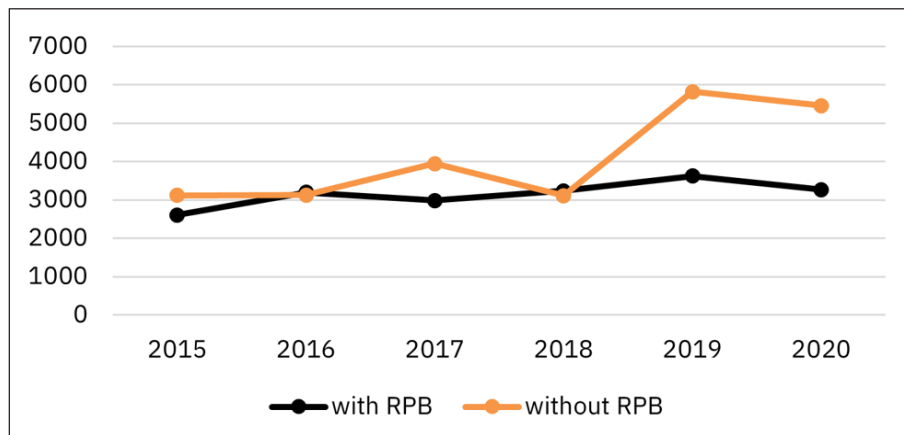
RPB. This may reflect more mature, structured planning in regions with RPB, enabling them to optimize budgets and reduce BTT funding during emergencies. Furthermore, Figure 4 reveals that areas with RPB achieve slightly higher BTT than those without RPB. This condition aligns with the potential for enhanced disaster management, given that the area has an IRB score higher than those without RPB.

Figure 2. IRB districts with and without RPB in 2015-2022



Source: BNPB (processed by authors)

Figure 3. BTT budget (million rupiah) districts with and without RPB in 2015-2020



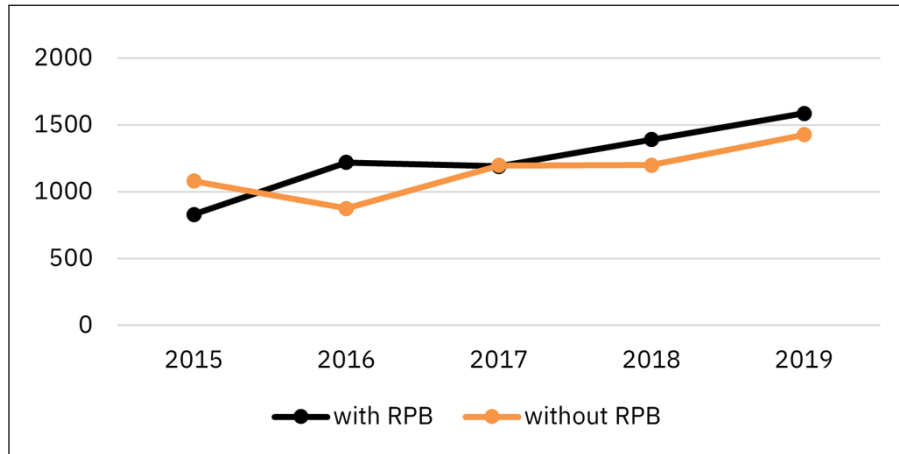
Note: This graph does not include 2021-2022, as management of the COVID-19 pandemic led to a significant spike in the BTT budget in that period.

Source: BNPB and Ministry of Finance (processed by authors)

Given the disaster management conditions in Indonesia as explained above, how effective is the response system in reducing losses from natural disasters? Theoretically, local governments are better positioned than the central government to deliver public goods and services aligned with their communities' preferences and needs, given their more immediate and comprehensive access to regional information. As Oates (1993) contends, this allows them to provide more effective public services. Governments at the regional level are also more responsive to the needs of

the majority of local communities (Bardhan, 2002). It is anticipated that adjusting local government expenditure policies through regional budget instruments will harmonize the availability and allocation of resources.

Figure 4. Realization of BTT (million rupiah) districts with and without RPB in 2015-2019



Note: The graph does not display the years 2020–2022, as management of the COVID-19 pandemic during those years led to a notable increase in the realization of BTT.

Source: BNPB and Ministry of Finance (processed by authors)

Governments encounter a persistent dilemma in allocating resources for disaster management. In disaster relief, budgeting for disaster management programs is challenging, marked by uncertainty and potential dilemmas. The timing and scale of financial allocations remain indeterminate because they depend on the unpredictable occurrence of disasters (Goodisman, 1983). The government needs to allocate several budgets for disaster management to protect the community's safety from the impacts of natural disasters. On the other hand, the government also needs to encourage development that supports productivity.

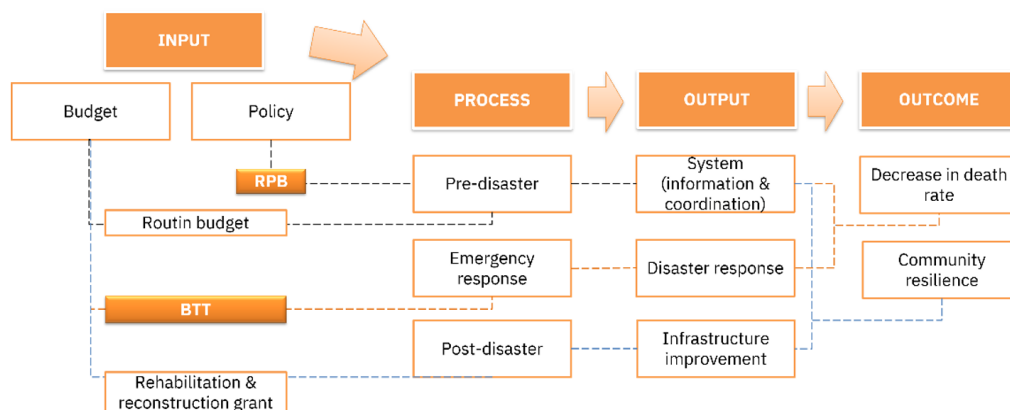
The Arrow-Lind paradigm posits that the government maintains a neutral stance towards risk, diversifying risks across various programs to mitigate the negative impact of natural disasters. Even so, Hochrainer & Pflug (2009) resist this paradigm in disaster-prone countries, where risk dissemination and collection become difficult. In these countries, the costs and negative consequences of natural disasters can outweigh the benefits of taking risks. In such a situation, avoiding risks by allocating an adequate budget for disaster management may be more appropriate than taking risks or remaining neutral, with negative consequences if the event occurs. However, this condition will impose an opportunity cost on other sectors. The budget allocated to disaster management may be diverted from other important sectors, such as education, infrastructure development, and poverty alleviation.

The next question pertains to the effectiveness of the allocated disaster management budget in achieving its intended outcomes. As previously mentioned, disaster deaths serve as the primary indicator of the effectiveness of disaster risk management strategies in mitigating the impact of natural disasters. In this scenario, the intended consequences of negative natural disasters, like death, are irreversible and irreparable. Disaster deaths serve

as the primary outcome indicator, reflecting the effectiveness of the disaster in mitigating its impact (Green et al., 2019). Mortality figures are widely used in the literature due to their comprehensive and reliable collection (Anbarci et al., 2005; Escaleras & Register, 2012; Kahn et al., 2005; Yamamura, 2012; Raschky & Schwindt, 2016). The extent to which fiscal allocations have successfully reduced disaster-related deaths through integrated mitigation, preparedness, and emergency response efforts demonstrates the effectiveness of the budget and governance in this case.

The existing literature on the implementation and efficacy of disaster management strategies, including their budget allocation, remains underdeveloped, particularly in quantitative analysis. Previous research primarily focused on qualitatively discussing the government's efforts to enhance the effectiveness of disaster management and the challenges it faces (Butt, 2014; James, 2008), while empirical literature is mainly comprised of cross-country studies (Skidmore & Toya, 2013). Complementing prior research, this study presents a country-specific analysis of Indonesia to quantitatively assess the effectiveness of local government measures in reducing deaths from natural disasters, focusing on the pre-disaster and emergency response stages. Furthermore, this study assesses the context of local expenditures on natural disasters and governance, focusing on the adoption of regulatory and disaster management measures. To our knowledge, no study has examined local governance and spending policies related to local disaster management.

Figure 5. Framework of RPB and BTT from Input, Process, Output, and Outcome Channels



Source: Authors

Appropriate policies and adequate budget allocations enable governments to reduce negative impacts and enhance the resilience of communities and ecosystems (Limariana et al., 2024; Wurarah & Mulyanto, 2024). Using the number of deaths as an outcome, this study focuses on implementing disaster management in the pre-disaster stage and during emergency response (Figure 5). During emergency response, local governments, per *Permendagri* 77/2020, provide BTT to address emergencies, including natural, non-natural, and social ones; search-and-rescue operations; and damage to facilities that disrupt public services. Local governments use these funds for evacuation, victim rescue, clean water, sanitation, food, clothing, health services, and shelters. The use of BTT is valid from

the time the emergency response is established until the end of the phase. Flexible access to emergency spending is essential to support rescue operations and facilitate the rapid evacuation of trapped or injured victims (Wang et al., 2018). Several Regional Apparatus Organizations (OPD), including the Environment and Forestry Service, the Public Works and Spatial Planning Office, and the Health Service, receive funding for pre-disaster activities. Various OPDs distribute a relatively small budget for pre-disaster activities. The BPBD, acting as the region's disaster management coordinator, allocates a relatively small portion to pre-disaster activities, primarily focusing on routine spending and maintenance (Dartanto et al., 2017; Oktari et al., 2017). This study uses the availability of RPB documents to provide an overview of pre-disaster activities carried out by local governments, while accounting for the complexity of pre-disaster budget allocation. Every five years, the BPBD coordinates the preparation of the RPB document, which involves other related OPDs. The RPB document includes disaster management mechanisms, resource allocation, and disaster risk reduction action plans. Establishing a coordination structure and system and preparing comprehensive policies and action plans in the RPB document illustrate the government's commitment and preparedness (Dariagan et al., 2021).

This study poses two questions. The first question concerns the effectiveness of BTT in reducing the death rate from natural disasters. A higher level of BTT indicates that the local government is better prepared and more committed to emergency response, thereby reducing the death rate from natural disasters. The second question examines the effectiveness of local governments with RPB documents in reducing death rates from natural disasters. Local governments prioritize delivering public services to enhance community welfare. Their performance is assessed through a multidimensional approach using Minimum Service Standards (SPM). Within this framework, RPB is classified as a basic service in the SPM. These services ensure that the quality and type of services are in accordance with the set standards, impacting direct service implementation. These RPBs are a form of decentralized policy, and existing cross-country studies show that local government policies on natural disasters are associated with improvements in casualty management (Sjöstedt & Povitkina, 2017; Skidmore & Toya, 2013). Thus, we expect local governments with RPBs to demonstrate a more substantial commitment to disaster preparedness and enhance regional capacity to lower the death rate from natural disasters.

This study focuses on the analysis from 2008 to 2022. We selected the sample year from 2008, considering the issuance of PP 21/2008, which mandates local governments to prepare RPBs. These RPBs are integrated into the broader development planning process, drawing upon the results of disaster risk analysis and activities outlined in the disaster management activity program. This study employs a fixed-effects estimation method to assess the correlation between RPB and BTT implementation and natural disaster mortality rates. The study is structured into four sections. The introduction explains the context, objectives, and scientific contributions. The second part discusses the methodology for calculating the correlation between BTT and RPB regarding natural disaster mortality rates. The third part presents the findings and discussion of the estimation. The final section offers concluding remarks and policy recommendations.

METHODS

This study analyzes secondary data, covering districts and municipalities in Indonesia from 2008 to 2022. The data were obtained from various sources, including the BNPB, Ministry of Finance, and Central Bureau of Statistics (BPS). The selected data sources were chosen for their comprehensiveness and relative consistency of the data they provide each year. Table 1 presents more detailed information on the operational variables used in the study.

This study employs a fixed effect method, presuming a correlation between the independent variables and unobserved heterogeneity. This method considers that each local government may have unique characteristics that affect the relationship between the realization of unexpected spending and disaster risk reduction. This approach can manage the effects of constant variables across regions and time developments, resulting in a more precise estimate of the correlation between disaster spending and the death rate from natural disasters. This reduces any potential endogeneity issue.

This study examines the effectiveness of regional disaster management spending and governance in reducing deaths and losses from natural disasters by estimating the following model:

$$DR_{it} = \beta_0 + \beta_1 BTT_{it} + \beta_2 RPB_{it} + \beta_3 GRDPC_{it} + \beta_4 HDI_{it} + \beta_5 POPDENS_{it} + \beta_6 VULNPOP_{it} + \sum_{j=1}^n \gamma_j DISFREQ_{j,it} + \theta_i + \varepsilon_{it} \quad (1)$$

The description of each variable in equation (1) is explained in Table 1. As a result of disaster management, DR represents the total number of deaths due to natural disasters in a district, divided by the district's population, within a year of the disaster. Following the guidelines of (Escaleras & Register, 2012), several adjustments were made to the calculation of DR. Firstly, the ratio is interpreted per 100,000 population because of its small size. Second, the model transformed this variable using a logarithm due to the significant variation in deaths. Finally, to account for disasters with zero fatalities, one death was added to each observation. Accordingly, DR is the result of $\ln((1 + \text{number of deaths})/(\text{population}/100,000))$.

The first independent variable is BTT, which represents each district government's actual emergency spending. BTT is allocated for spending during emergencies, including natural disasters, non-natural disasters, social issues, search and rescue operations, and damage to facilities or infrastructure that disrupt public services. Although its application extends beyond natural disasters, BTT remains unavailable to the public. Consequently, this study uses the overall BTT realization as a variable, which constitutes a limitation. The next independent variable is RPB, a dummy variable. A value of 1 indicates that the district has an RPB document, while 0 suggests otherwise. The local government prepares the RPB for five years and should periodically update it. However, if the local government has updated the RPB, the previous version will be used as a reference when preparing the development plan.

To account for regional characteristics and socio-economic heterogeneity, this study incorporates control variables such as the real Gross Regional Domestic Product per capita (GRDPC), the Human Development Index (HDI), population density (POPDENS),

and vulnerable population groups, including toddlers and the elderly (VULNPOP). It is hypothesized that GRDPC and HDI variables negatively impact mortality rates. Regions with high GRDP contribute to reducing the impact of natural disasters (Escaleras & Register, 2012). Higher-income areas are more likely to provide high-quality infrastructure and emergency services to protect communities from disaster deaths (Kahn et al., 2005).

Table 1. Description of Variables and Sources of Data Used in The Study

Variable name	Brief description	Source of data
Death Rate (DR)	The death toll from natural disasters is calculated by: $\ln((1+\text{number of deaths})/(\text{population}/100,000))$	BNPB & BPS
Emergency spending (BTT)	Realization of BTT (rupiah)	Ministry of Finance
Disaster Management Plan (RPB)	Dummy variable: Valued at 1, if there is an RPB document; 0 if otherwise.	BNPB
Income per capita (GRDPC)	Real gross regional domestic product per capita	BPS
Human Development Index (HDI)	Human development achievements are based on several basic components of quality of life.	BPS
Population Density (POPDENS)	The total population divided by the area (populations/km ²)	BPS
Vulnerable group population (VULNPOP)	The percentage of the population is under 5 years old and over 64 years old (%)	BPS
Frequency of floods and landslides (DF1)	Number of flood and landslide disaster events (times)	BNPB
Frequency of earthquake disasters (DF2)	Number of earthquake disaster events (times)	BNPB
Frequency of tsunami disasters (DF3)	Number of tsunami disaster events (times)	BNPB
Frequency of other disasters (eruptions, extreme weather, forest and land fires, droughts) (DF4)	Number of eruptions, extreme weather, forest and land fires, drought disaster events (times)	BNPB

Meanwhile, regions with high HDI scores tend to exhibit elevated literacy and education levels. These conditions enable residents to make informed decisions about safe construction practices, residence locations, and disaster protection strategies, reducing disaster-related deaths (Toya & Skidmore, 2007). Meanwhile, other variables, such as population density (POPDENS) and vulnerable population groups (VULNPOP), are believed to influence mortality rates positively. The more people in a densely populated area, the more deaths will occur in the event of a natural disaster (Padli et al., 2018). Vulnerable groups, such as toddlers and the elderly, exhibit reduced mobility and a limited capacity for self-evacuation when a disaster occurs. Furthermore, a weak immune system will be more susceptible to increased health risks during a natural disaster, which can increase mortality.

Meanwhile, disaster frequency (DISFREQ) refers to the number of natural disasters separated for each type. Each type of disaster can have a distinct impact on mortality rates. This study is divided into four disaster groups: floods and landslides, earthquakes, tsunamis, and other disasters (volcanic eruptions, extreme weather, forest fires, and

droughts). Furthermore, θ_i denotes a fixed effect vector, ε indicates the error term, i represents the district, and t is the year.

In equation (1), if $\beta_1 < 0$ with a significant value, it will confirm that the emergency spending can effectively reduce the death rate as an outcome of disaster management. Meanwhile, if $\beta_1 > 0$ with a significant value, the opposite Interpretation arises, namely that the allocation of unexpected spending has not been managed effectively in reducing the number of deaths. The local government's reliance on central government bailout funds may reduce the effectiveness of unexpected expenditure allocation in implementing disaster management in the region. Furthermore, if $\beta_2 < 0$ with a significant value, it indicates that local governments with RPB documents can be more effective at reducing disaster-related death rates than those without RPB documents. Conversely, if $\beta_2 > 0$, given their significant value, local governments with RPB documents are not yet as effective in implementing disaster management as those without RPB documents.

RESULTS AND DISCUSSION

The unit of observation in this study consists of annual data from each of the 443 districts from 2008 to 2022. The analysis was restricted to districts with complete data for all variables throughout the research period. Descriptive statistics and details of the variable employed in the analysis are presented in Table 2. The death rate ranged from 0.026 to 647.115, reflecting significant variation in mortality rates across regions. BTT also showed considerable variability, ranging from 0 to 394,034 million rupiah. This shows that some regions do not recognize BTT and instead rely on allocating emergency funds, grants, or assistance from the provincial and/or central governments for natural disaster response. Furthermore, the availability of RPB varied across regions, with an average score of 0.154, indicating limited adoption of formal disaster planning documents in many districts.

Table 3 presents the results of the fixed-effect estimation, both with and without control variables, to assess the consistency of the main independent variable coefficients, namely the BTT and RPB realizations. In the table, without adding control variables (column 1) and with them added (columns 2 and 3), the RPB coefficient remains negative and statistically significant. In contrast, the BTT coefficient is statistically significant and positive.

Table 3 reveals a negative correlation between the presence of the RPB and the death rate due to natural disasters. Controlling for all other variables, regions with RPB have an average mortality rate from natural disasters that is 6.1 percentage points lower than those without RPB. This finding aligns with Tay et al. (2022), who emphasize that the preparedness phase determines the operations to be carried out before a disaster strikes to support emergency response efforts effectively. Preparedness-related elements are outlined in the RPB. In this context, risk awareness is crucial for implementing operational plans and strategies, helping governments and communities prepare more effectively for disasters.

Table 2. Descriptive statistics

Variable	Obs.	Average	St. Dev.	Min.	Max.
DR (per 100,000 persons)	6645	1.176	13.528	0.026	647.115
BTT (million rupiah)	6645	5019.909	17667.319	0	394034
RPB (million rupiah)	6645	0.154	0.361	0	1
GRDPC (million rupiah)	6645	31.776	43.183	0.713	1045.988
HDI	6645	68.636	5.988	35.45	87.69
POPDENS	6645	1002.432	2175.478	0.41	15643
VULNPOP (%)	6645	14.574	1.951	2.096	21.372
DF_flood	6645	1.931	3.243	0	72
DF_landslide	6645	1.35	6.791	0	361
DF_earthquake	6645	0.07	0.311	0	7
DF_tsunami	6645	0.003	0.056	0	2
DF_eruptions	6645	0.022	0.4	0	24
DF_extremeweather	6645	1.765	6.352	0	327
DF_forestlandfire	6645	0.493	2.403	0	51
DF_drought	6645	0.177	0.648	0	28

Notes: In the estimation, disasters are divided into four groups, namely floods and landslides, earthquakes, tsunamis, and other disasters (volcanic eruptions, extreme weather, forest fires, and drought).

Source: BPS, BNPB, Ministry of Finance (processed by authors)

The importance of preparedness is further underscored by evidence that elevated exposure levels, when not accompanied by adequate readiness, significantly increase the risk and impact of disasters. Accordingly, emergency planning and preparedness remain critical—particularly in developing contingency plans, conducting emergency response simulations, and fostering cross-sector coordination among governments, communities, and security institutions (Geddam & Raj Kiran, 2024). Given prevailing conditions in the field, where the majority of districts remain without a formal RPB, there is a significant preparedness gap that urgently needs to be addressed. This observation is corroborated by a study conducted in Kuwait by (Al-Husain, 2023) , identifying key areas for improvement in organizational preparedness and resilience against disasters and crises. The study further highlights the need for continuous training programs, infrastructure investment, and supply chain sustainability to build a robust and sustainable disaster management system.

Conversely, Table 3 indicates that the realization of BTT did not correspond with a reduction in the death rate from natural disasters. The analysis reveals that a one percentage point increase in BTT realization is associated with a 0.9 percentage point increase in the mortality rate, holding all other variables constant. These findings highlight that pre-disaster management, as outlined in RPB, has demonstrated greater efficacy in reducing disaster-related mortality than reactive expenditures like BTT. The observed positive correlation with BTT suggests that this type of spending has not functioned as an effective instrument for reducing casualties from natural disasters.

Table 3. Estimation results with the fixed effect method

	(1)	(2)	(3)
BTT	0.005** (0.003)	0.005* (0.003)	0.009*** (0.003)
RPB	-0.105*** (0.029)	-0.131*** (0.03)	-0.061* (0.034)
GRDPC			0.046* (0.026)
HDI			-0.03*** (0.004)
POPDENS			-0.188*** (0.046)
VULNPOP			0.009 (0.009)
DF1		0.003 (0.004)	0.004 (0.004)
DF2		0.283*** (0.049)	0.297*** (0.049)
DF3		1.476*** (0.39)	1.427*** (0.399)
DF4		-0.007 (0.014)	-0.008 (0.014)
Constant	-0.898*** (0.015)	-0.924*** (0.018)	1.836*** (0.375)
N	6.645	6.645	6.645
R2	0,003	0,040	0,061

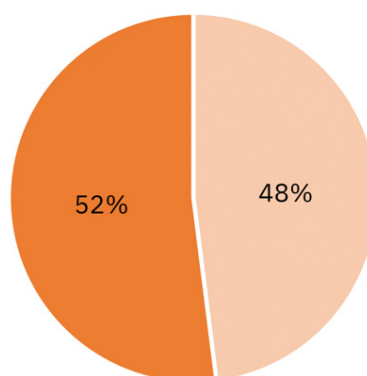
Note: * p < .10, ** p < .05, *** p < .01

Disaster risk reduction and mitigation are vital for public welfare and sustainable development. Although emergency expenditures during disasters are often necessary, relying solely on reactive spending without proper investment assessment may compromise long-term economic resilience. Thus, governments must adopt a more integrated and forward-looking approach—allocating funds for immediate response and pre-disaster mitigation, considering both direct and indirect losses through a holistic framework. This holistic investment approach improves the cost-effectiveness of disaster response and enhances community resilience by reducing exposure and vulnerability before disasters occur. Strategic funding in early warning systems, emergency preparedness programs, and health infrastructure has demonstrated efficacy in reducing mortality and economic disruption. In particular, pre-disaster investment can significantly reduce the strain on public finances during emergencies and ensure faster recovery and the continuity of essential services. Reinforcing these systems is especially critical in regions with high disaster exposure and limited institutional capacity. Persistently high mortality rates remain a substantial impediment to development, underscoring the urgency of improving early warning mechanisms, emergency preparedness, and healthcare systems as part of a long-term disaster risk governance strategy (Kyne & Kyei, 2024).

Among the control variables, HDI and population density showed negative effects. A higher HDI, which reflects better living standards and welfare, is linked to fewer disaster-related deaths. This suggests that people in more developed areas can make safer choices—such as building stronger houses, choosing safer locations, and understanding how to protect themselves—thereby reducing fatalities. Interestingly, areas with higher population density also tend to have lower death rates. This may be because densely populated, urban areas often have better disaster preparedness and response systems (Irajifar et al., 2016). While GDP per capita was expected to reduce mortality, it actually showed a positive, significant relationship. In some cases, rising GDP per capita may be accompanied by greater income inequality, limiting poorer groups' access to health services and increasing their mortality. The proportion of vulnerable populations did not significantly affect death rates. Meanwhile, the frequency of earthquakes and tsunamis had a significant positive impact on mortality. In contrast, the frequency of floods, landslides, and other disasters was not significant, given their relatively low average death tolls.

Although central and local governments engage in multiple dimensions of emergency planning and response, local governments bear the primary responsibility for emergency management. This is because local officials, such as firefighters, police, and emergency medical personnel, are the first to arrive at the scene and initiate emergency response efforts as soon as possible (Henstra, 2010). The effectiveness of local governments in coordinating disaster response efforts depends heavily on the quality of prior planning. In this context, local governments are expected to fulfill a fundamental governance role by creating a disaster management plan, which serves as the foundation for developing regional work plans, particularly those related to disaster management. Only about 48% of districts and cities (247 out of 514) have RPB. The estimates show that RPB availability significantly reduces disaster losses, particularly the death rate.

Figure 6. DSP transfer to districts in 2021 (natural disasters)



Source: BNPB (processed by authors)

The study's results revealed that BTT was ineffective at reducing death rates from natural disasters. The BTT realization mechanism may lack flexibility, making it challenging for local governments to directly intervene in the early stages of natural disaster emergency

response by carrying out evacuations. Allegations have emerged that the inefficacy of local governments' emergency spending is attributable to their continued reliance on central government financial assistance (Miao et al., 2021). The BNPB annually allocates ready-to-use funds (DSP), sourced from the State Budget (APBN) by the central government. The Ministry of Finance retains the authority to augment BNPB's allocation at any time, based on the amount requested, making it "infinite" and always available. These funds are distributed to various areas that require disaster management, particularly in the emergency response stage. Conversely, the DSP data from 2021 indicates that these funds primarily focus on managing the transition from emergency to recovery. This situation suggests that Indonesia's emergency spending, both at the central and regional levels, may still face effectiveness issues, as the share of spending on emergency response operations is not dominant (see Figure 6).

Under current conditions, the utilization of BTT in the initial stages of emergency evacuation remains operationally constrained and has yet to reach optimal effectiveness. Interestingly, the findings suggest a concurrent increase in both mortality rates and BTT realization. This relationship may arise from the frequent deployment of BTT during the recovery phase, particularly in operations involving the retrieval of deceased victims. Consequently, higher BTT realization may reflect improved identification and recovery of victims, thereby reducing the number of individuals classified as missing. If this interpretation is empirically valid, it indicates that BTT's effectiveness is improving, as it enhances the capacity to locate and identify victims during evacuation and recovery. In this sense, the number of victims recovered may serve as an indirect indicator of BTT's operational success in supporting emergency response and post-disaster recovery. Nevertheless, further empirical investigation is required to comprehensively assess BTT's effectiveness in minimizing unaccounted-for casualties and to distinguish its impacts across the phases of rescue and recovery operations.

CONCLUSION

This study found that Regional Disaster Management Plans (RPB) are associated with lower mortality rates from natural disasters. Regions with well-implemented RPBs tend to experience fewer disaster-related deaths. In contrast, the use of local emergency funds (BTT) has not been effective in reducing fatalities. In fact, larger BTT allocations are correlated with higher death rates. This may be due to the limited flexibility of BTT disbursement mechanisms or the reliance on central government assistance, which often delays early emergency responses.

These findings suggest that local governments' policy effectiveness is achieved through regional planning and institutional improvements in disaster management rather than through the size of local emergency spending. Therefore, local governments in Indonesia should enhance the quality of their RPBs and regularly prepare them to mitigate disaster risk effectively. Furthermore, the government should evaluate and enhance the flexibility of the BTT implementation mechanism to ensure its timely deployment during the initial emergency response stage, thereby reducing death rates from natural disasters.

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The Rising Food Prices in Ramadan and Its Impact on Inflation

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ABSTRACT

Research Originality: This study proposes a new contribution by analyzing the seasonal pattern of rising food prices in Ramadan and its impact on inflation over the period 2018–2024. This data range allows for more recent and relevant identification.

Research Objectives: This study aims to describe food prices before, during, and after Ramadan and to analyze their impact on inflation, using data from January 2018 to May 2024.

Research Methods: This research uses descriptive statistical methods to analyze food prices and inflation, and multiple linear regression to examine the impact of food prices on inflation.

Empirical Results: This study found that prices of all food commodities tended to increase before, during, and after Ramadan, especially in Ramadan 2022. Descriptively, inflation also showed an increasing pattern before, during, and after Ramadan in most observation years, except 2020. Multiple linear regression analysis revealed that only chicken prices had a significant effect on inflation, while the other nine foods did not.

Implications: These findings suggest that the government prioritize controlling the prices of strategic commodities like chicken during Ramadan by stabilizing supply and disseminating price information equitably. Furthermore, education on wise consumption and support for food access for poor groups can help mitigate price fluctuations on the demand side.

Keywords:

ramadan; food prices; inflation; seasonal analysis; multiple linear regression

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INTRODUCTION

Inflation is a general and persistent increase in the prices of goods and services over a specific period. As a key indicator in macroeconomics, inflation is a major concern for governments and economic actors because it directly impacts people's purchasing power and price stability. In Indonesia, inflation has become a serious topic of discussion, particularly its potential impact on public welfare. Structural factors driving inflation include excess demand relative to supply, rising prices of imported goods, excess money supply without a corresponding increase in production and supply, and political and economic conflicts. Furthermore, Indonesia's inflation dynamics are influenced by seasonal factors. Two seasonal factors consistently linked to price increases are Ramadan and Eid al-Fitr.

Several studies have shown that religious events, such as Ramadan, can change people's consumption patterns, particularly among Muslims, leading to a surge in demand for food commodities (Eyerici, 2021; Helbawanti et al., 2021). Theologically, Ramadan is understood as a month of self-control through fasting, intended to reduce food consumption (He & Tian, 2023). However, in practice, consumption among Muslims generally increases. Barakat et al. (2020) noted that household food spending can increase by up to 50% during Ramadan.

Research by Zahra et al. (2023) found that demand for food commodities continues to increase in the lead-up to Ramadan. This increase in consumption has led to rising prices for foods such as garlic, chicken, and sugar, which is predicted to have a positive impact on inflation (Bhattacharya & Gupta, 2017; Helbawanti et al., 2021; Samal et al., 2022). The impact is felt most severely by low-income groups, whose expenditures are dominated by food. In this context, price increases can lead to economic pressure on the poor, food insecurity, social instability, and exacerbate economic inequality. This condition contradicts Islamic economic principles, which emphasize justice, sustainability, and concern for the welfare of society (Ni'mah et al., 2023; Mirzaeia et al., 2023).

In addition to consumption, several researchers have analyzed the social and psychological impacts of Ramadan. Rouhani & Azadbakht (2014) and Rahman (2022) note that fasting is beneficial for health. In terms of social interactions and donations, Ramadan positively contributes to social solidarity in Muslim communities, fosters a spirit of cooperation, and influences social cohesion. These factors can develop a model of social solidarity to address disintegration and increase Muslim philanthropy to address poverty (Usman et al., 2020; Shalihin et al., 2020; Martens, 2014; Fahrullah et al., 2020; Shalihin & Sholihin, 2022).

In the context of stock returns, several researchers have studied the issue in depth. They argue that Ramadan provides a positive impact on stock returns. They found that stock returns are significantly higher during Ramadan. Ramadan has a positive impact on investor psychology, as it encourages a sense of solidarity and social identity among Muslims worldwide, leading to optimistic beliefs that impact investment decisions (Wasiuzzaman & Al-Musehel, 2017; Ahmad & Utami, 2019; Chowdhury & Hasan, 2022; Selvia & Yumna, 2022; Adib, 2024).

Most previous studies describe general consumption patterns or price fluctuations during Ramadan, without explicitly distinguishing between time periods or examining causal relationships with inflation. However, a more granular understanding of when and which commodities contribute most to inflation is crucial for policymakers. This study aims to fill this gap and offer a novel contribution by systematically analyzing food price movements and inflation across three time periods: before Ramadan (one month before), during Ramadan, and after Ramadan (one month after), using daily and monthly data from January 2018 to May 2024. This study also examines the effect of the prices of ten strategic food commodities on inflation. Thus, this study not only describes seasonal phenomena descriptively but also provides empirical evidence on the relationship between food prices and inflation during Ramadan. The results will likely inform the government in formulating price-control and consumer-protection strategies during this crucial religious period.

METHODS

This study uses secondary data, namely daily and monthly food price data, and monthly inflation data from January 2018 to May 2024. Food price data was collected from the National Strategic Food Price Information Center (PIHPS) website, and inflation data was collected from Statistics Indonesia (BPS). The commodities studied comprised 10 strategic foods: rice, chicken, beef, chicken eggs, shallots, garlic, red chilies, cayenne pepper, cooking oil, and granulated sugar.

The data analysis was conducted in two stages. First, descriptive statistical analysis was used to visually and numerically map food price movements and inflation across each phase of Ramadan. The goal was to illustrate patterns of price increases or decreases, as well as seasonal changes in inflation. Second, this study aims to analyze the effect of food prices on inflation using multiple linear regression. The method is used to predict the value of the dependent variable if the values of the independent variables are known, and to determine the direction of the relationship between the dependent variable and its independent variables. The multiple linear regression equation model predicted in this study is as follows:

$$\begin{aligned} \text{INFLATION} = & \beta_0 + \beta_1 \text{RICE_PRICE} + \beta_2 \text{CHICKEN_PRICE} + \beta_3 \text{BEEF_PRICE} \\ & + \beta_4 \text{EGGS_PRICE} + \beta_5 \text{SHALLOTS_PRICE} + \beta_6 \text{GARLIC_PRICE} \\ & + \beta_7 \text{REDCHILIES_PRICE} + \beta_8 \text{CAYENNEPEPPER_PRICE} + \beta_9 \\ & \text{COOKINGOIL_PRICE} + \beta_{10} \text{GRANULATEDSUGER_PRICE} + e \end{aligned}$$

Food prices are the independent variable consisting of the price of rice (X1), chicken (X2), beef (X3), chicken eggs (X4), shallots (X5), garlic (X6), red chilies (X7), cayenne pepper (X8), cooking oil (X9), and granulated sugar (X10). Meanwhile, inflation is the dependent variable (Y). The observation period is divided into three seasonal phases each year: before Ramadan (one month before), during Ramadan, and after Ramadan (one month after). The total observations span seven years (2018–2024), resulting in 3 phases × 7 years = 21 time periods as observation units. Using 10 independent variables

(food commodities) and one dependent variable (inflation rate), the total number of observations was 210.

Before conducting a hypothesis test, the first stage is the classical assumption test, which aims to ensure that the regression equation obtained is accurate, unbiased, and consistent. The classical assumption test consists of tests for multicollinearity, normality, heteroscedasticity, and autocorrelation. The data in this study are not time series because they use data before Ramadan (a month before Ramadan), during Ramadan, and after Ramadan (a month after Ramadan), so an autocorrelation test is not required.

First, the normality test is carried out using the Jarque-Bera test, and the decision is based on the p-value. If the p-value is > 0.05 , the data are typically distributed. Second, the multicollinearity test is used to determine whether, in the regression model, there is a perfect or near-perfect linear relationship between some or all independent variables by examining the VIF values. Third, the heteroscedasticity test is used to determine whether the classical assumption is violated. In this study, the heteroscedasticity test uses the Glejser method. The next step is a hypothesis test, which aims to determine the influence and relationship between the independent and dependent variables. The significance of the relationship between variables can be seen from the probability value. The last stage is to determine and predict the extent of the independent variables' contribution to the dependent variable using the determination coefficient (R^2) and the adjusted R-squared.

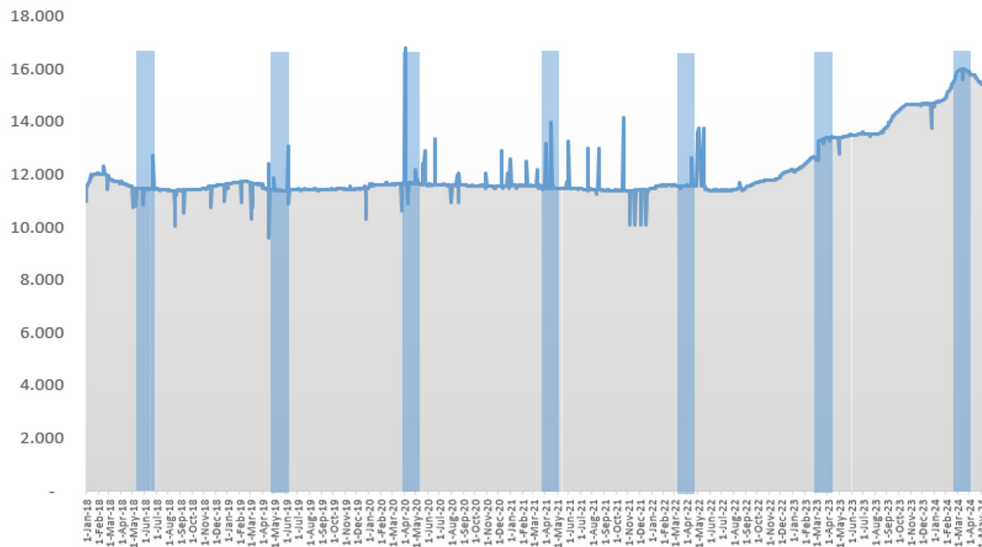
RESULTS AND DISCUSSION

Results

To understand the dynamics of food prices and inflation during Ramadan, a descriptive analysis was conducted on price data for ten major food commodities and monthly inflation data for the past seven years (2018–2024). This analysis aimed to identify seasonal patterns, specifically trends in price increases and inflation before, during, and after Ramadan. The primary focus of this descriptive analysis is to observe: whether food prices and inflation increase before Ramadan; 2) whether food and inflation peak during Ramadan; and 3) how food prices and inflation adjust after Ramadan. The visual data presented in each figure illustrates seasonal trends that can provide an early indication of each commodity's potential contribution to inflation.

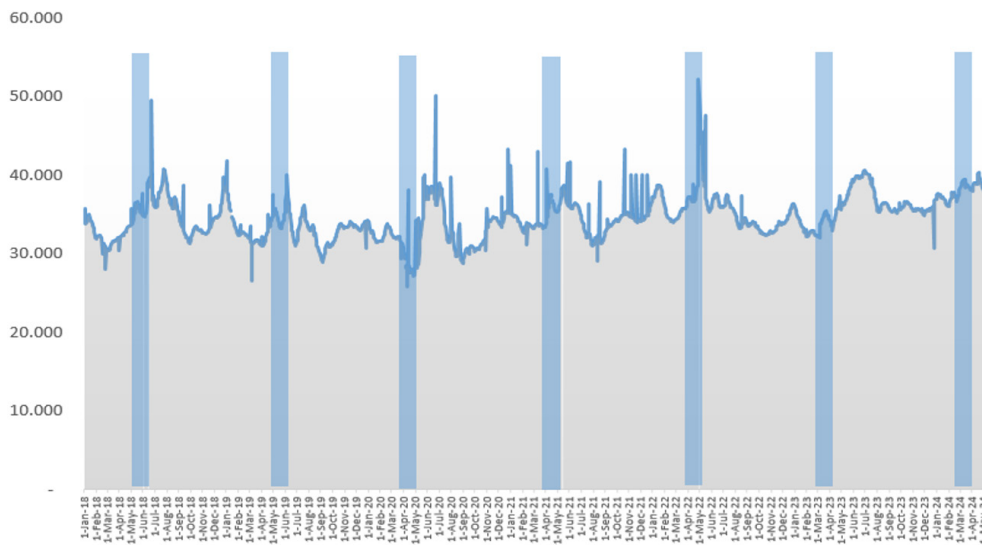
Rice is the main food of the Indonesian population and tends to increase in price ahead of Ramadan, though with much lower fluctuations than commodities such as chili. The price of rice at normal times is around IDR 11,000 per kg; during Ramadan, it generally increases to around IDR 12,000 per kg. The highest increase in rice occurred in Ramadan 2020, reaching IDR 16,800 per kg (PIHPS Nasional, 2020). The increase also occurred in Ramadan 2024, reaching IDR 16,000 per kg (PIHPS Nasional, 2024).

Figure 1. Rice Prices January 2018 - May 2024



Source: National PIHPS (processed data), 2024

Figure 2. Chicken Prices January 2018 - May 2024



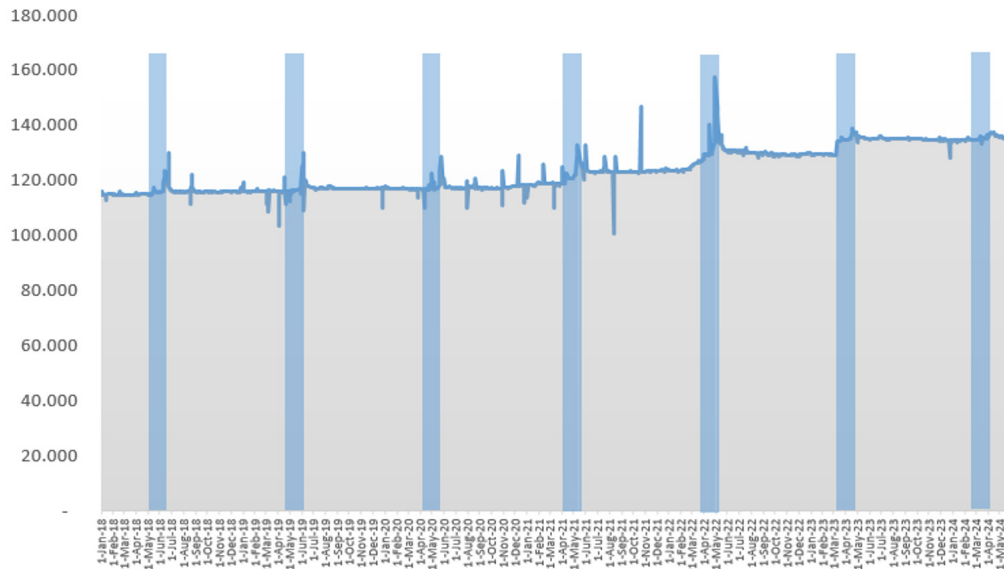
Source: National PIHPS (processed data), 2024

A more precise pattern of sustained price increases is evident in meat commodities. The dynamics of meat prices are correlated with the month of Ramadan in 2018-2024. In Ramadan 2018, the highest chicken price was IDR 49,500 per kg. The price continued to rise to IDR 52,000 per kg in Ramadan 2022. Likewise, for beef, the highest price of beef was IDR 119,700 per kg in Ramadan 2018. In Ramadan 2022, the price jumped to IDR 150,000 per kg (PIHPS Nasional, 2018; PIHPS Nasional, 2022).

The price of chicken eggs tends to fluctuate because they are a daily staple in almost every community. The price of chicken eggs increases every Ramadan, reaching its highest in Ramadan 2022, which is IDR 43,000 per kg (PIHPS Nasional, 2022). However, the

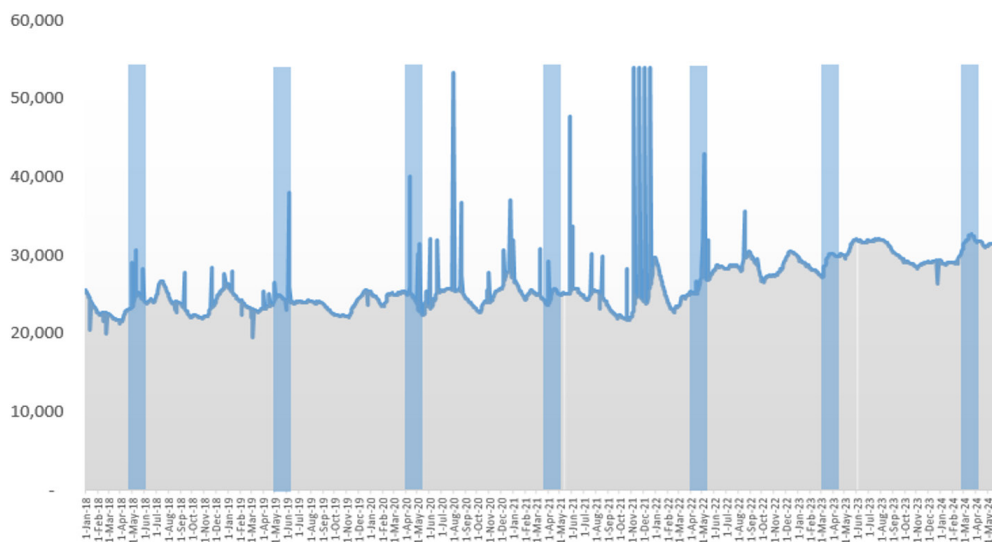
price of chicken eggs previously also experienced a higher increase, reaching IDR 54,000 per kg from November to December 2021 (PIHPS Nasional, 2021).

Figure 3. Beef Prices January 2018 - May 2024



Source: National PIHPS (processed data), 2024

Figure 4. Eggs Prices January 2018 - May 2024

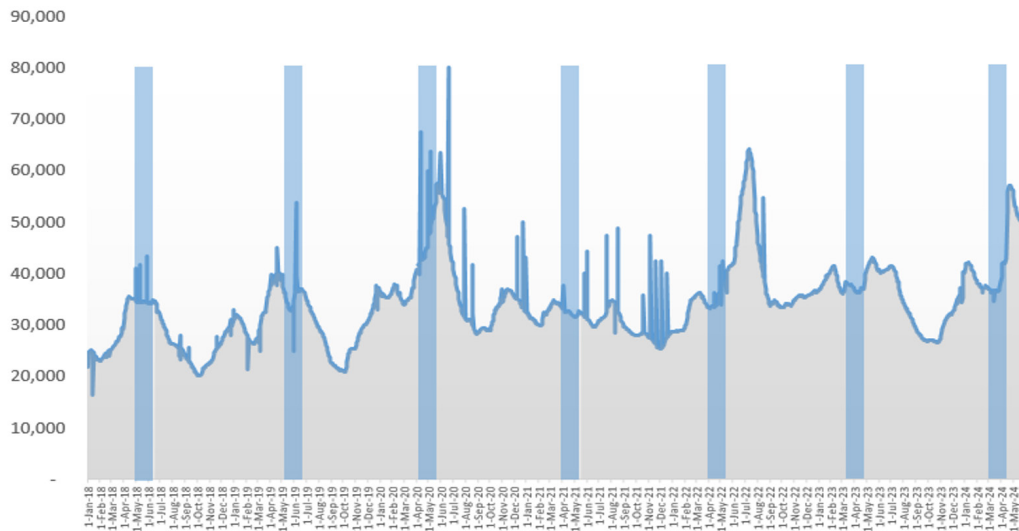


Source: National PIHPS (processed data), 2024

The prices of shallots and garlic are seen to fluctuate significantly both during Ramadan and in other months. Shallots experienced the highest increase during Ramadan 2020, which was IDR 64,000 per kg. Even one month after Ramadan, the price was still high, which was IDR 80,000 per kg (PIHPS Nasional, 2020). The price of garlic experienced the highest increase before, during, and after Ramadan in 2019, namely from IDR 60,000 per kg to IDR 62,600 per kg, and reached the highest price of IDR

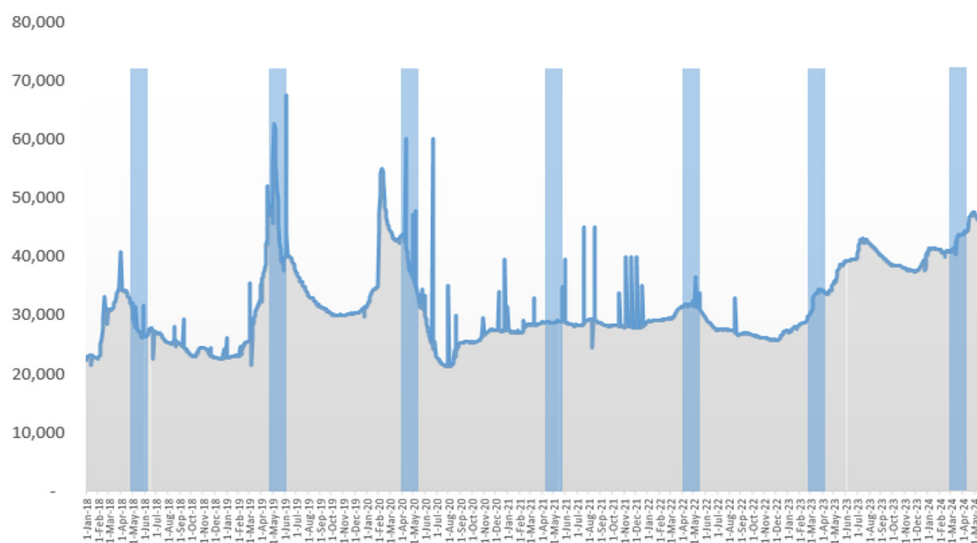
67,500 per kg (PIHPS Nasional, 2019). The following year's Ramadan, the prices of shallots and garlic also increased, but not as much as in 2019 and 2020.

Figure 5. Shallots Prices January 2018 - May 2024



Source: National PIHPS (processed data), 2024

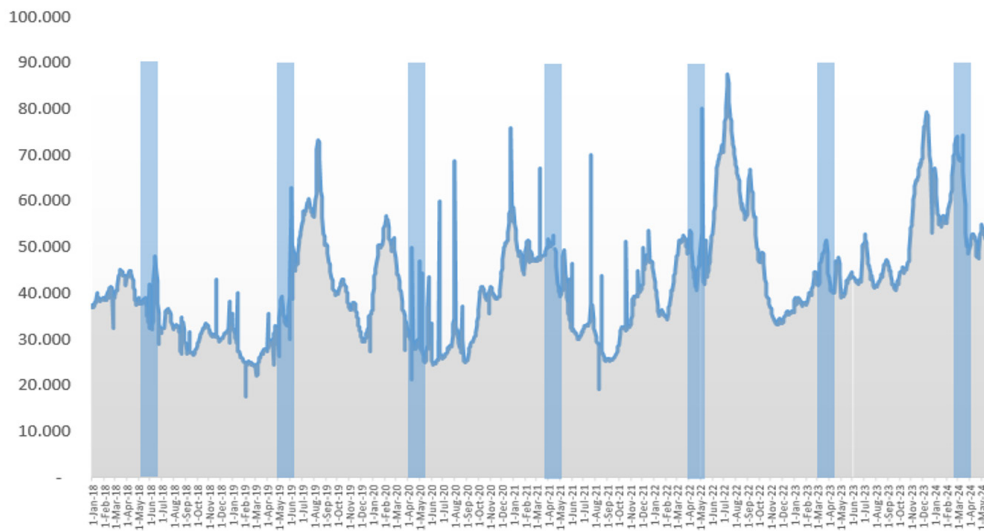
Figure 6. Garlic Prices January 2018 - May 2024



Source: National PIHPS (processed data), 2024

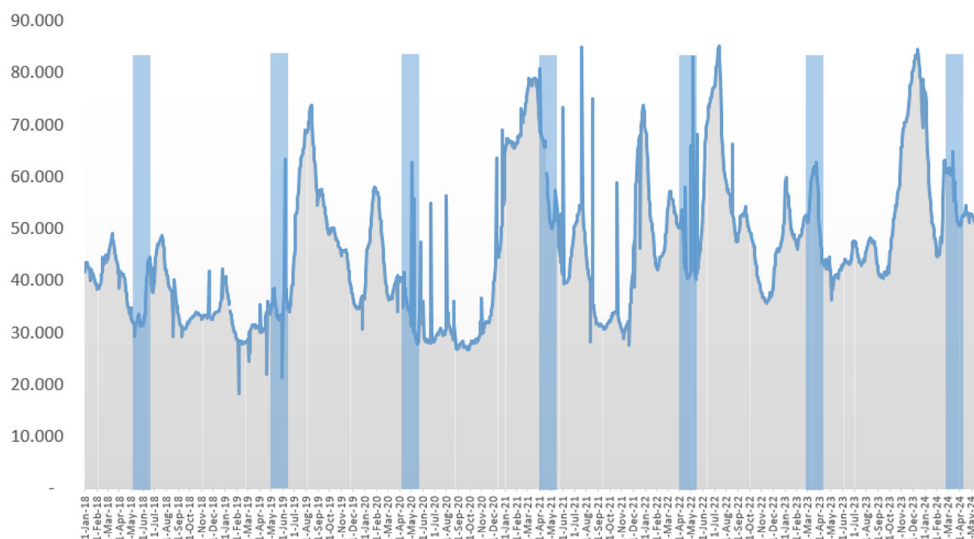
The commodity that seems to fluctuate the most around Ramadan is chili. The price of chili, which usually is around IDR 30,000 per kg, generally jumps to IDR 60,000 per kg during the month of Ramadan. In fact, during Ramadan 2022, chili prices even reached IDR 80,000 per kg (PIHPS Nasional, 2022). However, the cost of chilies also increased outside Ramadan. The prices of red chilies and cayenne peppers reached IDR 87,550 and IDR 85,250 per kg, respectively, in July 2022.

Figure 7. Red Chilies Prices January 2018 - May 2024



Source: National PIHPS (processed data), 2024

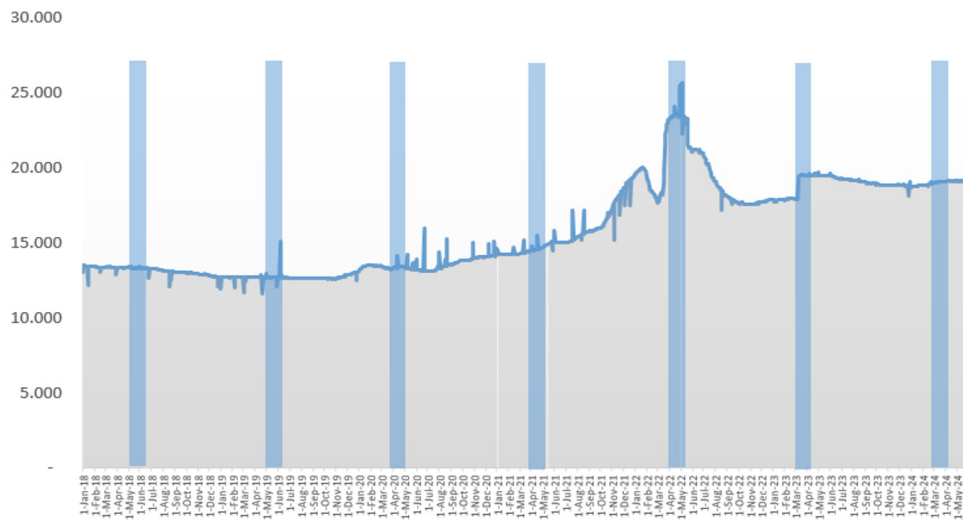
Figure 8. Cayenne Pepper Prices January 2018 - May 2024



Source: National PIHPS (processed data), 2024

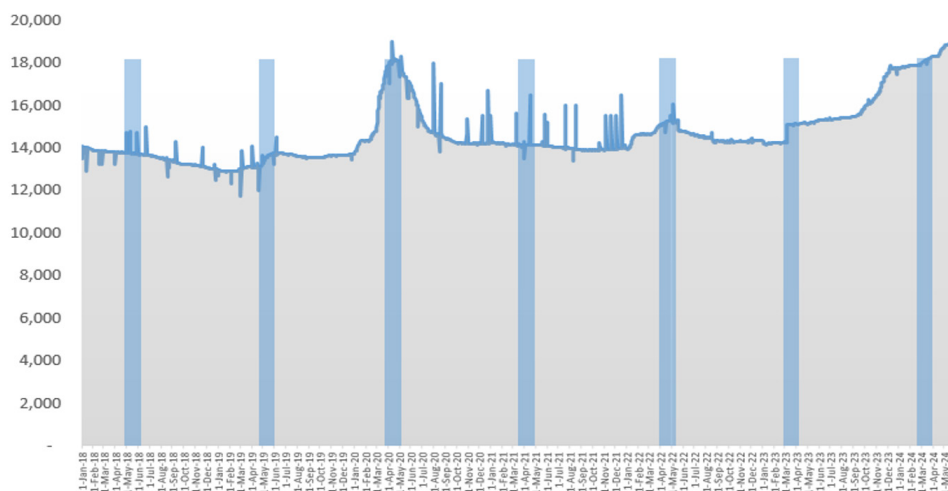
Another pattern of price increases for necessities during the month of Ramadan is cooking oil. The price of cooking oil has increased significantly from around Rp13,000 per liter in Ramadan 2018 to around Rp25,000 per liter in Ramadan 2022 (PIHPS Nasional, 2022). The price of granulated sugar also increased during Ramadan, but by less than other food prices. The highest price of granulated sugar during Ramadan in 2020 was IDR 19,000 per kg (PIHPS Nasional, 2020). Currently, the cost of granulated sugar is still in the range of IDR 18,850 - 18,900 per kg (PIHPS Nasional, 2024).

Figure 9. Cooking Oil Prices January 2018 - May 2024



Source: National PIHPS (processed data), 2024

Figure 10. Granulated Sugar Prices January 2018 - May 2024



Source: National PIHPS (processed data), 2024

Price fluctuations before Eid al-Fitr are a recurring and inevitable phenomenon. This pattern aligns with basic economic theory: when demand rises, prices tend to increase. The surge in consumer demand, limited anticipation of price hikes, and overall economic activity during the festive season all contribute to this trend. Rising food prices, in turn, push up the inflation rate. Historical data show that inflation consistently climbs before and during Ramadan. In 2018, inflation rose by 0.11%, from 0.1% in April to 0.21% in May, and continued to increase by 0.38% after Ramadan (from 0.21% in May to 0.59% in June). In 2019, it grew by 0.24%, from 0.44% in April to 0.68% in May. Similarly, in 2021, inflation rose by 0.05% before Ramadan (from 0.08% in March to 0.13% in April) and by another 0.19% afterward (from 0.13% in April to 0.38% in May). The same trend appeared in 2022, with inflation jumping by 0.87% (from 0.08% in

March to 0.95% in April). In 2023, inflation increased by 0.02% before Ramadan (from 0.16% in February to 0.18% in March) and by 0.15% after (from 0.18% in March to 0.33% in April). In 2024, inflation rose again before Ramadan by 0.15% (from 0.37% in February to 0.52% in March). The only exception occurred in 2020, when inflation remained stable before and after Ramadan.

Based on Table 1, the price of chicken meat has a significant effect on inflation, as the p-value is $0.0323 < 0.05$. This means that if the price of chicken meat increases, inflation will also increase by 0.0079 units, before, during, and after the month of Ramadan. Meanwhile, the prices of other foods — namely rice, beef, chicken eggs, shallots, garlic, red chilies, cayenne pepper, cooking oil, and granulated sugar — before, during, and after Ramadan do not have a significant effect on inflation, as indicated by p-values > 0.05 . The coefficient values in the equations are rounded for ease of reading. The complete coefficient values are shown in Table 1.

Table 1. Multiple Linear Regression Test Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-184.0070	168.3954	-1.092708	0.3001
RICE_PRICE	0.004650	0.009475	0.490727	0.6342
CHICKEN_PRICE	0.007858	0.003162	2.484948	0.0323
BEEF_PRICE	0.000578	0.001604	0.360400	0.7260
EGGS_PRICE	-0.002220	0.003508	-0.632881	0.5410
SHALLOTS_PRICE	-0.0000755	0.001973	-0.038255	0.9702
GARLIC_PRICE	0.0000907	0.001441	0.062973	0.9510
REDCHILIES_PRICE	-0.000521	0.000904	-0.576128	0.5773
CAYENNEPEPPER_PRICE	-0.000729	0.000688	-1.059678	0.3142
COOKINGOIL_PRICE	-0.000762	0.003292	-0.231574	0.8215
GRANULATEDSUGER_PRICE	-0.003977	0.006774	-0.587059	0.5702

Source: Processed Data (2024)

DISCUSSION

This study found that all food commodities experienced price increases before, during, and after Ramadan. Most food prices saw the highest increases in Ramadan 2022, including chicken, beef, chicken eggs, red chilies, cayenne pepper, and cooking oil. Meanwhile, rice experienced the highest price increase in Ramadan 2024, shallots in Ramadan 2020, garlic in Ramadan 2019, and granulated sugar in Ramadan 2020. Chicken and beef experienced quite significant increases during Ramadan, but in the following months, their prices stabilized again. Meanwhile, other commodities experienced increases again in other months. The second finding shows that descriptively, the increase in food prices was followed by an increase in inflation before and during Ramadan in 2018, 2019, 2021, 2022, 2023, and 2024.

Meanwhile, during Ramadan in 2020, inflation did not increase. A descriptive analysis of daily food price data found that all food commodities experienced price increases before, during, and after Ramadan, followed by an increase in inflation. However, the multiple linear regression analysis found that only chicken prices had a significant impact on inflation before, during, and after Ramadan, indicating that when chicken prices rise, inflation also increases. Meanwhile, the prices of other foods — namely, rice, beef, chicken eggs, shallots, garlic, red chilies, cayenne pepper, cooking oil, and granulated sugar — do not have a significant effect on inflation.

The results of this study align with Permatasari et al. (2023), who found that fluctuations in the prices of necessities often occur before, during, and after national religious holidays such as Ramadan and Eid al-Fitr. An international study in Türkiye and Bangladesh by Eyerci (2021) and Hossain et al. (2025) also found that seasonal factors such as Ramadan, demand spikes, panic buying, and hoarding ahead of Eid al-Fitr exert significant short-term inflationary pressures, consistent with the demand-pull theory.

Price increases also occur in global markets. For sugar, the monthly price of raw sugar on the global market increases by approximately 6.06 percent (or \$17.78 per metric ton) annually before Ramadan (Hossain et al., 2018). According to Ni'mah et al. (2023), the increase in the prices of necessities during the month of Ramadan can be attributed to several factors, including high demand driven by increased consumption, price speculation, changes in consumer behavior, and supply disruptions. Hosen (2024), in a study in Bangladesh, found that among Muslims, there was a substantial increase in purchases: 40.6% during Ramadan and 76.3% during Eid al-Fitr.

Rising food prices can raise the inflation rate. The inflation rate in Indonesia is determined by changes in the prices of all commodities grouped into seven subgroups. Of the seven commodity groups, food is the most susceptible to price increases, driven by demand pressures (demand side) or reduced supply (supply side) (Nairobi & Caroline, 2021). In their research, Islam et al. (2025) argue that rising food prices and inflation can significantly exacerbate food insecurity in households, especially in slum areas. Among households that were food secure during periods of low inflation, high food prices left 46% mildly food insecure, 21% moderately food insecure, and 12% severely food insecure. The remaining 21% remained food secure despite high food inflation.

Although the descriptive analysis in this study found that all food commodities experienced price increases before, during, and after Ramadan which was followed by an increase in inflation, based on multiple linear regression analysis, only the price of chicken meat had a significant effect on inflation before, during, and after Ramadan; while the other nine foods did not have a significant effect. This study suggests that inflation during Ramadan may rise due to rising food prices. However, not all food items significantly impact inflation. The results of this study align with those of Helbawanti et al. (2021), who found that chicken prices significantly affected inflation. In contrast, the prices of red chilies, cayenne peppers, and chicken eggs did not. Pratiwi's (2023) results also show that the prices of rice and cooking oil were not causally related to inflation. However,

the results of this study differ from those of Syamil and Azhari (2025), who found that garlic and shallot prices influenced short-term inflation.

Furthermore, rice showed the strongest long-term effect and variance decomposition. This difference in results may be due to differences in observation time. Furthermore, Syamil & Azhari (2025) did not analyze other strategic commodities such as sugar, chicken, eggs, and cooking oil, which also contribute significantly to inflation. Based on a literature study, in addition to consumer demand and behavior, structural factors such as raw material availability, production processes, distribution, government policies, and climate change also influence food price fluctuations (Timmer, 2017; Davis et al., 2021; Irabor et al., 2022; Olufemi-Phillips et al., 2024; Antonio et al., 2025). These factors can exacerbate price volatility, particularly when supply cannot keep up with seasonal demand spikes, such as those during Ramadan. For example, in the case of rice, over the last four years production has continued to decline, from 33.9 million tons in 2018 to 31.4 million tons in 2021. The different patterns of rice price increases during Ramadan over the last two years indicate a more dominant structural problem than a simple spike in demand related to Ramadan. In the last four years, rice production has continued to decline, from 33.9 million tons in 2018 to 31.4 million tons in 2021. In 2022, rice production was reported to have increased to 32.1 million tons, up around 700 thousand tons from the previous year. However, this data needs to be accepted with caution because it runs counter to the price of rice, which has continued to rise since September 2022, forcing the government to import 500,000 tons of rice by the end of 2022. Moreover, in 2023, rice imports reached 3.06 million tons.

For chili and onion commodities, the prices are very fluctuating (volatile food) because chili is a type of food that cannot be stored for a long time, so its stock and availability in the market are greatly influenced by the weather and harvest season. The buffer stock strategy for chili and onion tends to be ineffective because storing them fresh incurs high costs. Meanwhile, processed chili and onion, which have a long shelf life, are less preferred by consumers. Just like chili and onions, chicken eggs also experience quite fluctuating prices because they are a food that almost everyone consumes. After all, it is pretty practical to be used as food. Chicken eggs are also often used as a protein alternative if we cannot afford meat or fish. The demand for chicken eggs will always be high, which will affect the price of this commodity. Therefore, policies to control inflation driven by rising food prices cannot focus solely on consumption but must also address the broader structure of food production and governance. A more comprehensive, long-term approach is needed to maintain food price stability, particularly before and during periods of high seasonal demand, such as Ramadan.

CONCLUSION

This study aims to describe the dynamics of food prices and inflation before, during, and after Ramadan, and to analyze the impact of food prices on inflation. The descriptive analysis shows that almost all food commodities experienced price increases

during all three phases of Ramadan, with the highest spikes occurring during Ramadan 2022, particularly for chicken, beef, eggs, red chilies, cayenne pepper, and cooking oil. Inflation also tended to increase before and after Ramadan, except in 2020. Although the descriptive analysis indicates that the majority of food prices increased before, during, and after Ramadan, followed by increases in inflation, the multiple linear regression analysis shows that, among the ten food commodities tested, only chicken prices consistently had a significant effect on inflation across all phases of Ramadan.

This finding indicates that rising chicken prices play a significant role in driving inflation during Ramadan. Based on the results of this study, it is recommended that the government strengthen its price control strategy, particularly for inflation-sensitive food commodities such as chicken. Stabilization efforts can be implemented through increasing price information transparency, strengthening strategic food reserves, and controlling import volumes in a targeted manner. On the other hand, the public can also contribute by ensuring equitable consumption and maintaining social solidarity, so that food demand during Ramadan is not concentrated among certain groups and does not put excessive inflationary pressure on the economy.

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Frugal Living is A New Alternative Gen Z Lifestyle

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ABSTRACT

Research Originality: This research novelty concerns the location of Surakarta City and the relationship between lifestyle and the love of money in relation to frugal living.

Research Objectives: This study examines the frugal living practices of Generation Z in Surakarta City.

Research Methods: This study used quantitative methods, including PLS-SEM, for analysis. The variables in this study include frugal living, lifestyle, love of money, and financial management.

Empirical Results: The findings show that lifestyle and love of money significantly influence frugal living among Generation Z in Surakarta City. At the same time, financial management does not have a significant impact on frugal living among Generation Z in Surakarta City.

Implications: These results highlight the importance of financial literacy improvement policies that promote environmentally friendly consumption patterns and raise awareness among Generation Z about using local products.

Keywords:

financial management; frugal living; Generation Z; love of money

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INTRODUCTION

The presence of technological developments provides easy access to information, which impacts people's consumption behavior (Paramita & Cahyadi, 2024). Technological developments make it easy to access various forms of information, one of which is the current trend of financial technology and e-commerce, which has a negative effect on consumerism and impulsive behavior (Fikri & Junaidi, 2024; Maula et al., 2025). In addition, the development of trends and the fear of young people missing out on current trends (FOMO/Fear of Missing Out) leads to excessive consumption, also known as hedonism (Wiyanto et al., 2022; Andrini et al., 2024). In the long run, this kind of behavior will be financially detrimental and foster an individualistic personality (Bayer, 2024; Nurhasanah & Kesuma, 2023).

Impulsive buying behavior and hedonism driven by easy access to technological developments are most commonly experienced by Generation Z today (Syandana & Dhanian, 2024). As a digital-native generation with an advantage in leveraging current technological developments, social media is a benchmark for lifestyle (Philp & Nepomuceno, 2020). In addition to FOMO, the YOLO principle (You Only Live Once) is owned by Generation Z, which influences a high-lifestyle mindset because it believes life is only once, so it must be enjoyed by finding happiness in life today (Mutmainnah et al., 2025). The principle triggers Generation Z to adopt a consumptive attitude as a means of seeking recognition in the social environment and self-satisfaction, thus making Generation Z's consumption irrational (Salsabila & Metekohy, 2024; Nurhasanah & Kesuma, 2023). According to the Central Bureau of Statistics (BPS), the total population of Generation Z in 2025 is 71,074.1 thousand people, indicating that 24.98% of the total population in Indonesia is Generation Z. Generation Z, which was born in 1997-2012, is currently the majority who are still students or just starting to enter the workforce, so they have limited funds. The limited funds of Generation Z are not commensurate with its strong desire to gain recognition and boost self-esteem, creating a problem for the generation (Agustin & Prapanca, 2023).

According to Bayer (2024), frugal living is a lifestyle that involves controlling consumption levels and using resources as much as possible to achieve long-term goals. Frugal living is a life concept that minimizes consumption to save on expenses through a prudent approach to spending (White, 2021; Salsabila & Metekohy, 2024). The goal of frugal living is a long-term objective realized through a pattern of consumption habits aligned with needs (Kusumawardhany, 2023). Inversely proportional to the phenomenon of consumptive attitudes to fulfill lifestyles driven by technological developments in the modern era, especially Generation Z (Pavita & Susanti, 2024). Therefore, frugal living is essential for Generation Z to achieve financial security in the future.

A study conducted in Malang by Hasanah & Badria (2024) revealed that Generation Z has a high level of social responsibility and an understanding of the importance of good management; however, temptations on the consumption side and social pressure tend to make Generation Z more consumptive. Research conducted by Ambarsari & Asandimitra (2023) found that lifestyle affects consumptive behavior. However, budget

constraints to implement a lifestyle in accordance with current trends encourage financial management behavior, as found in the research of Oktaviani, Indriasari, & Meiriyanti (2025). Therefore, the application of frugal living requires sacrifice, avoiding consumptive or impulsive buying, and financial management, along with a simple lifestyle aimed at future financial stability.

According to Cahyani (2022), a hedonic lifestyle affects the financial management behavior of Generation Z; low financial management behavior indicates a high level of hedonic lifestyle. In contrast to the study by Agnas et al. (2024), which found that lifestyle and love of money have no significant effect on financial management behavior in Samarinda, experience and financial literacy have a direct influence on financial management behavior. Generation Z, who exhibit good financial management behavior, tend to view money as an important aspect, which positively influences their financial management behavior (Ulumudiniati & Asandimitra, 2022). The study by Kumalasari et al. (2025) in Yogyakarta found that love of money affects financial management: a high level of love of money is associated with well-managed financial management, thereby fostering an anti-consumptive mindset.

A study conducted in Kediri, according to Hidayah et al. (2025), found that frugal living will form anti-consumptive habits and mindsets that can improve mental well-being and reduce financial anxiety in social life. A future-oriented mindset can foster economic independence and give Generation Z an advantage in navigating future economic uncertainty (Kapitan et al., 2021; Suárez et al., 2020).

The study by Kusumawardhany (2023) revealed that Generation Z practices frugal living by budgeting for consumption, planning every expenditure, prioritizing shopping according to needs, and developing a shopping strategy, as demonstrated through a case study in the Surabaya area. In implementing frugal living, financial management is needed through controlling consumption expenditures and a prudent attitude towards managing finances, prioritizing the fulfillment of needs over wants (Kapitan et al., 2021). The study in Palembang, according to Hartantri et al. (2024), found that frugal living has a significant effect on financial management, thereby reducing the risk of debt bondage and future economic problems. This finding is consistent with research by Suárez et al. (2020) in Spain, which found that frugal living positively influences price awareness, age, self-control, discount hunting, social spending, and goal influence. In addition, the practice of frugal living affects the level of thrifty attitude, which in turn influences lifestyle (Nugroho & Albab, 2023).

Previous studies provide an overview of the relationship between frugal living and financial management (Hartantri et al., 2024; Kapitan et al., 2021; Kusumawardhany, 2023; Nugroho & Albab, 2023; Suárez et al., 2020), but have not explained explicitly about lifestyle and financial behavior when implementing frugal living. Studies by Ambarsari & Asandimitra (2023), Oktaviani et al. (2025), Cahyani (2022), and Agnas et al. (2024) found that there is a lifestyle influence on financial management, but there is no explicit integration towards frugal living. Financial management is related to the

love of money, so it indirectly relates to anti-consumption and lifestyle (Hidayah et al., 2025; Kumalasari et al., 2025; Ulumudiniati & Asandimitra, 2022). In addition, few studies examine frugal living among research subjects across specific generations. This study aims to analyze the influence of lifestyle, love of money, and financial management on frugal living by Generation Z in Surakarta City. The novelty of this research lies in the location research in Surakarta City, which has not been conducted by previous researchers specifically. It also discusses the relationship between a love of money and frugal living, a topic that previous researchers have rarely studied.

METHODS

This research uses a quantitative approach to analyze the influence of lifestyle, love of money, and financial management on frugal living behavior by Generation Z in Surakarta City. This research was conducted in Surakarta City in 2025, using primary data collected through questionnaires and in-depth interviews with respondents.

Table 1. Definition of Operational Variable

Variable	Indicator Variable	Measurements	Sources	Reference
Frugal Living (Y)	- Must have a control attitude - Caring for goods for the long term - Disciplined attitude in financial management - Save on expenses - Maximizing resources	Likert Scale 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree	Primary	(Bayer, 2024; Hartantri et al., 2024; Hasanah & Badria, 2024; Hidayah et al., 2025; Kapitan et al., 2021; Kusumawardhany, 2023; Philp & Nepomuceno, 2020; Salsabila & Metekohy, 2024; Suárez et al., 2020; White, 2021)
Lifestyle (X1)	- Using local brands - Choosing a simple lifestyle - Does not follow current fashion trends - Lifestyle allocation - Using second-hand/thrifty items	Likert Scale 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree	Primary	(Agnas et al., 2024; Ambarsari & Asandimitra, 2023; Cahyani, 2022; Nasution, Rasip, & Wardhani, 2023; Nurhasanah & Kesuma, 2023; Oktaviani et al., 2025; Ramandati, Nawir, & Marlina, 2021)
Love of Money (X2)	- Buying at a later date - Prudence in consumption - Choosing discount prices - Reducing the portion of social activities - Having a stingy attitude - Avoid impulsive buying	Likert Scale 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree	Primary	(Agnas et al., 2024; Bayer, 2024; Kapitan et al., 2021; Kumalasari et al., 2025; Lestari, Triandini, Saputra, Dyasvaro, & Putri, 2023; Rizki, Setiawati, & Utama, 2025; 'Ulumudiniati & Asandimitra, 2022)
Financial Management (X3)	- Transaction bookkeeping - Developing budgeting - Separation of funds - Categorizing funds according to needs	Likert Scale 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree	Primary	(Hartantri et al., 2024; Kapitan et al., 2021; Kusumawardhany, 2023; Nugroho & Albab, 2023; Suárez et al., 2020; White, 2021)

According to the Central Bureau of Statistics (BPS), Surakarta City (2025) The population of Surakarta City is 529,079. The percentage of Generation Z in Surakarta City is 23.76% or 125,728 people. This study used 150 Generation Z respondents in Surakarta City. The sampling technique was purposive sampling of Generation Z respondents in Surakarta City, with data collected through the distribution of questionnaires and in-depth interviews.

Table 1 presents the operational definitions of the variables in this study, with frugal living as the dependent variable. Independent variables are lifestyle, love of money, and financial management. Data for each variable is obtained using a Likert scale, where one indicates strongly disagree until five indicates strongly agree.

This study uses Structural Equation Modeling (SEM) with the Partial Least Squares (PLS) approach to simultaneously analyze the relationships among variables, incorporating validity and reliability in the evaluation. Hair Jr et al. (2021) SEM-PLS is used as the analytical method in this study to explore deeper behavioral actions and the effects of independent variables on dependent variables that do not meet the normality assumption. SEM-PLS is an approach to validating models that provides an overview of the relative contribution of independent variables in predicting constructs (Bayaga & Kyobe, 2022). According to Cepeda-Carrion et al. (2019), PLS-SEM is used to determine the type of model through composites. SEM-PLS to analyze because it fits the theoretical framework.

RESULTS AND DISCUSSION

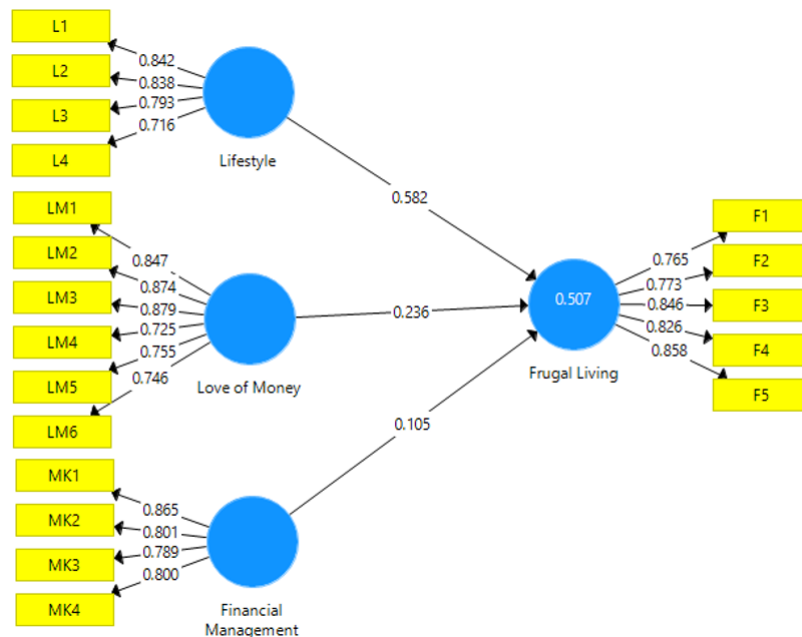
The main findings of this study show that lifestyle and a love of money influence frugal living, while financial management does not influence frugal living among Generation Z in Surakarta City. The motivation for Generation Z in Surakarta City to adopt frugal living is limited funds. Based on primary data, 67.3% of respondents have incomes below the minimum wage in Surakarta City. This fact finally encourages Generation Z to practice frugal living so that they can meet their needs in the future.

Table 2. Characteristics of Respondents

	Category	Frequency
Gender	Female	66.0%
	Male	34.0%
Age	18-19 years old	25.3%
	20-21 years old	36.0%
	22-23 years old	27.3%
	24-25 years old	11.3%
Income/Pocket Money	<Rp999,999	23.3%
	Rp1,000,000 – Rp1,999,999	44.0%
	Rp2,000,000 – Rp2,999,999	25.3%
	>Rp3,000,000	7.3%
Origin	Outside Surakarta City	44.7%
	Inside Surakarta City	55.3%
Current Residence	Rural	36.7%
	Urban	63.3%

Table 2 provides an overview of respondents' characteristics, with 66% female and 34% male. The age range of respondents is 18-25 years old, with a mode of 20-21 at 36%. The pocket money of Generation Z in this study is considered income because they are students at the college and have not yet earned their own income. Most of the respondents' income falls in the range of Rp1,000,000 – Rp 1,999,999, accounting for 44%. The lowest income level among respondents is >999,999, which accounts for 23% of respondents. This study is dominated by Generation Z respondents living in Surakarta City (55.3%) and those living outside Surakarta City (44.7%). 67.3% of Generation Z respondents have an income below the Surakarta City minimum wage of Rp2,416,560. Limited funds motivate Generation Z in Surakarta City to practice frugal living. Clear rules do not define frugal living among Generation Z. However, it can also be done by organizing a lifestyle that is not consumptive and by choosing the lowest price for an item of the same use and quality.

Figure 1. Outer Loadings



The validity test results are used to determine the validity correlation between indicators through outer loading (Hair Jr et al., 2021). The provisions in the validity test are considered valid if their loading factor is greater than $\alpha = 0.05$; this is shown in the figure below. The validity test, which is deemed valid, indicates that this research is feasible for further processing. Figure 1 shows the outer loading results, which show that it is valid to use.

The validity test between indicators in this study is above 0.05, so the indicators of each variable are declared valid for research and proceed to the next test. Table 3 presents the reliability test results for three measurements: Cronbach's alpha, composite reliability, and Average Variance Extracted (AVE). The reliability test criteria are considered valid

if they meet the requirements for a Composite Reliability (CR) value above 0.7 and an AVE value above 0.5 (Bayaga & Kyobe, 2022).

Table 3. Cronbach's Alpha, Composite Reliability, and AVE

Variable	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Frugal Living (Y)	0.873	0.908	0.663
Lifestyle (X1)	0.813	0.876	0.638
Love of Money (X2)	0.896	0.917	0.651
Financial Management (X3)	0.841	0.887	0.663

The reliability test, as indicated by Cronbach's alpha and composite reliability (CR) for all variables, was above 0.7, so this research is valid and can proceed to the next reliability test. The AVE values for all variables in this study are above 0.5, indicating that the AVE test results are valid. Based on the test results of these three measurements, the research is valid for the following data processing stage. Table 4 shows the influence of the independent variables on the dependent variable used in this study. The R-square value is 0.507, indicating that the independent variables explain 50.7% of the variation in the frugal living variable, while other variables outside this study explain 49.3%.

Table 4. R-Square Result

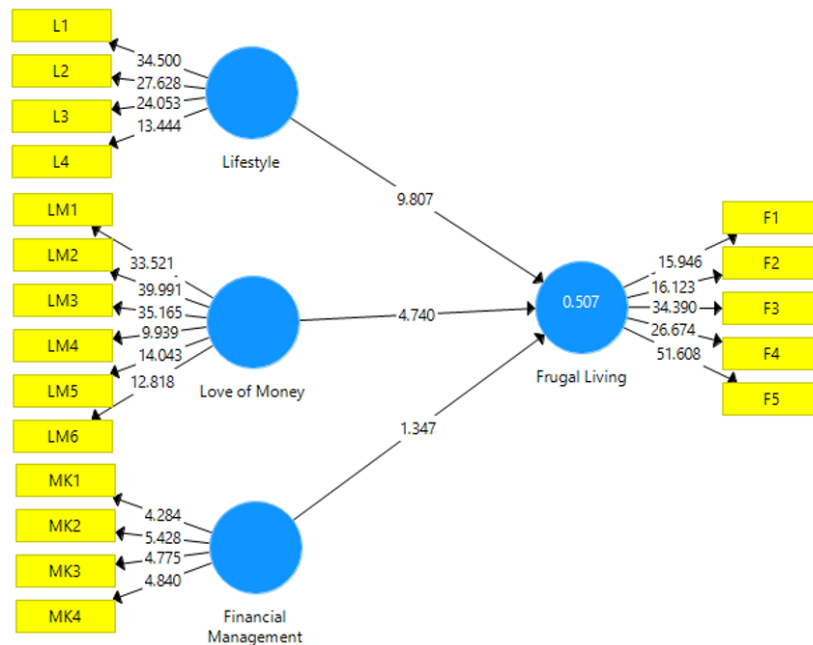
Frugal Living	Original Sample	P-Value
R-Square	0.507	0.000
R-Square Adjusted	0.497	0.000

Bootstrapping provides a complete measurement of the t-statistic value with a P-value, which is divided into two forms, namely image visualization and a table (Cepeda-Carrion et al., 2019). Where image visualization makes it easy to skim the t-statistic value, and the table will provide details about the research result. Bootstrapping can help show that latent variables influence changes in indicators. The significance test is used to determine the closeness of the relationship between the independent and dependent variables. The bootstrap results above are explained in detail through the path coefficient.

The bootstrapping results for the indicators of all research variables show that the t-statistic is above 1.96, indicating that all frugal living indicators are valid and significant. The most substantial indicator value in the frugal living variable is shown in indicator F5, namely, using maximum resources, with a t-statistic value of 51.608. The most substantial indicator value in the lifestyle variable, with a t-statistic of 34.500, is observed for L1 (using local brands). The value of the indicator variable 'love of money' is associated with a prudent attitude towards consumption (LM2), with a t-statistic of 39.991. The highest t-statistic for the financial management variable is 5.428 in MK2 (preparing budgets).

Table 5 presents the path coefficients for the research variables, reflecting the inner model of the results of this research data processing.

Figure 2. Bootstrapping



Lifestyle variables have a significant positive effect on the frugal living of Generation Z in Surakarta City. The t -statistic value of $9.807 > 1.96$, with a p -value of $0.000 > 0.05$, indicates a significant result. The original sample shows a positive level, and it can be concluded that every increase in the application of a simple lifestyle by Generation Z will increase frugal living by 0.582.

Table 5. Path Coefficient

Variable			Original Sample (O)	Sample Mean (M)	T-Statistics	P-Values
Lifestyle	→	Frugal Living	0.582	0.582	9.807	0.000
Love of Money	→	Frugal Living	0.236	0.237	4.740	0.000
Financial management	→	Frugal Living	0.105	0.110	1.347	0.179

This study found that Generation Z in Surakarta City tends not to follow the current trends, especially regarding contemporary fashion. Related to the limited funds owned, which are limited to the pocket money given by parents. In addition, based on the results of data processing and interviews in this study, a phenomenon emerged: Generation Z migrants to Surakarta City tend to follow lifestyle trends. However, the trend is still within reach because they want to continue using public facilities and local brands. On the other hand, Generation Z who choose to continue their studies

in Surakarta City must meet their own needs through their income, which is used for food, boarding, laundry, electricity, and other living expenses. This condition motivates Generation Z in Surakarta City to do frugal living.

Previous research on lifestyle variables was conducted by Nurhasanah & Kesuma (2023) and Ramandati et al. (2021), who explained that lifestyle factors affect Generation Z's financial planning. The social environment of Generation Z has a positive influence on financial management and helps reduce excessive consumption. Nasution et al. (2023) case study in Medan found that rural students experience changes in behavior when adapting to urban styles, so they tend to be more consumptive due to the easy accessibility of obtaining these goods, in line with this study which, found that Generation Z who migrated and chose to continue their studies in Surakarta City tended to follow the development of trends, although still within a reasonable level.

The findings in Surakarta City differ from those of Ambarsari & Asandimitra (2023), who found that lifestyle affects consumption behavior because Generation Z is easily influenced by the times and follows current trends. Respondents in Surakarta City are more skilled at managing emotions when consuming. Respondents recognize that poor financial management will lead to a prioritization of pleasure over consumption (Cahyani, 2022). They still prioritize lifestyle, but are at a reasonable stage. In addition, lifestyles that aim to gain recognition and higher social status require greater financial resources (Oktaviani et al., 2025). Encourages Generation Z in Surakarta City, for example, by using local brands that offer the same sound quality as well-known brands to fulfill their lifestyle needs.

Love of money has a significant positive effect on frugal living. This study found that love of money affects the frugal living of Generation Z in Surakarta City. Indicators of love of money in this study include buying goods when offered significant discounts and engaging in social action to protect the surrounding environment. The results of data processing and interviews in this study found the phenomenon that Generation Z respondents carry out the love of money attitude by looking for the best discount offers on the goods/services needed to reduce the amount of consumption expenditure made, but not infrequently, due to the discount offer made, respondents become more consumptive. In addition, the wise use of technology involves leveraging features such as free shipping, discounts, and cashback offered on e-commerce and e-wallet platforms. Offering a large discount and buying only what is needed will minimize expenses.

In line with previous studies by Lestari et al. (2023), love of money is associated with personal financial management behavior. Love of money tends to make people more enthusiastic about good financial management, thereby positively influencing it (Kumalasari et al., 2025). Previous research by Ulumudiniati & Asandimitra (2022) suggests that money is an important and valuable aspect of life that represents each individual's achievements, a component of the theory of planned behavior. The results of the interviews with Generation Z respondents in Surakarta City in this study show that they take action to save, such as investing in stocks or crypto. In line with research by Kapitan et al. (2021), offering large discounts attracts frugal individuals. The results of

data processing and interviews in this study also found that Generation Z respondents in Surakarta City exhibit a love-of-money attitude and use frugal-living skills. The skills used by Generation Z in Surakarta City in this study include cooking, washing, and driving. The next phenomenon found in this study is that Generation Z in Surakarta City tends to avoid fast fashion for sustainability and simplicity in life. In line with Bayer (2024), frugal behavior is a social action that involves environmentally friendly consumption by using the skills one possesses to reduce spending.

This research contradicts previous research conducted by Agnas et al. (2024) and Rizki et al. (2025), that love of money does not affect financial management; the attitude of love of money creates a strong desire to encourage consumptive behavior with the principle of Generation Z that You Only Live Once (YOLO) so that the form of love of money is done only to enjoy life at this time without worrying about current consumption expenditures. The love of money among Generation Z in Surakarta City tends to reduce consumption by leading them to seek the best deals.

Financial management variables do not influence the application of frugal living among Generation Z. This study found that financial management does not affect Generation Z's frugal living in Surakarta City. Generation Z practices financial management through frugal living, but the financial management system they use does not yet have a consistent pattern. This is one of the reasons that financial management does not affect frugal living behavior. If these respondents become fixated on the financial management they do and find out that there is an overspend, it will cause anxiety and depression. A study by White (2021) found that high levels of consumption will affect mental health, including anxiety and depression. In addition, based on interview results and data processing, this study found that respondents' awareness of future consequences of consuming at this time encouraged them to budget. Respondents' budgets are usually flexible, and many are even over budget. In line with research by Suárez et al. (2020), long-term consequences are positively associated with Consciousness for Sustainable Consumption (CSC).

In contrast to previous research by Hartantri (2024), which found that financial management affects frugal living, good financial management will reduce the risk of economic problems, so financial planning is needed to implement it. Kusumawardhany (2023) found that planning and controlling expenses significantly affected Generation Z's frugal acceptance behavior. Studies by Kapitan et al. (2021) found that frugal consumers generally limit spending and avoid the temptation of attractive offers that can increase consumption. Therefore, sacrifices to avoid consumptive attitudes and impulsive buying by adopting a simple lifestyle and practicing sound financial management for future financial stability.

CONCLUSION

This study aims to analyze the influence of lifestyle, love of money, and financial management on frugal living by Generation Z in Surakarta City. Based on the results, lifestyle and a love of money affect the frugal living of Generation Z in Surakarta City,

while financial management does not. The findings show that Generation Z in Surakarta City does not really follow current fashion trends but instead prefers local brands due to limited funds. Reducing the level of consumption expenditure by looking for the best discount offers and utilizing their skills. In addition, the financial management carried out does not yet have a consistent pattern.

Based on the findings, the Indonesian government needs to improve financial literacy policies specifically for Generation Z and provide support for local products. Financial literacy policies should not only emphasize financial recordkeeping and the use of emerging financial technologies, but also teach environmentally friendly consumption habits. In addition, it is necessary to cultivate the habit of using local products, especially among Generation Z, who often experience FOMO about current trends.

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Employment as the Missing Link: Full Mediation of Minimum Wage Effect on Per Capita Income in Central Java

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ABSTRACT

Research Originality: This paper is original by explicitly analyzing employment as a mediating variable in the relationship between minimum wage and per capita income, given the inconclusive findings of previous research on these variables.

Research Objectives: This study investigates the relationship between minimum wage and per capita income and examines the mediating role of employment with two control variables: government expenditure and education.

Research Methods: This study utilized secondary data from BPS covering 35 districts and municipalities in Central Java Province over the period 2018–2023. The study applies panel-data regression, complemented by mediation analysis using path analysis and the Sobel test.

Empirical Results: The minimum wage does not directly affect per capita income; instead, its impact is fully mediated by employment. The finding suggests that the minimum wage alone does not raise per capita income; rather, it exerts its influence indirectly by improving employment, which in turn drives income growth. As control variables, government expenditure and education exert positive and significant effects on per capita income.

Implications: A minimum wage policy must be accompanied by job-creation strategies. A minimum wage increase without policies that maintain or increase jobs will not effectively boost per capita income.

Keywords:

minimum wage; per capita income; employment; government expenditure; education

How to Cite:

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INTRODUCTION

The primary emphasis in Indonesia's economic development initiatives, particularly in Central Java Province, has consistently been on economic growth and improving community welfare. Per capita income is a metric that reflects a region's welfare. Per capita income is an economic metric used to determine the average income of individuals in a territory over a designated period. According to Statistics Indonesia (BPS, 2023), Central Java ranks 31st among Indonesian provinces in per capita income. In 2023, Central Java's per capita income was IDR 45.16 million, much below the national average of IDR 79.56 million. DKI Jakarta has the highest per capita income, while Papua Barat Daya has the lowest. Among the other provinces on the island of Java, Central Java ranks fifth out of six, above DI Yogyakarta, which historically had the lowest per capita income on the island.

During the period from 2018 to 2023, DKI Jakarta exhibited the greatest per capita GRDP among all provinces on the island of Java. This amount significantly exceeds that of other provinces, more than Rp300 million per capita in 2023. This data indicates that Jakarta, as the hub of governance and commerce, has a significantly more advanced economy than other provinces. Central Java and DI Yogyakarta exhibited the lowest per capita GRDP among the provinces on the island of Java, with both falling below Rp50 million per capita in 2023. Central Java is the province with the third-largest area in Java, characterized by enormous and diverse natural resources; nonetheless, it lags in per capita income due to the predominance of the agricultural sector and low-tech industries. This fact indicates a substantial economic disparity among provinces on the island of Java. Moreover, substantial variations in per capita GRDP exist among cities and regencies within Central Java Province, comprising 29 districts and six municipalities.

Semarang possesses the greatest per capita GRDP among other districts and municipalities in Central Java, as it serves as the provincial capital and the hub of government and administration. Districts such as Pemalang, Grobogan, and Kebumen have comparatively low per capita GRDP. A notable discrepancy exists between urban and rural regions. Urban areas such as Semarang, Surakarta, and Kudus exhibit significantly higher per capita GRDP than rural areas such as Rembang, Brebes, and Pemalang. This condition indicates that economic hubs are situated in major urban centers.

The minimum wage is one of the factors that influence per capita income. Article 1, paragraph 1, of Law Number 78 of 2015 states that the minimum wage is a monetary right granted by the employer to the worker/laborer as compensation for services rendered, in accordance with the provisions of the legislation. By providing a decent wage standard, this policy aims to protect workers from labor exploitation. A higher minimum wage is expected to improve the income and welfare of the workforce. The increase in the minimum wage is expected to raise labor income, thereby increasing per capita income (Chen & Xu, 2024; Lv et al., 2023; Sabokkhiz et al., 2021).

The urgency of minimum wage in economic development is highlighted by its multifaceted impacts. On the one hand, it can reduce household economic vulnerability,

raise consumption, and support economic growth (Lv et al., 2023; Sabokkhiz et al., 2021). On the other hand, challenges remain in its enforcement, particularly in developing countries characterized by abundant informal sectors (Badaoui & Walsh, 2022). The academic debate has therefore centered on whether the minimum wage primarily serves as a tool for welfare improvement or as a labor-market distortion.

The impact of the minimum wage on employment remains a contentious issue in economics, as this controversy illustrates. While some studies find positive effects (e.g., Kar et al., 2019; Chen & Xu, 2024), others report negative impacts on vulnerable groups (Paun et al., 2021; Rybczynski & Sen, 2018; Broecke et al., 2017). These inconsistencies reflect differences in the structure of the labor market, enforcement capacity, and economic context. In developed countries, wage increases may improve household income without substantial job loss, while in developing countries, due to work informality and weak enforcement, the risk of unemployment is magnified. Thus, the existing literature has not reached a consensus on whether minimum wage increases or suppresses per capita income, directly or indirectly.

In this study, government expenditure and education are used as control variables to reduce bias and ensure the impact of the minimum wage on per capita income is correctly analyzed. These two variables were chosen because they play an important role in shaping a region's economic and social conditions. Government spending that supports economic development, particularly in sectors such as infrastructure, health, and education, can influence regional economic growth (Clements et al., 2024; Cooray & Nam, 2024; Haini, 2020; Anwar et al., 2020; Ojede et al., 2018). Effective government spending strategies can support economic and social development and improve community welfare by increasing per capita income.

Besides government spending, education is also an important factor that influences economic growth. Better education equips the workforce with higher skills and knowledge, leading to better jobs with higher wages. Long-term economic growth is predominantly driven by human capital (Hanushek & Woessmann, 2021). Higher income in society leads to a cumulative increase in per capita income (Kusuma & Wijaya, 2023).

Research on the effect of the minimum wage on per capita income yields inconclusive findings. Using survey data from 1984 to 2013, Dube (2019) found that minimum wages increase the incomes of the poor. Accordingly, Overstreet (2019) found a positive relationship between the minimum wage and per capita income in Arizona, indicating that a 1 percent increase in the minimum wage would increase per capita income by 1.13 percent. Thus, the benefits to low-income workers outweigh the costs borne by high-income residents and employers through minimum wage increases.

However, Overstreet cautioned that wage increases should not lead to unemployment. Research in Hungary indicates that firms respond to minimum wages by substituting labor for capital, and that the disemployment effect is higher in industries that have more difficulty passing wage increases on to consumers (Harasztosi & Lindner, 2019).

The impact of the minimum wage on poverty alleviation will be small if layoffs resulting from an increase in the minimum wage are large (Dube, 2019). Using data from Sumatra Island from 2008 to 2017, Pratama et al. (2020) found that provincial minimum wages had a significant positive impact on employment in the long term but a significant negative impact on employment opportunities in the short term.

Despite extensive studies, the existing literature has two significant limitations. First, most research focused on the direct relationship between the minimum wage and per capita income, yielding inconclusive results. Few studies have explored the indirect mechanism, particularly through the mediating role of employment. Second, the Indonesian context, characterized by a large informal sector, provincial disparities, and high variability in the enforcement of labor regulations, remains understudied.

To address these gaps, this study explicitly investigates the mediating role of employment in the relationship between minimum wage and per capita income while controlling for government expenditure and education. This approach allows us to determine if the minimum wage can enhance welfare solely through job creation, rather than through the direct income effect. Therefore, the study contributes to the ongoing debate by reconciling the income and substitution effects and by providing evidence from Central Java Province.

METHODS

This study employs a quantitative associative approach. This study was conducted across 29 districts and 6 municipalities in Central Java Province, using panel data from 2018 to 2023. The research objects include the minimum wage, government expenditure, education, employment, and per capita income of regencies and cities in Central Java Province. This research utilizes data from Statistics Indonesia (BPS). In this study, there are four variables: the dependent variable (per capita income), the independent variable (minimum wage), the mediating variable (employment), and the control variables (government expenditure and education).

Panel data regression analyzes models using three approaches: the common effects model, the fixed effects model, and the random effects model. To determine the regression model, there are three types of tests: the Chow test, the Hausman test, and the Lagrange multiplier test. This study uses path analysis to evaluate the causal relationships among variables, thereby enabling an understanding of the direct and indirect effects of independent variables on the dependent variable. The following are the steps in using path analysis assisted by Eviews 12 software, as follow:

- a. Regressing the independent variable (W) and control variables, namely government spending (G) and education (E) on the dependent variable (Y).
- b. Regressing the independent variable (W) on the mediating variable (Z).
- c. Regressing the independent variable (W) on the dependent variable (Y) by adding a mediating variable (Z).

Based on the path analysis steps, the regression model in this study is formulated as follows:

$$Y_{it} = \alpha + \beta_1 W_{it} + \beta_2 G_{it} + \beta_3 E_{it} + e_{it} \quad 1)$$

$$Z_{it} = \alpha + \beta_1 W_{it} + e_{it} \quad 2)$$

$$Y_{it} = \alpha + \beta_1 W_{it} + \beta_2 G_{it} + \beta_3 E_{it} + \beta_4 Z_{it} + e_{it} \quad 3)$$

However, since each variable has different units, the regression model is transformed into natural logarithm form.

Y : Percapita Income

α : Constant

β : Regression Coefficients

W : Minimum Wage

G : Government Expenditure

E : Education

Z : Employment

i : 35 regencies/cities in Central Java Province

t : 2018-2023

The Sobel test can be used to test hypotheses in regression models with mediating variables. The indirect effect of the independent variables on the dependent variable is investigated through the mediating variable in the Sobel test. The objective of this test is to determine whether the mediating variable can substantially influence the relationship between other variables. The Sobel test formula is as follows:

$$Sab = \sqrt{b^2 Sa^2 + a^2 Sb^2 + Sa^2 Sb^2}$$

where:

Sab : Standard error of indirect effect

a : Path of variable W with variable Z

b : Path of variable Z with variable Y

Sa : Standard error of coefficient a

Sb : Standard error of coefficient b

To determine the significance of the indirect effect, it is necessary to calculate the t-value using the formula:

$$t = \frac{ab}{Sab}$$

It is possible to determine the presence of a mediating influence by comparing the statistical value to the table value. If the statistic value is larger than the table value, it is assumed that there is a mediating effect; otherwise, there is no mediating effect.

RESULTS AND DISCUSSION

Based on Chow and Hausman tests, the best model for equations (1) and (3) is the Fixed Effect Model, while for equation (2) it is the Random Effect Model. In panel data analysis, classical assumption tests typically only include tests for multicollinearity and heteroscedasticity. This is because panel data is a combination of cross-sectional and time-series data and has characteristics similar to those of cross-sectional data. Furthermore, the normality assumption is not required for a Best Linear Unbiased Estimator (BLUE). The results of the tests indicate that the regression models for equations (1), (2), and (3) are free of multicollinearity and heteroscedasticity. Table 1 presents the summary of the path coefficients.

Table 1 shows that, based on the estimates from structural models I and III, the minimum wage yields a p-value > 0.05 and a t-statistic < the t-table value. This result indicates that the minimum wage does not have a significant effect on per capita income. Both government expenditure and education yield probability values < 0.05 and t-statistics > the t-table value. This result means that government expenditure and education have a positive and significant effect on per capita income. Based on the structural model II estimate, the minimum wage yields a p-value of < 0.05 and a t-statistic > the t-table value, indicating that the minimum wage has a positive and significant effect on employment. The estimation of structural model III shows that employment yields a p-value of < 0.05 and a t-statistic > the t-table value, indicating that employment has a positive and significant effect on per capita income. Based on Table 1, the following path diagrams in Figures 1, 2, and 3 can be formed.

Table 1. Summary of Path Coefficients

Variable	Coefficient	Std error	t-value	Prob
Structural equation I (W + G + E with regard to Y)				
Ln_W - Y	-0.040206	0.073171	-0.549478	0.5834
Ln_G - Y	0.164522	0.050392	3.264877	0.0013***
Ln_E - Y	0.781229	0.217635	3.589622	0.0004***
Structural equation II (W with regard to Z)				
Ln_W - Z	0.409240	0.042574	9.612487	0.0000***
Structural equation III (W + G + E + Z with regard to Y)				
Ln_W - Y	-0.097152	0.071109	-1.366251	0.1737
Ln_G - Y	0.182111	0.048265	3.773158	0.0002***
Ln_E - Y	0.594175	0.212332	2.798334	0.0057***
Ln_Z - Y	0.263396	0.062269	4.229984	0.0000***

Source: Data processed (2024)

Figure 1. Structural Equation Model Path Diagram (1)

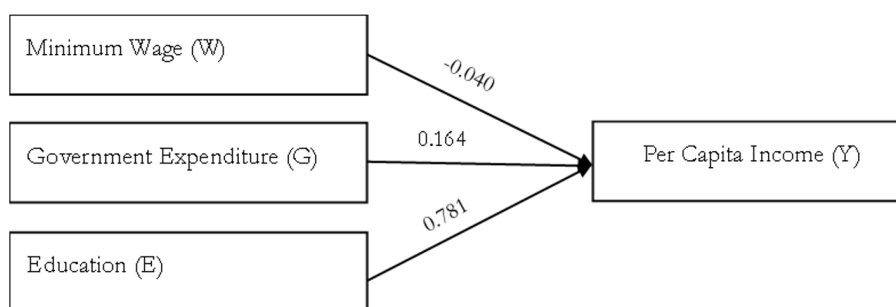


Figure 2. Structural Equation Model Path Diagram (2)

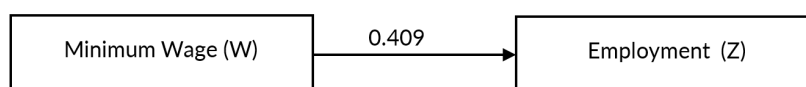
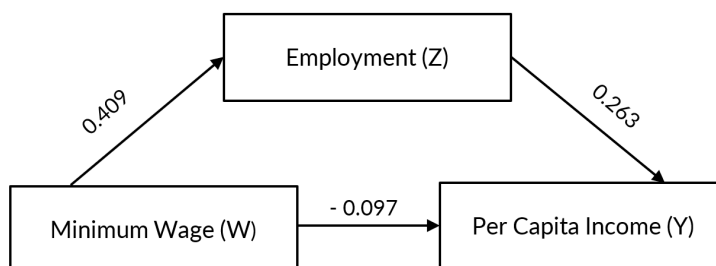


Figure 3. Structural Equation Model Path Diagram (3)



Based on the summary table of path coefficients and the structural equation path diagram, the minimum wage variable does not have a significant direct effect on per capita income, with a coefficient of -0.040. The indirect effect of the minimum wage on per capita income through employment (Z) can be calculated by multiplying the coefficient of X on Z with the coefficient of Z on Y, resulting in $(0.409) \times (0.263) = 0.107$. Then, the total effect of the minimum wage variable on per capita income is $(-0.040) + (0.107) = 0.067$.

The next test is the Sobel test, which is used to analyze the mediation hypothesis. In this context, the Sobel test can measure the magnitude of the indirect effect of the minimum wage (W) on per capita income (Y) through employment (Z). The mediation effect test is carried out using the following formula:

$$Sab = \sqrt{b^2 Sa^2 + a^2 Sb^2 + Sa^2 Sb^2}$$

$$t = \frac{ab}{Sab}$$

$$t = \frac{ab}{\sqrt{b^2 Sa^2 + a^2 Sb^2 + Sa^2 Sb^2}}$$

$$t = \frac{0.409 \times 0.263}{\sqrt{0.263^2 0.042^2 + 0.409^2 0.062^2 + 0.042^2 0.062^2}}$$

$$t = 3.871$$

The Sobel test indicates that employment mediates the relationship between the minimum wage and per capita income, as evidenced by the t-statistic exceeding the t-table value ($3.871 > 1.971$). The regression results show that the direct effect of the minimum wage on per capita income is not significant, whether employment is included or excluded from the model. Therefore, employment is a full mediator in the relationship between minimum wage and per capita income.

The results indicate that the minimum wage does not have a significant direct effect on per capita income. This condition may be because the minimum wage policy applies to only a small proportion of formal workers. At the same time, per capita income is calculated as total income divided by the total population, including entrepreneurs, informal workers, and the unemployed. In developing nations like Indonesia, the prominent role of the informal sector and SMEs (Charina et al., 2024; Surtiari et al., 2024), which are exempt from minimum wage regulations, means that many workers do not benefit from the policy. Paradoxically, an increase in the minimum wage may result in unexpected consequences, such as layoffs or reduced new hiring, which could lead to lower total income. This argument aligns with Bhorat et al. (2017), who found that the minimum wage has a significant negative impact on per capita income. Research in Hungary shows that firms respond to minimum wages by substituting labor for capital, and that the disemployment effect is higher in industries that have more difficulty passing wage increases on to consumers (Harasztosi & Lindner, 2019). Dube (2019) argued that the impact of the minimum wage on poverty alleviation will be small if layoffs resulting from an increase in the minimum wage are large.

In Central Java, this result is particularly understandable given the province's economic structure. Central Java has a large share of employment in agriculture and low-tech manufacturing, sectors with limited compliance with minimum wage regulations. Moreover, disparities between urban centers such as Semarang and rural districts such as Grobogan or Pemalang imply that the aggregate effect of minimum wage on per capita income is diluted when calculated at the provincial level. This structural heterogeneity helps explain why the direct effect disappears in the statistical model.

Government spending has a positive and significant effect on per capita income, as expenditures on education, infrastructure development, and health can improve the quality of life. Government investment in infrastructure projects such as roads, bridges, and public facilities not only creates employment but also improves public access to basic services by enabling better infrastructure and increased labor productivity, which in turn will positively impact per capita income. This result is in line with Dudzevičiūtė et al. (2018), who found that in eight EU countries there was a significant relationship between government spending and economic growth. The finding also supports Ahuja and Pandit (2020), who analyzed panel data from 59 developing countries during 1990-2019 and found unidirectional causality — i.e., government spending promotes economic growth — consistent with the Keynesian framework. Chandana et al. (2020) found that government spending, particularly capital expenditure, has a significant positive effect on economic growth in both the short and long term, while recurrent expenditure has no significant effect.

Education has a positive and significant effect on per capita income. This is because, as education levels increase, individuals' skills and knowledge also increase. This allows for

obtaining better and more productive jobs, which will then increase per capita income. This result is consistent with the previous research (Hanushek & Woessmann, 2021; Jamel et al., 2020; Ogundari & Awokuse, 2018; Erić, 2018) that education has a positive and significant impact on per capita income/economic growth.

The minimum wage has a positive and significant effect on employment. From a labor supply perspective, higher wages will encourage higher labor force participation. Minimum wage increases encourage higher labor force participation among parents of dependent children (Godøy et al., 2019). In the US, Otterby et al. (2024) found a positive relationship between labor force participation and minimum wage. In OECD countries, a 1% increase in minimum wage was associated with a 0.17% rise in employment (Kar et al., 2019).

However, the employment data in this study do not distinguish between the formal and informal sectors. Formal employment may decrease while informal employment increases, potentially obscuring sectoral differences at the provincial level. This aligns with Broecke et al. (2017), who suggested that minimum wage effects in emerging economies often manifest in rising informality rather than net job losses. Compared with Pratama et al. (2020), who found long-term employment gains but short-term employment losses in Sumatra, our results suggest that Central Java may be experiencing stronger labor-market absorption into informal and semi-formal jobs, cushioning the short-run disemployment effect.

This study finds that employment has a positive and significant effect on per capita income. An increase in employment enables more individuals to participate in the labor market. As labor force participation rises, aggregate income in an economy also increases, thereby boosting per capita income. Based on the Sobel test, employment fully mediates the effect of the minimum wage on per capita income across 35 districts/municipalities in Central Java Province from 2018 to 2023. Complete mediation means that the minimum wage → employment → per capita income channel is the only significant pathway. This result means that a minimum wage increase does not automatically increase the average income of the population. Its effect operates through employment. The minimum wage only affects per capita income if it first affects employment. If raising the minimum wage does not raise the employment rate (or even lowers it), per capita income will not go up.

Theoretically, this finding advances the debate on the dual effects of minimum wage policy. It suggests that in Central Java, the income effect (higher wages) is not sufficient to raise per capita income unless it translates into higher employment. In contrast, the substitution effect (job loss) remains a risk in the formal sector. This reinforces the argument that minimum wage policies should be evaluated not merely as redistributive tools but also as labor-market activation mechanisms, in which employment growth is the key transmission channel to welfare gains.

These findings have important implications for the formulation of minimum wage policy. Job-creation strategies must accompany the minimum wage. A minimum wage increase without policies that maintain or increase employment will not be effective in boosting per capita income, for example, by providing incentives for MSMEs and labor-intensive industries to continue recruiting workers even as the minimum wage rises. Furthermore, policymakers need to consider labor elasticity. If the minimum wage increase is too high and leads to workforce reductions, the impact on per capita income could

actually be negative. Therefore, minimum wage adjustments should take into account the labor market's absorption capacity.

Beyond wage setting, complementary policies such as vocational training, technological upgrading for SMEs, and rural industrialization programs are essential. These interventions would not only preserve employment but also enhance productivity, ensuring that wage increases are matched with efficiency gains. By targeting labor-intensive sectors and fostering the formalization of informal enterprises, policymakers can strengthen the positive mediation channel identified in this study.

CONCLUSION

This study finds that employment fully mediates the relationship between minimum wage and per capita income in Central Java Province. The control variables—government expenditure and education—also have a significantly positive effect on per capita income. Therefore, the management of minimum wage policy, government spending, and practical education is crucial to improving societal welfare. Concerning the finding of a full mediation effect of employment, the government needs to develop policies that encourage job creation, such as incentives for labor-intensive industries, workforce training, and investment facilitation. To ensure that minimum wage policies do not negatively impact employment, wage increases must be in line with productivity improvements. This can be achieved by enhancing workforce skills and adopting technologies that support efficiency and competitiveness.

Furthermore, provincial governments can design complementary programs to support small and medium-sized enterprises (SMEs), given their significant role in labor absorption in Central Java. While this study provides clear policy insights, it is limited in scope to Central Java Province and a specific time frame (2018–2023). Future research is encouraged to extend the regional and temporal coverage and to differentiate between formal and informal labor markets to capture more nuanced effects.

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The Future of Health Expenditure in ASEAN Countries: A Forecasting Analysis with ARIMA

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ABSTRACT

Research Originality: The primary contribution of this research is its novel analysis and forecasting of health expenditure in the ASEAN region, which has been previously underexamined by scholars.

Research Objectives: This research forecasts per capita health expenditure across three ASEAN countries, broken down by government, private, and out-of-pocket sources.

Research Methods: This study employs a time series ARIMA model approach using secondary data from the World Bank for the period 2000 to 2021.

Empirical Results: The findings indicate that projections for all three countries significantly increase across all health expenditure categories. Singapore is expected to see a sharp surge in all health expenditure components. At the same time, Indonesia is forecasted to achieve the highest growth rate in percentage terms, but lags in nominal terms. Conversely, Malaysia is projected to experience moderate growth in health expenditure.

Implications: This research underscores the financing disparities and the urgent need for health system reform.

Keywords:

health expenditure; forecasting models; health system; ARIMA

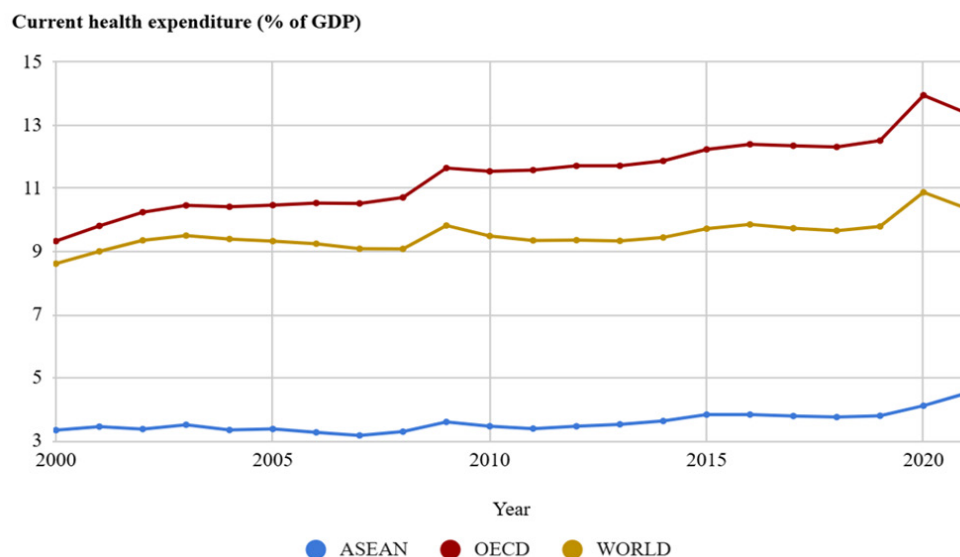
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INTRODUCTION

One of the pillars of a country's development is the health sector, where strengthening the health system contributes to economic growth by creating new jobs, increasing productivity, and developing basic service infrastructure. (Stenberg et al., 2017). Based on data from the Institute for Health Metrics and Evaluation, total global health expenditure in 2017 reached USD 7.9 trillion and is projected to increase to USD 11.0 trillion in 2030 (IHME, 2020). In Southeast Asia alone, data from the World Health Organization reported that total health expenditure in ASEAN countries reached USD 49.7 billion in 2017 (GHED WHO, 2018). This number represents a 42% increase compared to the previous five years. Despite the increase in spending in the health sector, the percentage.

Figure 1. Current Health Expenditure (% of GDP)



Source: World Bank, Processed

The allocation of GDP to the health sector in ASEAN countries remains lower than the OECD average and global total healthcare spending. The lack of funding allocation results in dire consequences, such as low life expectancy and high infant and toddler mortality rates (Rahman et al., 2018). On the other hand, government spending on the health sector tends to have a greater impact on health improvements in Southeast Asia. In contrast, private-sector health expenditures show only positive effects in countries with high levels of prosperity, such as Brunei and Singapore (Singh et al., 2022). Nevertheless, trends in public health spending across ASEAN countries vary: some show improvement, while others remain lagging (Li et al., 2021). This inequality is exacerbated by other problems, namely the still significant gap in financial protection and access to health services, especially among vulnerable populations, and the high out-of-pocket costs, which increase the risk burden for the group (Myint et al., 2019).

ASEAN countries such as Indonesia, Singapore, and Malaysia face increasingly complex health challenges due to population growth, demographic changes, and the increasing prevalence of non-communicable diseases (NCDs). In Indonesia, stroke and heart disease are the diseases that cause the highest mortality rates, contributing to 141 and 90 out of 100,000 population, respectively (WHO, 2022). Other health challenges facing Indonesia include low life expectancy, high maternal and infant mortality rates, and limited access to health services for children (Agustina et al., 2019; Fahdhienie et al., 2024; BPS, 2023). On the other hand, Singapore is facing a surge in NCDs along with an aging population and unhealthy lifestyles, which are driving a significant increase in the prevalence of obesity and type 2 diabetes (Phan et al., 2014; Department of Statistics, 2024). Meanwhile, Malaysia had the highest obesity rate in Southeast Asia in 2016, and faces challenges related to unequal access to health, especially for migrant groups (Loganathan et al., 2019; Central Intelligence Agency, 2017). Given these challenges, projections of healthcare funding allocations to maintain sustainability are important for countries' long-term planning and development, as they provide insight into future trends in health needs. These projections enable governments and stakeholders to identify funding gaps, formulate policies that respond to demographic and epidemiological changes, and allocate resources more efficiently.

The aforementioned projections can take the form of program planning, enabling the smooth, structured implementation of healthcare projects. Furthermore, projected expenditure can be an important indicator in the readiness of the health system in a country, some studies show that an increase in health expenditure can reflect a commitment to good health services, such as a study (Martínez et al., 2021) conducted in Spain an increase in health budgets can directly improve patient satisfaction and the perception of quality of service, mainly if it is focused on primary care and diagnostic tools and studies In Australia, public health expenditure that increased by 1% was associated with a 2.2% decrease in the number of Years of Life Lost (YLL), especially in areas with poor health outcomes (Edney et al., 2018). However, another view is that the increase in health expenditure needs to be balanced with efficiency, because without proper management, the increase in the budget may not achieve the expected health outcomes (Garcia-Escribano et al., 2022).

A major problem in the field of research on health expenditure projections is that it is still dominated by focusing on countries with large economies. One of the studies with the same focus is the research conducted by Jakovljevic et al. (2022), which projects BRICS countries' health spending through 2030, with an emphasis on government spending, prepaid, and direct financing by individuals (out-of-pocket). The study is supported by findings (Sahoo et al., 2023) on health expenditure, with an emphasis on public financing and out-of-pocket costs to achieve Universal Health Coverage (UHC) in BRICS countries by 2035. Further discussed in the findings (J. Wang et al., 2024), the prediction of health expenditure and the long-term trend in America are examined using the Support Vector Regression (SVR) method, with the results highlighting the urgent need for effective

policies to address the rising health expenditure. Another study by Luo et al. (2024) examines Total Health Expenditure (THE) in China using the System Dynamics (SD) approach and shows an increasing trend in health expenditure until 2060. It discusses the urgency of improving the efficiency of total health expenditure to address the challenges of population aging and decline.

The novelty of this study lies in a comparative analysis of projected health expenditures across the three ASEAN countries, a topic that remains underexplored in regional empirical research. The absence of studies projecting health expenditure in ASEAN countries is a gap that can be updated. Thus, this study aims to analyze the health policy implications of projected health spending in 3 ASEAN countries —Indonesia, Singapore, and Malaysia — until 2035.

METHODS

This study aims to analyze the health expenditure of three Southeast Asian countries: Indonesia, Singapore, and Malaysia. The data are sourced from the World Development Indicators (World Bank, 2025), which are all expressed in current international dollars and adjusted for purchasing power parity (PPP). The data are based on the System of Health Accounts 2011 (SHA 2011) classification framework, developed by the OECD, WHO, and Eurostat, which provides an overview of financial flows related to the consumption of health goods and services. The data in the study, sourced from the World Bank, is only available through 2021. Therefore, this study is inherently limited by the availability of such data.

Table 1. Operational Variables

Variables	Definitions	Period	Sources	Code
Current health expenditure per capita, PPP (current international \$)	All expenditures on health goods and services from all sources of financing	2000-2021	World Bank – WDI	<i>hecap</i>
Domestic general government health expenditure per capita, PPP (current international \$)	Health expenditure by domestic governments per capita, where all funding comes from the government, including insurance and transfers, but does not include health assistance from abroad	2000-2021	World Bank – WDI	<i>ghcap</i>
Domestic private health expenditure per capita, PPP (current international \$)	Health expenditure from non-government sources, such as the community and per capita insurance	2000-2021	World Bank – WDI	<i>phcap</i>
Domestic private health expenditure per capita, PPP (current international \$)	Direct health expenditure by individuals, without third-party financing such as per capita insurance.	2000-2021	World Bank – WDI	<i>ofpcap</i>

ARIMA is a commonly used method for predicting and analyzing data compiled in a time series. This analysis uses an approach with three main elements, namely Auto Regressive (AR), differentiating (d), and Moving Average (MA), and all are represented (p,d,q) (Bandyopadhyay, 2016).

Auto-Regressive (AR) is a linear statistical model used to predict a variable based on the lag values of that variable. In this model, the y_t following the AR process, the values y_t are influenced by the y in the past, (Choudhary et al., 2022) shown in Equation 1:

$$y_t = \delta + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \dots + \phi_p y_{t-p} + \epsilon_t \quad (1)$$

The model includes a component of the (δ) , a set of lag variables from y_t (y_{t-i}) that depicts dependency y_t to the previous value, the autoregressive parameter (ϕ_{t-i}) , and the error component (ϵ_t) . If the model includes lag up to an order of p , then the autoregressive process is referred to as AR order of p .

The Moving Average (MA) model is one of the linear model approaches, where the analyzed variables are formed based on a combination of error terms in the current period and the previous period. This model represents the relationship between the current value and random fluctuations that occur over a period of time, shown in Equation 2:

$$y_t = \delta + \theta_1 \epsilon_{t-1} + \theta_2 \epsilon_{t-2} + \dots + \theta_q \epsilon_{t-q} + \epsilon_t \quad (2)$$

The model includes components θ , which plays a role in associating the current value with several prediction errors from previous periods. The error comes from the autoregressive model in the previous period. When the model accounts for errors up to lag q , then the model is categorized as a model with order q .

This study utilizes R Studio software, utilizing the `auto.arima()` function with a prediction interval set at a 95% confidence level, the `auto.arima()` function automatically determines the best order combination (p,d,q) based on the determination of root units, minimization of the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) (Zhang et al., 2023), as well as the maximum likelihood (MLE) estimate to obtain the most optimal ARIMA model (Wong et al., 2021).

The root of the root unit test is conducted to ensure the stationarity of the data, with the results serving as the basis for determining whether differentiating processes are necessary to form an optimal ARIMA model. Meanwhile, AIC and BIC testing are performed to compare various models. The difference is that AIC uses a linear penalty on the number of parameters. At the same time, BIC gives a logarithmic penalty on the sample size, making it more conservative for complex models. In the diagnostic test, white noise testing is carried out. The test was conducted using the Ljung-Box test statistics to verify the absence of autocorrelation in the residuals, thereby confirming that the model effectively captured the data structure (Pei et al., 2024). If the p-value is more than 0.05, it can be said to meet the assumption of White Noise.

RESULTS AND DISCUSSION

The section presents the projected health expenditure for Indonesia, Singapore, and Malaysia. The findings show an increase in health expenditure across all components in all three countries. Singapore is projected to experience increases across all health expenditure components. In contrast, Indonesia is projected to have the highest growth rate, albeit with a nominal figure that is significantly lower than Singapore's. The third country involved in this research, Malaysia, is expected to experience more moderate growth than the other two countries.

Table 2. Descriptive Statistics (Mean and Standard Deviation)

Country	hecap	ghecap	phecap	ofpcap
Indonesia	249.8671 (102.4904)	99.19548 (66.74544)	147.6956 (47.97503)	107.9053 (34.67953)
Singapore	2870.088 (1365.114)	1298.502 (953.7125)	571.586 (440.3465)	1031.536 (200.2997)
Malaysia	734.8482 (266.1519)	388.1598 (147.6448)	346.6776 (119.7713)	255.1862 (89.1483)

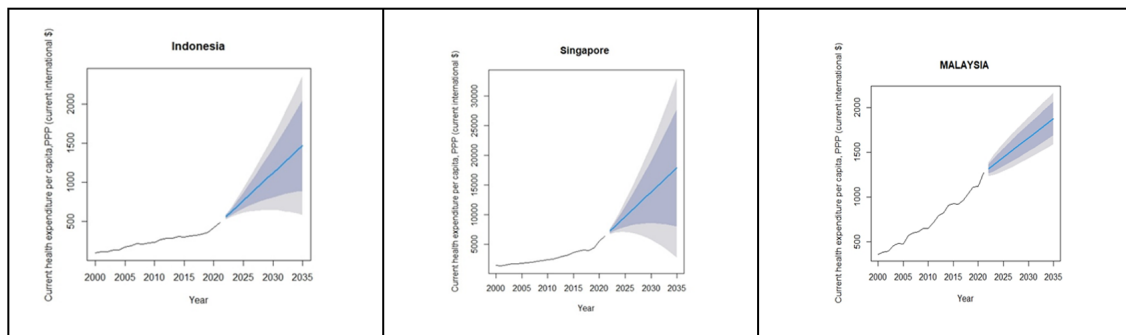
Table 2 displays the average values and standard deviations (in parentheses) for the four types of per capita health expenditure, expressed in current international dollars with purchasing power parity (PPP) adjustment, for the period 2000-2021. Singapore recorded the highest value of per capita health expenditure (\$2870.088), far above Malaysia (\$734.8482) and Indonesia (\$249.8671). A similar pattern was observed in government healthcare spending, where Singapore excelled on average (\$ 1,298,502), followed by Malaysia (\$ 388,159) and Indonesia (\$ 99,195). The highest ranking for private health expenditure per capita remains in Singapore (\$571.59), followed by Malaysia (\$346.68) and Indonesia (\$147.70). Meanwhile, the highest direct health expenditure per capita from personal pockets was recorded in Malaysia (\$255.19), followed by Singapore (\$1031.54) and Indonesia (\$107.91).

Figure 2 and Table 3 present the estimated total per capita health expenditure in US dollars for Indonesia, Singapore, and Malaysia from 2022 to 2035, adjusted for purchasing power parity (PPP) and inflation. Projections show that the per capita health expenditure level in 2035 will be the highest in Malaysia, Singapore, and Indonesia. Based on estimates, in 2035, the per capita health expenditure for Malaysia is estimated at \$ 1,875,623 (95% PI: \$1,587,060 - \$2,164,187), for Singapore at \$ 17,897,336 (95% PI: \$2,726,342 - \$33,068,331), and for Indonesia at \$ 1,472,558 (95% PI: \$582,709 - \$2,362,408).

Table 3. Projected Health Expenditure for 2025, 2030, and 2035 (per capita)

Country	2025	2030	2035	%Growth 2025-2035
Indonesia	765.9450 (609.0629, 922.8271)	1120.4361 (645.1635 ,1595.7086)	1472.5586 (582.7091, 2362.4082)	92.25%
Singapore	9651.113 (7042.908 ,12259.317)	13774.225 (5735.198, 21813.251)	17897.336 (2726.342 ,33068.331)	85.44%
Malaysia	1441.758 (1287.515, 1596.002)	1658.691 (1427.325, 1890.056)	1875.623 (1587.060, 2164.187)	30.09%

Figure 2. Current Health Expenditure of Indonesia, Singapore and Malaysia



Source: Data processed (2025)

Projected government health-sector expenditure per capita for 2025, 2030, and 2035 is shown in Table 4. By 2025, per capita government expenditure on the health sector is projected to be \$516.22 (95% PI: 379.06–653.38) for Indonesia, \$ 6,760.03 (95% PI: 4,371.19–9,148.87) for Singapore, and \$832.88 (95% PI: 683.26–982.50) for Malaysia. By 2030, the value of this health expenditure increases to \$802.90 (95% PI: 400.55–1205.25) for Indonesia, \$ 10,207.81 (95% PI: 2,844.92–17,570.71) for Singapore, and \$832.88 (95% PI: 683.26–982.50) for Malaysia.

By 2030, the value of this health expenditure increases to \$802.90 (95% PI: 400.55–1205.25) for Indonesia, \$ 10,207.81 (95% PI: 2844.92–17,570.71) for Singapore, and \$982.84 (95% PI: 715.63–1,250.06) for Malaysia. Meanwhile, the projected 2035 per capita government expenditure for the health sector in Indonesia is expected to reach \$1089.58 (95% PI: 341.88–1837.28), while in Singapore it is \$13655.59 (95% PI: -239.43–27550.61) and in Malaysia it is \$1132.81 (95% PI: 745.47–1520.15).

Table 4. Projected Government Health Expenditure for 2025, 2030, and 2035 (per capita)

Country	2025	2030	2035	%Growth 2025-2035
Indonesia	516.2201 (379.0620, 653.3782)	802.8983 (400.5478, 1205.2488)	1089.5790 (341.8768, 1837.2812)	111.07%
Singapore	6760.031 (4371.1920, 9148.869)	10207.810 (2844.915, 17570.706)	13655.590 (-239.4313, 27550.612)	102%
Malaysia	832.8770 (683.2581 982.4958)	982.8438 (715.6305, 1250.0571)	1132.8106 (745.4682, 1520.1530)	36.01%

Table 5. Projected Private Sector Health Expenditure for 2025, 2030, and 2035 (per capita)

Country	2025	2030	2035	%Growth 2025-2035
Indonesia	196.1074 (108.78212, 283.4326)	208.5270 (-7.35622, 424.4102)	220.9466 (-155.32950, 597.2228)	12.67%
Singapore	2622.227 (2406.685, 2837.768)	2961.490 (2638.178, 3284.803)	3300.754 (2897.513, 3703.995)	25.88%
Malaysia	624.7349 (574.6644, 674.8055)	711.5849 (636.4792, 786.6907)	798.4349 (704.7615, 892.1082)	27.8%

In terms of projected private sector expenditure on health in 2025, the estimated per capita private sector spending in Indonesia is projected to be \$196.11, with a 95% prediction interval ranging from \$108.78 to \$283.43. In Singapore, the figure is significantly higher at \$2,622.23, with a 95% prediction interval of \$2,406.69 to \$2,837.77. Malaysia's estimated expenditure stands at \$624.73, with a 95% prediction interval of \$574.66 to \$674.81.

By 2030, Indonesia's private sector spending is expected to increase to \$208.53, though the range is vast, from -\$7.36 to \$424.41. For Singapore, the projected amount rises to \$2,961.49, with a 95% prediction interval of \$2,638.18 to \$3,284.80. In Malaysia, the estimate is \$711.58, with a 95% prediction interval of \$636.48 to \$786.69. Looking ahead to 2035, Indonesia's private sector spending is forecast to reach \$220.95, with a lower boundary of -\$155.33, indicating high uncertainty, and an upper bound of \$597.22. In Singapore, health expenditure is projected to be \$3,300.75, with a 95% prediction

interval of \$2,897.51 to \$3,703.99. In Malaysia, the estimated expenditure is \$798.43, with a 95% prediction interval of \$704.76 to \$892.11. Table 5 provides detailed data on these projections.

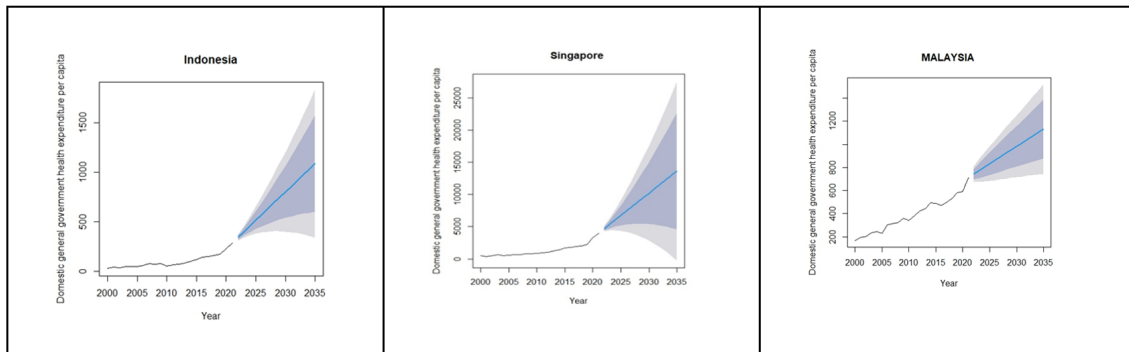
The projections in Table 6 indicate that out-of-pocket per capita shows an increasing trend across the three countries under study: Indonesia, Singapore, and Malaysia. By 2025, Singapore is expected to have the highest per capita expenditure of \$1568.12 (95% PI: 1346.30–1789.94), followed by Malaysia with \$456.67 (95% PI: 407.68–505.66), while Indonesia recorded the lowest figure of \$137.51 (95% PI: 73.46–201.56). The same trend continues in 2030, with Singapore remaining at the top at \$ 1,741.61 (95% PI: \$1,408.88–\$2,074.34), followed by Malaysia at \$518.94 (95% PI: \$ 445.45–\$ 592.42) and Indonesia at \$145.38 (95% PI: \$ 3.48–\$ 287.28). By 2035, the output gap between these countries is expected to become more pronounced. Singapore is projected to spend \$1,915.10 per capita (95% PI: \$ 1,500.11–\$ 2,330.08), while Malaysia increases to \$581.20 (95% PI: \$ 489.55–\$ 672.86). Indonesia is expected to maintain a lower spending of \$153.24 (95% PI: -81.90–388.39).

Table 6. Projected Out-of-Pocket Health Expenditure for 2025, 2030, and 2035 (per capita)

Country	2025	2030	2035	%Growth 2025-2035
Indonesia	137.5117 (73.461237, 201.5622)	145.3763 (3.476183, 287.2763)	153.2408 (-81.903676, 388.3853)	11.43%
Singapore	1568.118 (1346.299, 1789.936)	1741.608 (1408.880, 2074.336)	1915.099 (1500.114, 2330.084)	22.13%
Malaysia	456.6719 (407.6806, 505.6632)	518.9373 (445.4504, 592.4242)	581.2027 (489.5484, 672.8570)	27.27%

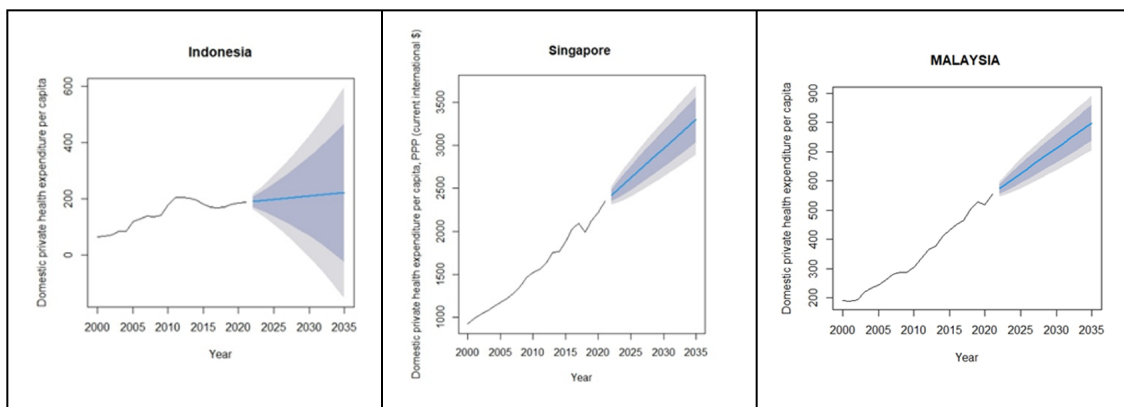
This result aligns with the research by Zheng-Zheng Li et al. (2021), which found that Indonesia's public health expenditure is converging, whereas its private health expenditure is diverging. The research shows that only its public health expenditure is catching up with those of ASEAN countries with higher health expenditures. In contrast, Singapore's public health expenditure is becoming more divergent, while its private health expenditure is moving in the opposite direction. This result is attributed to Singapore's status as a developed country, where the government-run insurance and healthcare systems serve 90% of its citizens. Unlike other countries, Malaysia's public and private health expenditure are actually converging. This condition is likely due to their stable, developing economy and moderately high public health spending.

Figure 3. Government Health Expenditure per Capita in Indonesia, Singapore and Malaysia



Source: Data processed (2025)

Figure 4. Domestic Private Health Expenditure per Capita in Indonesia, Singapore and Malaysia



Source: Data processed (2025)

In this section, we will discuss health spending in Indonesia. With per capita health expenditure estimated to continue increasing, the government needs a strategy to reduce the burden on the community. This burden reduction aims to maintain people's purchasing power and improve their welfare (Gourley et al., 2021). One strategy the government can implement is to increase government spending in the health sector. According to World Bank data from 2022, Indonesia spends only about 1.39% of its national GDP on health. This figure ranks Indonesia fourth-lowest in health expenditure among Southeast Asian countries, with Timor-Leste having the highest health sector spending (10.31%), followed by Thailand (3.89%). By increasing spending in the health sector, the government can significantly enhance the quality of national healthcare (Deka, 2020). Furthermore, allowing an increase in national health expenditure can help improve national economic performance, as maintaining health is strongly correlated with a nation's capacity to generate income and the productivity of its labor (Raghupathi et al., 2020).

One way to ensure the performance of government health spending is to restore the mandatory spending policy in the health sector, which was previously abolished in Act No. 17 of 2023 (Rambe et al., 2024). This mandatory spending policy can be

further developed using the WHO recommendations—5-6% of the state budget—and adjusted to a higher or lower level, depending on regional needs. The implementation of this policy has been proven to reduce the health disparity rate and improve welfare and quality in health services, as seen in the United States (Westmoreland et al., 2006) and the United Kingdom (Charlesworth et al., 2021)

However, government spending in the health sector must also be followed by efficient and effective planning in its implementation. As the health burden is expected to increase in the coming years, the government needs to consider several measures to ensure public health, including financially revitalizing the National Health Insurance system. One of the most concerning health issues in Indonesia is the habit of smoking. A report by the Global Adult Tobacco Survey (GATS) in 2021 showed that around 34.5% of adults in Indonesia consume tobacco products. Although this is concerning, it also means that the national revenue from cigarette excise is high. Through PMK No. 143 of 2023, the government has determined that around 37.5% of cigarette excise proceeds must be allocated to the Health Insurance Administration Agency (BPJS). This figure is still much lower than the previous regulation, under Law 31 No. 28 of 2009, where the cigarette excise allocated to BPJS is a minimum of 50%. By reconsidering this allocation figure, the government can secure additional funding for the health insurance system. In addition, the government can implement incentives for healthy habits, such as supporting daily walking or running programs, quitting smoking, regular health check-ups, and weight-loss programs that can be tracked through the application. This healthy habit incentive program has been implemented in the Netherlands through the *Samengezond* program and has been shown to impact public health positively (Agachi et al., 2024).

The discussion will continue by examining conditions in Singapore. Singapore's projected per capita health expenditure growth shows a significant spike trend. Based on 2021 data, per capita health expenditure reached \$ 6,352.62 and is projected to increase by \$ 17,897,336 in 2035, or grow by around 181.73%. Government spending for the government sector is projected to reach \$13655,590 in 2025, rising 241% from 2021. Private spending is projected to reach \$3300,754 by 2035.

Meanwhile, the surge in Out-Of-Pocket expenditure is estimated to reach \$1,915 per capita in 2035. This surge, driven by inflation and economic growth, poses a threat to the health system, as changes in demand will destabilize it. In this context, Singapore faces a demographic threat, namely a rapidly aging population. Singapore is projected to have a proportion of citizens aged 65 years and above by 2030, reaching 23–25% of the total population (Chan, 2017). The growth of the elderly population, coupled with the increasing prevalence of chronic diseases, puts substantial pressure on intermediate and long-term care (ILTC) services and a burden on the health system as a whole (Tan et al., 2021). This is reflected in the finding that the median annual healthcare cost per capita for patients with multimorbidity (SGD 682) is almost twice that of patients without multimorbidity (S. Tan et al., 2021). Correspondingly, the average annual medical cost for patients with type 2 diabetes mellitus in Singapore was found to be

US\$2,034, with 61% from inpatient services, 35% from outpatient services, and 4% from emergency department (A&E) services. This data indicates an increase in multimorbidity and complications of chronic diseases with significant implications for the structure and sustainability of health financing.

Singapore has an efficient health system that spends only 4-5% of its national income (GDP) on the health sector, well below the levels in many other countries. According to the aforementioned figure, only a third of the cost is covered by the Singapore government, while the community bears the remaining two-thirds through the health savings system, insurance, or direct payments (Lim, 2017). By allocating around 4–5% of GDP to health, Singapore's Universal Health Coverage (UHC) Index is 88/100 in 2021, while compared to the group of countries with government health expenditure of 4.01–8% of GDP, it has an average UHC Index of around 59 (Lozano et al., 2020).

Singapore's health financing system emphasizes individual responsibility, with programs such as MediSave, MediShield Life, and government subsidies through MediFund, all of which focus on inpatient care (Ministry of Health, 2024). However, the existence of this structure poses an equity challenge related to personal income, especially for outpatient treatment or expensive long-term care, which disproportionately affects low-income communities, despite this approach potentially keeping government spending low (Myint et al., 2019). According to the Commonwealth Fund website, Medisave has not been able to reach nursing homes or home- or center-based services. In addition, outpatient costs, such as GP visits or specialist clinics, can vary widely and sometimes exceed MediSave savings (Earn, 2020). With these conditions, Singapore is expected to implement more comprehensive interventions by strengthening health savings schemes, such as MediSave, and developing preventive strategies to reduce the prevalence of chronic diseases.

The final discussion will focus on the conditions in Malaysia. Malaysia's projected healthcare spending shows a gradual upward trend, with an estimated per capita health expenditure reaching \$1,875 by 2035, representing a 30.09% increase from 2025. Despite the increase, this growth rate is significantly lower than that of Singapore (85.44%) and Indonesia (92.25%), indicating potential stagnation in health financing relative to future needs. One of the key factors is limited fiscal space, as public spending on health in Malaysia remains 4.4% of gross domestic product (GDP), below the WHO-recommended range of 5–6% needed to achieve universal health coverage (UHC). This is further exacerbated by the high burden of out-of-pocket (OOP) expenditures by households, which accounted for 31.5% of total healthcare spending in 2021 (Ministry of Health Malaysia, 2023). This situation can increase the risk of potentially heavy financial burdens for households, especially for vulnerable groups. Inequities in the distribution of health resources can also worsen access to services. As Lim et al. (2017) found, access to primary healthcare in rural areas of Malaysia lags behind that in urban areas in terms of the number of facilities, the number of health workers, and the level of services offered.

In addition to the fiscal aspect, Malaysia's health system also faces structural problems. According to the 2023 Ipsos Health Service Monitor report, Malaysians identify several key issues, including long waiting times (50%), shortages of medical personnel (45%), and the high cost of care (45%). However, public trust in the health system remains high, with Malaysia ranked third globally in terms of trust in healthcare services, after Singapore and Switzerland (IPSOS, 2023). This data shows that despite significant pressure on the system, public confidence in the skills and quality of health professionals' services remains unshaken. However, without an accompanying systemic approach to addressing capacity and efficiency issues, this high level of trust risks becoming a paradox.

Given the complexity of challenges in Malaysia's health system and projected health expenditures, a planned policy strategy is needed, including optimizing the distribution of health workers by providing competitive incentives based on geographical needs to overcome inequality in access to health services, especially in remote areas. Another idea is to strengthen sectoral collaboration by developing public-private partnerships, which are crucial for enhancing efficiency, expanding capacity, and driving innovation in the provision of healthcare facilities.

Indonesia, Malaysia, and Singapore have striking differences in health expenditure projections. The state of Singapore nominally and effectively leads the world in per capita health expenditure, but it still faces challenges in access and personal cost burdens. Malaysia recorded moderate growth, but this risked stagnation without reforms. Meanwhile, Indonesia is projected to experience the highest growth in percentage terms; however, it still lags in nominal terms and faces challenges, including low government spending and service inequality. In this comparison, Singapore is in the best position, although the country is not free from challenges in healthcare expenditure. However, Indonesia has a unique opportunity to enhance the effectiveness of its fiscal policies and allocations.

CONCLUSION

The study shows that the trend of per capita health expenditure in Indonesia, Singapore, and Malaysia is projected to increase across all financing sources—government, private financing, and private spending—until 2035. The results show an increase in health expenditure across all components in all three countries. Singapore is projected to see increases across all health expenditure components. Indonesia is projected to experience the highest growth rate, although its nominal rate is significantly lower than Singapore's. In Malaysia, it is expected to experience more moderate growth than the other two countries.

The findings reveal challenges in ASEAN, including a high out-of-pocket burden, high costs of treating chronic diseases, and unequal access to health services. The governments of the three countries must prioritize increasing budget allocation, such as reinstating mandatory spending in Indonesia and increasing public spending in

Malaysia. Revitalization of financing schemes is also crucial, for example, by increasing the allocation of cigarette excise for BPJS Kesehatan in Indonesia and expanding MediSave coverage in Singapore. In addition, a shift in focus to prevention through health incentive programs, system optimization with incentives for medical personnel, and public-private partnerships will ensure a sustainable and equitable health system. Therefore, policies that prioritize strengthening government health allocations, enhancing health insurance schemes, increasing the budget for health programs while maintaining the principle of efficiency in budget management, and optimizing investment ratios between preventive and curative care efforts to achieve Universal Health Coverage (UHC) are needed.

The ARIMA model is employed in this study to predict per capita health spending from both government and private sources, as well as out-of-pocket expenditures, from 2022 to 2035. Although the ARIMA model is generally recognized as effective in predicting time series data, its application in health expenditure projections has several limitations. First, the ARIMA Model used can predict the short term, but as the forecasting period increases, its accuracy decreases (Luo et al., 2017). Second, the ARIMA model is conventionally designed to handle univariate and linear time series, so it has limitations in capturing a wide range of complex relationships (Wang et al., 2024), as is often the case in health expenditure data. These limitations restrict the model's ability to account for the various factors that contribute to changes in health expenditure, such as economic shocks, epidemics, and regulatory changes. Third, there are several cases of uncertainty in the projection results that are reflected in the wide prediction interval, one of the factors that is suspected to be due to the limitations of historical data, specifically the range of health expenditure data covering the period 2000-2021, which limits the model's ability to identify long-term trends reliably.

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Unlocking Sustainability in Informal Micro Enterprises: Capital Access in The Fintech Era

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ABSTRACT

Research Originality: This study offers a unique exploration of how capital access mediates the impact of financial literacy and fintech peer-to-peer (P2P) lending on the sustainability of micro and small enterprises (MSEs) in traditional markets, utilizing SDG-based indicators.

Research Object: This study examines the effects of financial literacy and fintech P2P lending on capital access and sustainability of MSEs in traditional markets.

Research Methods: The study employed a quantitative approach, utilizing Structural Equation Modeling analysis, using 232 MSEs in Jakarta.

Empirical Results: The findings indicate that financial literacy and fintech P2P lending have a positive impact on both capital access and the sustainability of MSEs. However, capital access did not significantly affect the sustainability of MSE or mediate either factor.

Implications: The Financial Services Authority (OJK) must enhance legislation protecting MSEs from fintech risks and promote financial literacy. The OJK must coordinate P2P platforms, cooperatives, and MSE offices. Creating an inclusive fintech ecosystem for traditional market MSEs, with microloans and mentorship, is essential for viable financing.

Keywords:

financial literacy; financial technology; access to finance; SMEs sustainability; sustainable development goals (SDGs)

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INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) in Indonesia represent a significant market opportunity for the financial services sector, especially formal financial institutions, to facilitate financing. Nevertheless, most MSMEs face challenges in obtaining funding from traditional financial institutions such as banks. A significant number of MSMEs are unbanked and lack essential documents, such as financial statements, business licenses, and adequate collateral, which are necessary prerequisites for accessing bank loans. Consequently, numerous MSMEs were ensnared by predatory lenders or turned to exorbitant Internet loans for business expansion (Candraningrat et al., 2021). The Indonesian Financial Services Authority (OJK) reported that outstanding online finance, specifically fintech peer-to-peer (P2P) lending, reached IDR 51.46 trillion in 2023, indicating a year-on-year growth of 28.11 percent. Of this total, 38.39 percent was allocated to micro, small, and medium enterprises (MSMEs), with disbursements amounting to IDR 15.63 trillion for individual MSMEs and IDR 4.13 trillion for business organizations. The significant increase in fintech financing illustrates the persistent intermediation role and the substantial demand from the public and MSMEs for more accessible and expedited financial services compared to traditional banks and finance companies (OJK Press Release, 2023).

Numerous micro and small enterprises (MSEs) in traditional markets exhibit low financial literacy. They lack an understanding of fundamental concepts such as cash flow management, loan interest, and working capital budgeting. Inadequate literacy levels hinder entrepreneurs from effectively leveraging financing opportunities, rendering micro and small enterprises in traditional markets susceptible to financial risks and causing them to continue encountering challenges in accessing financial resources due to a lack of comprehension of financial management (Kurniasari et al., 2023). A considerable number of MSMEs with limited financial literacy engage with financial products and services through online loans (Nugraha et al., 2022). However, some MSMEs use these loans for consumption rather than constructive business development. This problem stems from a lack of understanding of the importance of financial management in entrepreneurship. Access to digital financial products, such as online loans, can substantially enhance the financial inclusion of MSMEs if utilized correctly (Nugraha et al., 2022). The integration and collaboration between P2P lending and banks foster favorable trends in business cycle growth, especially in the small business sector (Alshater et al., 2022). The swift expansion of digital financial services, particularly during the COVID-19 pandemic, is a significant factor propelling the adoption of fintech apps, necessitating an understanding of digital finance (Uthaileang & Kiattisin, 2023).

Siddik et al. (2023) demonstrated that fintech and financial literacy are crucial determinants of corporate sustainability success in Bangladesh. Moreover, access to finance has a significant mediating influence on the relationship between fintech adoption and sustainability performance, as well as between financial literacy and sustainability performance. The data indicate that access to finance enhances sustainability performance. Charfeddine et al. (2024), Frimpong et al. (2022), Lontchi et al. (2023), and Masdupi et al. (2024) suggest that financial literacy has a positive influence on financial access

and enhances the performance of MSMEs. Alharbi et al. (2022) and Kurniasari et al. (2023) demonstrate that financial literacy has a positive influence on financial accessibility, a finding corroborated by Jun and Ran (2024). Digital finance can mitigate financial limitations. According to Meressa (2023), entrepreneurial financial literacy enhances the sustainability of small enterprises in Ethiopia.

Abbasi et al. (2021) investigated the impact of peer-to-peer (P2P) lending on the access to financing of small and medium-sized enterprises. Utilizing a sample of OECD nations from 2011 to 2018, they found that P2P lending enhances the financial accessibility of MSEs. Small and medium-sized enterprise owners or managers can fulfill their liquidity requirements through peer-to-peer lending. Conversely, Doumi et al. (2024) found contrasting results, suggesting that P2P lending does not directly influence financial access. Lontchi et al. (2023) found that fintech has a positive impact on the performance of MSEs in Cameroon. Efendi et al. (2023) indicated that P2P lending has a positive influence on capital access, although it does not significantly affect the sustainability performance of MSEs in Indonesia.

The accessibility of working capital allows MSMEs to enhance their production capacity, create goods, and endure market challenges. Frimpong et al. (2022) and Khan et al. (2021) propose that access to digital finance enhances the performance of MSMEs. Nohong et al. (2021) discovered that funding strategies for working capital and firm investment can enhance entrepreneurial success, as evidenced by periodic increases in sales and profits. Research (Meressa, 2023) demonstrates that access to formal credit funding mediates the relationship between entrepreneurial financial literacy and the sustainability of MSMEs. Alharbi et al. (2022) substantiate the mediating role of capital access, illustrating its favorable influence on the relationship between financial literacy and MSME performance in Saudi Arabia. Masdupi et al. (2024) found that financial access is not a critical determinant of the sustainability of MSEs. However, that capital access may mediate the impact of fintech adoption on the sustainability performance of MSEs (Siddik et al., 2023).

This study examines the role of capital access in mediating the impact of financial literacy and P2P lending on the sustainability of micro and small enterprises in traditional marketplaces, addressing the identified flaws and deficiencies in prior studies. The primary objective of this research is to ensure that micro and small enterprises have the potential for growth and development, particularly in securing funding. Capital access plays a crucial role in the development of SMEs in Indonesia; however, the majority of SMEs face challenges in obtaining financing from conventional financial institutions such as banks. As a result, several micro and small enterprises are ensnared by Internet loans that offer little in terms of conditions yet entail exorbitant interest rates. Consequently, our research aims to provide answers to the challenges faced by MSEs, specifically by developing a model for MSE sustainability that examines the impact of financial literacy and fintech P2P lending on capital accessibility and its effect on MSE sustainability in Jakarta.

This study addresses a deficiency in the current literature (Babajide et al., 2023; Charfeddine et al., 2024; Endris & Kassegn, 2022; Frimpong et al., 2022; Kurniasari

et al., 2023; Lontchi et al., 2023; Meressa, 2023; Rizki & Hendarman, 2024) by investigating the impact of financial literacy, fintech P2P lending, and capital accessibility on the performance and sustainability of MSMEs using a novel framework. This study employs distinct indicators compared to other research, using measures that align with the Sustainable Development Goals (SDGs) within the framework of online lending to MSMEs in informal, socially relational, conventional marketplaces. Consequently, this study can be characterized as distinct and novel.

This study is expected to provide theoretical insights that enhance the understanding of the impact of financial literacy and fintech peer-to-peer lending on capital accessibility and the sustainability of micro and small enterprises, particularly within the traditional market sector. The findings of this study are anticipated to establish a basis for MSEs to enhance financial literacy and effectively leverage FinTech. These findings are anticipated to assist fintech service providers in creating products designed for MSE requirements and aid the government in developing more effective financial inclusion and digitalization policies for micro and small enterprises in traditional markets.

METHODS

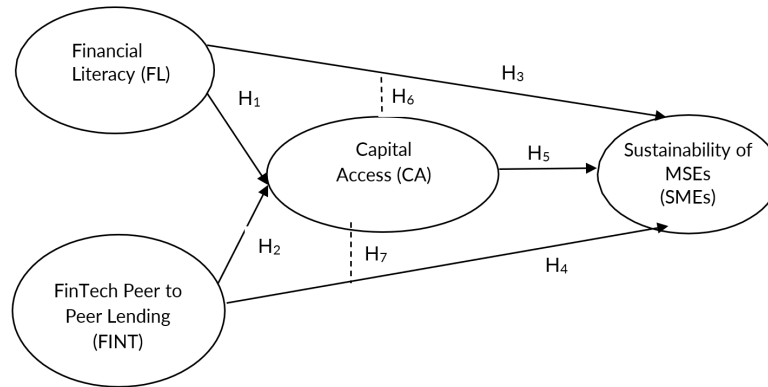
This study used a quantitative methodology with a causal framework to achieve its aims. The sample comprised micro and small enterprises in traditional markets in Jakarta, Indonesia. The sample approach employed the calculation formula of Hair et al., which multiplied the number of indicators by a factor of five to ten (Wati, 2021): the minimum sample size was 140, given the 28 questions. This study had a sample size of 232 MSEs in Jakarta that had applied for online loans, distributed among Central, South, West, East, and North Jakarta. The research data were gathered through a survey that employed a questionnaire utilizing a Likert scale, which ranged from "strongly disagree" to "strongly agree," with a scoring system of 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree).

The research variables are the sustainability of MSE (dependent variable), financial literacy and fintech P2P lending (independent variables), and capital access (intervening variable). Indicators employed to assess the sustainability of MSE include production, sales, and revenue growth, product innovation, consumer happiness, market expansion, and workforce expansion (Babajide et al., 2023; Kurniasari et al., 2023; Masdupi et al., 2024; Meressa, 2023). Financial literacy is assessed using indicators such as general financial knowledge, financial management, asset comprehension, transaction documentation, routine financial reporting, comprehensive financial reporting, and business facilitation (Alharbi et al., 2022; Babajide et al., 2023; Charfeddine et al., 2024; Frimpong et al., 2022; Masdupi et al., 2024). Fintech P2P lending is assessed using metrics such as fund selection, innovation in financial planning, effective fund utilization, comprehension of lending institution technology, fund application, and loan agreements (Lontchi et al., 2023; Masdupi et al., 2024; Wati et al., 2020). Capital access is assessed using measures such as capital magnitude, financing origin, simplicity of fund acquisition, repayment

duration, and the ratio of loans to capital (Alharbi et al., 2022; Charfeddine et al., 2024; Masdupi et al., 2024).

Drawing on prior theories and studies, the author developed a conceptual framework as a problem-solving methodology, as illustrated in Figure 1.

Figure 1. Conceptual Framework



Source: Author's elaboration (2025)

Figure 1 illustrates the correlation between financial literacy and Fintech P2P lending characteristics, specifically capital access, and their direct and indirect impact on the sustainability of micro and small enterprises. This study examines micro and small enterprises within traditional markets, comprising five direct and two indirect hypotheses for the research model.

Data analysis employed a Structural Equation Model with Smart PLS version 4.1.1.4 software. Data analysis with Smart PLS uses outer and inner model measurements. The outer model was used to test the validity and reliability of the constructs. The inner model was used to test the goodness-of-fit model and perform hypothesis testing. The framework for evaluating this hypothesis is as follows.

Model 1 is used to test hypotheses 1-2

$$CA = \beta_1 FL + \beta_2 FINT + \varepsilon_1 \dots (\text{Model 1})$$

Model 2 is used to test the direct hypotheses (3-5) and indirect hypotheses (6-7)

$$SMEs = \beta_3 FL + \beta_4 FINT + \beta_5 CA + \beta_6 FL_CA + \beta_7 FINT_CA + \beta_8 Size + \varepsilon_2 \dots (\text{Model 2})$$

This study employed a control variable, represented by the size of the MSE, which was proxied by the number of employees in the MSE, to assess the robustness of the model. The robustness test was performed by evaluating the model using the MSE size as a control variable (main model) and a model excluding the MSE size (robust model). If the analysis results are consistent, the research model is deemed robust; conversely, if the models are inconsistent, they are considered to be sensitive.

RESULTS AND DISCUSSION

The research participants were proprietors or managers of micro and small enterprises in traditional markets located in five administrative cities in Jakarta, Indonesia. According to Table 1, the business location group with the highest number of respondents was North Jakarta, with 66 respondents, or 28% of the total 232 respondents. Conversely, the category with the fewest respondents was West Jakarta, with 19 respondents (8% of the total 232 respondents). The predominant respondents in this survey were women, comprising 57% of the 232 participants surveyed. The predominant age group among responders was 20-30 years, with 128 individuals (55%), while those over 30 years of age constituted 41%. The predominant educational attainment among respondents was high school, vocational high school, or Islamic high school (SMA/MA), comprising 153 individuals (66%) of the total respondents.

Table 1. Respondent Characteristics

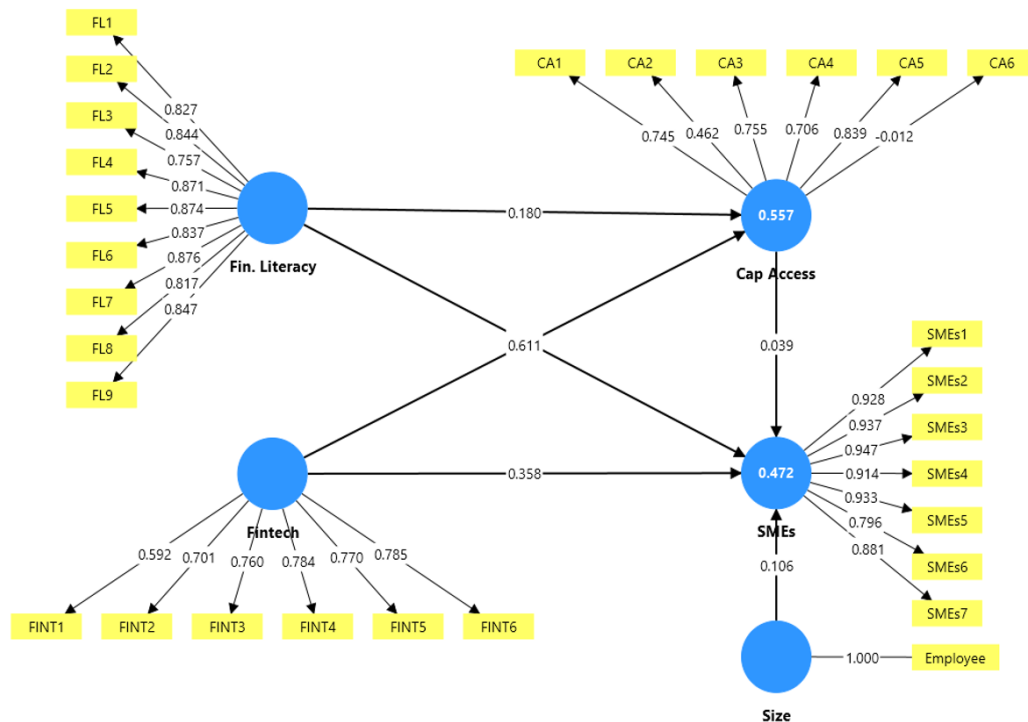
Characteristics	Amount	Percentage	Characteristics	Amount	Percentage
Business Location			Gender		
North Jakarta	66	28%	Woman	132	57%
West Jakarta	19	8%	Man	100	43%
Central Jakarta	64	28%		232	100%
East Jakarta	35	15%	Education		
South Jakarta	48	21%	SD/MI	11	5%
	232	100%	Junior High School	26	11%
Participant Age			Senior High School	153	66%
< 20 years	9	4%	Diploma	17	7%
20-30 years	128	55%	S1	25	11%
> 30 years	95	41%		232	100%
	232	100%	Business fields		
Marital			Culinary	163	70%
Bachelor	111	48%	Fashion	40	17%
Marry	121	52%	Souvenir	7	3%
	232	100%	Automotive	14	6%
Business Age			Agribusiness	8	3%
< 1 year	37	16%		232	100%
1-3 years	72	31%	Number of employees		
3-5 years	57	25%	Have no employees	148	64%
> 5 years	66	28%	1-2 officers	45	19%
	232	100%	3-5 officers	25	11%
			> 5 officers	14	6%
				232	100%

Source: Author's calculation (2025)

According to Table 1, 111 (48 %) business owners were single, while 121 (52%) were married. The predominant business sector among respondents was the culinary industry, with 163 individuals, or 70% of the total respondents. Conversely, the industry with the fewest participants was agribusiness, including only eight respondents, or 3% of the total. The majority of respondents have operated their firm for 1-3 years, comprising 72 individuals, or 31% of the total respondents. Simultaneously, 37 respondents, nearly 16% of the total, had operated their businesses for less than a year. The majority of respondents, comprising 148 individuals or 64% of the total, do not employ any staff, while a minority, consisting of 14 respondents or 6% of the total, have more than five employees.

External model evaluation in this study employed validity and reliability assessments. An indication is deemed valid if its outer loading value exceeds 0.7. Hair et al. (2019) indicated that outer loading levels ranging from 0.50 to 0.60 remain appropriate during the scale development phase of the research. Variable dependability was assessed using composite reliability and Cronbach's alpha. The subsequent graph illustrates the external loading values in the study model.

Figure 2. Outer Loading Test Results



Source: Output Smart PLS 4.1.1.4 (2025)

According to the outer loading assessment (Figure 2), two indicators, CA2 and CA6, were deemed invalid because their outer loading values were below 0.5. Consequently, these two indicators were eliminated from the research model. Table 2 shows the outer loading that excluded markers CA2 and CA6, adhering to an outer loading threshold of 0.5.

According to Table 2, the outer loading values for all indicators related to financial literacy, fintech P2P lending, capital access, and the sustainability of micro and small enterprises in traditional markets exceeded 0.5. This indicates that all indicators are valid and exhibit strong convergent validity, as evidenced by the Average Variance Extracted (AVE) values, which also surpass 0.5, as demonstrated in Table 3.

Table 2. Outer Loading of Research Indicators

Variables	Indicator	Outer Loading	Result
Financial Literacy (FL)	FL1	0.827	Valid
	FL2	0.844	Valid
	FL3	0.757	Valid
	FL4	0.871	Valid
	FL5	0.874	Valid
	FL6	0.837	Valid
	FL7	0.876	Valid
	FL8	0.817	Valid
	FL9	0.847	Valid
Fintech Peer to Peer Lending (FINT)	FINT1	0.586	Valid
	FINT2	0.695	Valid
	FINT3	0.763	Valid
	FINT4	0.787	Valid
	FINT5	0.771	Valid
	FINT6	0.787	Valid
Capital Access (CA)	CA1	0.74	Valid
	CA3	0.743	Valid
	CA4	0.74	Valid
	CA5	0.86	Valid
Sustainability of Micro and Small Enterprises (SMEs)	SMEs1	0.928	Valid
	SMEs2	0.937	Valid
	SMEs3	0.947	Valid
	SMEs4	0.914	Valid
	SMEs5	0.933	Valid
	SMEs6	0.796	Valid
	SMEs7	0.881	Valid

Source: Author's calculation (2025)

Table 3. Composite Reliability, Cronbach Alpha, and AVE

Variable	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Financial Literacy	0.947	0.949	0.956	0.705
Fintech P2P lending	0.829	0.843	0.875	0.541
Capital Access	0.774	0.789	0.855	0.597
Sustainability of MSEs	0.963	0.969	0.97	0.822

Source: Author's calculation (2025)

The study's dependability was assessed by analyzing the composite reliability and Cronbach's alpha values. A build is deemed dependable if its composite reliability value exceeds 0.70 (Wati, 2021). The composite reliability and Cronbach's alpha values for the independent variables of financial literacy and fintech P2P lending, the mediating variable of capital access, and the dependent variable of MSE sustainability exceeded 0.7 (refer to Table 4), demonstrating that all variables possessed adequate reliability, fulfilling the criteria for Cronbach's alpha and composite reliability.

The inner model test, also known as the structural model test, aims to assess the relationships between the constructs within the study framework. Model determination necessitates evaluation strategies prior to hypothesis testing (Goodness of Fit). The Stone-Geisser Q-square test is used in model determination assessment to evaluate the R-squared value. The dependent variables and the magnitude of the structural route coefficients were also considered in this study. According to Wati (2021), the intended result for endogenous latent variables in a structural model is an R-squared value. A correlation coefficient of ≥ 0.67 indicated strong results, whereas coefficients ranging from 0.19 to 0.33 were deemed weak, and those between 0.33 and 0.67 were classified as moderate. The goodness-of-fit test evaluates the model fit by considering all the coefficients of determination (R^2) from the two equations. The initial equation had an R^2 value of 0.544, whereas the subsequent equation had an R^2 value of 0.717.

The results of the Q-squares calculations are as follows:

$$Q^2 = 1 - (1 - R_1^2) (1 - R_2^2)$$

$$Q^2 = 1 - (1 - 0.552) (1 - 0.472)$$

$$Q^2 = 1 - (0.448) (0.528)$$

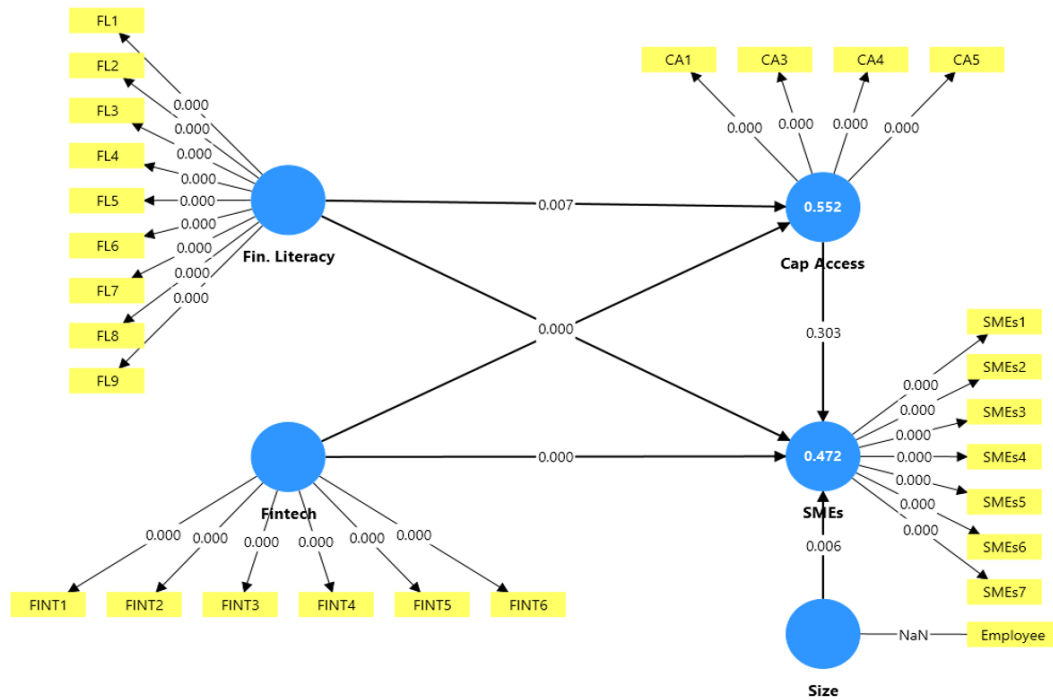
$$Q^2 = 1 - (0.2365)$$

$$Q^2 = 0.763$$

The predictive relevance (Q^2) was 0.763, indicating that the model explained 76.3% of the total variance in the structural relationships among the four variables examined, with the remaining variance being attributed to other factors. This research model possesses significant strength because of its Q value of above 0.67.

The research model demonstrated substantial predictive validity. The predictive relevance rating of 76.3% indicates that the models account for 76.3% of the variability in the data, meaning that the model explains 76.3% of the information in the data. The remaining 23.7% is attributed to variables external to the research model and errors. The results demonstrate that the PLS model is highly effective, accounting for 76.3% of the total information.

Figure 3. Outer loading test results



Source: Output Smart PLS 4.1.1.4 (2025)

This study employs T-statistics and P-values to evaluate the hypothesis. If the P-values are below 0.05, the study hypothesis may be accepted. The outcomes of the research hypothesis test performed using the inner model are shown in Figure 3.

The following is the research model equation based on the results of hypothesis testing:

$$CA = 0.211 FL + 0.583 FINT + \varepsilon_1 \dots (\text{Model 1})$$

$$SMEs = 0.329 FL + 0.358 FINT + 0.04 CA + 0.008 FL_{THAT} + 0.023 ENDT_{THAT} + 0.108 Size + \varepsilon_2 \dots (\text{Model 2})$$

The results in Table 4 demonstrate that financial literacy and fintech P2P lending significantly enhance MSEs' capital access in traditional markets at the 1% level of significance. Financial literacy and fintech peer-to-peer lending significantly enhance the sustainability of traditional micro and small enterprises at the 1% significance level. Conversely, Capital access does not substantially affect the sustainability of MSEs in

traditional markets. Capital access did not significantly moderate the relationship between financial literacy and fintech P2P lending on the sustainability of micro and small enterprises in traditional markets in Jakarta, Indonesia.

The research model test, based on the R-squared value, yielded a value of 0.552 for the capital access model, indicating that the model exhibits substantial variation. The MSEs' capital access in traditional markets is affected by financial literacy and fintech P2P lending by 55.2%, with the remaining 44.8% influenced by characteristics not included in the research model. The model test for MSE sustainability reveals an R-squared value of 0.472, indicating that the MSE sustainability model accounts for a substantial 47.2% of the variance, which is influenced by financial literacy, fintech P2P lending, and capital access, both directly and indirectly. The remaining 52.8% was attributed to factors beyond the scope of this study's research model. The outcomes of the sensitivity analysis of the research model demonstrate robustness, as evidenced by the consistency of the hypothesis test findings, which remain unchanged upon excluding the control variable of MSE size from the model (robust model).

Table 4. Hypothesis Testing & Robust Test Results

Hypothesis		Main Model			Robust Model		
		Coeff	T-stat	P value	Coeff	T-stat	P value
Capital Access Model							
H1	Financial literacy (FL)	0.211	2.439	0.007***	0.211	2.439	0.007***
H2	Fintech P2P lending (FINT)	0.583	7.221	0.000***	0.583	7.221	0.000***
R ²		0.552 (55.2%)			0.552 (55.2%)		
Adjusted R ²		0.548 (54.8%)			0.548 (54.8%)		
MSE Sustainability Model							
H3	Financial literacy (FL)	0.329	3.364	0.000***	0.336	3.379	0.000***
H4	Fintech P2P lending (FINT)	0.358	3.689	0.000***	0.365	3.679	0.000***
H5	Capital access (CA)	0.04	0.515	0.303	0.047	0.612	0.27
H6	FL → CA	0.008	0.473	0.318	0.01	0.561	0.287
H7	FINT → CA	0.023	0.499	0.309	0.028	0.589	0.278
Size (Control variable)		0.108	2.493	0.000***	-	-	-
R ²		0.472 (47.2%)			0.461 (46.1%)		
Adjusted R ²		0.463 (46.3%)			0.454 (45.4%)		
Predictive relevant (Q ²)		0.763 (76.3%)			0.759 (75.9%)		

Source: Author's calculation (2025)

Table 5. Results of f-Square Testing

Hypothesis		Main Model		Robust Model	
		F ²	Results	F ²	Results
Capital Access Model					
H1	Financial literacy (FL)	0.053	Small	0.053	Small
H2	Fintech P2P lending (FINT)	0.404	Big	0.404	Big
MSE Sustainability Model					
H3	Financial literacy (FL)	0.103	Small	0.106	Small
H4	Fintech P2P lending (FINT)	0.092	Small	0.093	Small
H5	Capital access (CA)	0.001	Weak	0.002	Weak
Size (Control variable)		0.021	Small		

Source: Author's calculation (2025)

The F-square test quantifies the extent to which the exogenous latent variable affects the endogenous latent variables. The f-square serves as a measure of the strength of influence: it is considered weak if the result is <0.02 , moderate if >0.02 , medium if >0.15 , and large if >0.35 . According to Table 5, the F-statistic value indicating the impact of financial literacy on capital access and the sustainability of micro and small enterprises (MSEs) is minimal, whereas the f-square value representing the effect of fintech peer-to-peer (P2P) lending on capital access is substantial; however, its influence on the sustainability of MSEs in traditional markets is negligible. Concurrently, the impact of capital accessibility on the sustainability of micro and small enterprises is minimal. The F-square test results indicate that fintech P2P lending plays a pivotal role in facilitating capital access for MSEs in traditional markets in Jakarta.

The results of the hypothesis testing indicate that financial literacy has a significant impact on capital access for micro and small enterprises (MSEs) in traditional markets. This study supports both Financial Literacy Theory (Lusardi & Mitchell, 2011) and Capital Accessibility Theory (Beck & Demirguc-Kunt, 2006). The empirical research demonstrates that financial literacy is not just theoretical knowledge; it is also a strategic asset (Barney, 1991) that can enhance the connection between MSEs and both official and informal sources of finance. Key indicators of financial literacy, such as the ability to generate financial reports, understand the benefits of those reports, and effectively manage financial information, play a crucial role in reducing information asymmetry. This, in turn, increases financial institutions' confidence in MSEs.

These findings contribute to the microfinance literature by clarifying how applied financial literacy catalyzes improving capital access in the informal sector, including traditional markets.

The findings of this study corroborate those of previous studies (Efendi et al., 2023; Frimpong et al., 2022; Kurniasari et al., 2023), indicating that financial literacy has a positive influence on financial accessibility. Micro and small enterprises with strong

financial literacy can prepare basic financial reports, calculate their capital needs, and identify suitable funding sources, thereby facilitating access to formal credit. The findings of this study corroborate those of previous studies (Efendi et al., 2023; Frimpong et al., 2022; Kurniasari et al., 2023), indicating that financial literacy has a positive influence on financial accessibility. Micro and small enterprises with strong financial literacy can prepare basic financial reports, calculate their capital needs, and identify suitable funding sources, thereby facilitating access to formal credit. This finding was corroborated by Alharbi et al. (2022), Frimpong et al. (2022), and Jun and Ran (2024), who demonstrated that financial literacy has a positive influence on MSMEs' access to finance. The findings of this study highlight the importance of financial education initiatives targeting MSMEs, particularly in traditional markets, in enhancing their access to suitable financing. In light of this empirical evidence, local governments, the Financial Services Authority, cooperatives, and fintech platforms must establish organized and context-specific financial literacy training programs that emphasize both the fundamental concepts and practical aspects of preparing financial reports, recording transactions, and evaluating capital structures. These findings indicate that financial institutions and fintech companies should consider financial literacy as a criterion for creditworthiness that may partially substitute for collateral requirements, especially for non-bankable MSMEs. This could promote a more inclusive and sustainable financial framework within the traditional MSME sector.

The results of the hypothesis testing demonstrate that fintech P2P lending significantly enhances MSEs' access to capital in traditional markets. This study corroborates the Financial Intermediation Theory (Allen & Santomero, 1997), which posits that financial institutions facilitate the connection between capital providers and capital recipients. Fintech P2P lending serves as an efficient digital middleman, particularly for MSMEs that official financial institutions, such as banks, inadequately support. These findings further corroborate the Technology Acceptance Model (Davis, 1989), indicating that usability and perceived advantages propel the adoption of fintech for capital access requirements. MSEs have widely accepted P2P lending in the traditional market. The use of technology, including fintech, is expected to rise if it offers concrete advantages, such as enhanced convenience and expedited access to funding for micro and small enterprises that previously struggled to secure credit from traditional banks.

The findings of this study corroborate those of Abbasi et al. (2021) and Efendi et al. (2023). This study demonstrates that fintech peer-to-peer lending has a positive influence on capital accessibility for small and medium-sized firms. The emergence of financial technology (Fintech), particularly peer-to-peer (P2P) lending, signals a shift toward increased capital accessibility, suggesting that banks must innovate their funding mechanisms to maintain competitiveness, especially in providing adaptable solutions for restructuring and high-risk situations (Palmieri & Ferilli, 2024). Fintech P2P lending facilitates effortless access to unsecured loans through digital verification, thereby enhancing access to finance for micro and small enterprises. Owners and

managers can fulfill their company's liquidity requirements by utilizing P2P lending fintechs (Abbasi et al., 2021). However, this study contradicts the findings of Doumi et al. (2024), who indicated that Fintech P2P lending does not directly influence financial access.

The findings of this study suggest that fintech P2P lending can serve as a strategic remedy for micro and small enterprises in traditional markets, helping them overcome capital limitations that frequently impede business growth. Micro and small enterprises have more adaptable and accessible funding options through the use of digital technologies. This discovery presents fintech firms with an opportunity to expand their market reach by targeting micro and small enterprises that the traditional financial system currently under-supports. The Indonesian Financial Services Authority (OJK) must enhance regulations to safeguard MSEs against the risks associated with unlawful fintech and encourage digital financial literacy to enable MSEs to adopt fintech judiciously. Additionally, local governments and MSME offices should form strategic alliances with licensed fintech firms to enhance access to technology-driven financing in the traditional market. Consequently, fintech P2P lending functions as both an alternative financial tool and a catalyst for financial inclusion and sustainable economic empowerment in Indonesia.

The results of the hypothesis testing demonstrate that financial literacy has a significant impact on the sustainability of micro and small enterprises in traditional markets. This study supports the Resource-Based View hypothesis (Barney, 1991), highlighting that internal competencies, such as financial literacy, are vital resources that can provide a durable competitive advantage for MSMEs. Financial literacy empowers business professionals to make informed decisions regarding financial management, capital allocation, cash flow oversight, and risk assessment, thereby enhancing firm resilience to market fluctuations. This study corroborates the findings of Lusardi and Mitchell (2014), indicating that financial literacy is significantly associated with improved financial management practices and enhanced long-term financial resilience.

The findings of this study corroborate those of previous studies (Meressa, 2023; Masdupi et al., 2024; Siddik et al., 2023), indicating that financial literacy is a crucial determinant of the sustainability of small and medium firms. These results suggest that enhancing financial literacy among traditional market MSMEs is crucial for ensuring the long-term sustainability of their businesses. Entrepreneurs with strong financial literacy are more adept at systematically planning their enterprises, transparently recording and managing their finances, and circumventing destructive debt habits. This corroborates Huston's (2010) viewpoint that financial literacy is an essential skill for the success of small enterprises, especially in informal economic settings such as traditional marketplaces. Consequently, enhancing practical and contextual financial training and mentorship, particularly through partnerships with financial institutions, cooperatives, trade offices, and MSMEs, is imperative. Central and regional governments must develop a financial literacy curriculum tailored to the needs of micro and small enterprises in traditional markets and establish a monitoring and evaluation framework to assess the progress of financial

literacy and its impact on sustainability. Moreover, collaboration between microfinance institutions and micro and small enterprises is crucial to delivering accessible financial products and ensuring continuous financial literacy.

The results of the hypothesis testing demonstrate that fintech P2P lending exerts a favorable and significant influence on the sustainability of MSEs in the traditional market. This study corroborates the Financial Intermediation theory (Allen & Santomero, 1997), which posits that financial institutions, including innovations in financial technology, mitigate asymmetric information and enhance capital access, particularly for sectors inadequately served by traditional financial institutions. Fintech P2P lending serves as a more inclusive funding option for MSMEs, which frequently encounter obstacles related to collateral, formal documentation, and bank creditworthiness issues. This study corroborates the findings of previous studies (Lontchi et al., 2023), which showed that fintech has a positive and considerable impact on the sustainability of SMEs in Cameroon (Chen et al., 2019). Gozman et al. (2018) highlighted that fintech platforms can facilitate financial access and enhance the growth and resilience of small enterprises through rapid, adaptable, and technology-driven funding.

The findings of this study suggest that fintech P2P lending can serve as a vital tool for enhancing the sustainability of MSEs in Jakarta, especially regarding working capital financing, investment in production equipment, and company expansion. Expedited and streamlined financing via fintech P2P lending facilitates business continuity, innovation, and resilience amid fluctuating market conditions. Moreover, the technology employed by fintech promotes MSEs to adopt digital systems for financial transactions, an essential step towards technology-driven company transformation. These findings underscore the need for rules and oversight to safeguard MSEs against potential fintech risks, including exorbitant interest rates and a lack of transparency. The government, specifically the Financial Services Authority, must enhance fintech literacy instruction for MSEs in traditional markets and promote coordination among P2P lending platforms, cooperatives, MSE offices, and supporting institutions. Moreover, it is essential to promote the establishment of an alternative credit score system utilizing MSE digital data, enabling MSEs without formal credit records to obtain funding with quantifiable risk.

The hypothesis testing results demonstrate that capital access does not exert a significant positive impact on the sustainability of MSEs in traditional markets. This discovery undermines the traditional perspective of the Capital Constraint Theory (Beck & Demircug-Kunt, 2006), which posits that restricted capital access is a significant barrier to the growth and sustainability of MSMEs. In traditional markets, these findings suggest that MSME sustainability is not exclusively reliant on capital. This corroborates the conclusions of Atmadja et al. (2016), who indicated that access to money, in the absence of sufficient financial management skills, does not positively influence firm sustainability. The findings of this study contrast with those of previous studies (Frimpong et al., 2022; Khan et al., 2021; Mang'ana et al., 2024; Siddik et al., 2023), indicating that capital access enhances the sustainability of small and medium firms by boosting sales and profitability. Nonetheless, the findings of this study corroborate

those of Masdupi et al. (2024), who concluded that capital access is not a pivotal component of SMEs' sustainability.

This empirical research demonstrates that several micro and small enterprises in traditional markets have failed to optimize the capital acquired from official and informal institutions. Issues such as inadequate financial literacy, the absence of business planning, and limited innovation in capital utilization prevent existing capital from fostering sustained improvements in productivity and business competitiveness. In traditional markets, which primarily rely on experience and social interactions, business sustainability is bolstered more by social networks, customer loyalty, and operational efficiency than by access to funding. The findings underscore the need for a comprehensive strategy to enhance the sustainability of MSEs, particularly in traditional markets. The government and financial institutions should prioritize not only the expansion of capital access but also the enhancement of business mentorship programs, financial management training, and the incorporation of relevant simple technologies tailored to the needs of micro and small enterprises in traditional markets. Financing programs that incorporate financial literacy and business performance assessments must be established to ensure that accessible capital effectively enhances firm sustainability. Moreover, formulating policies that address local requirements while considering the socioeconomic attributes of traditional markets is essential for developing more relevant and effective intervention programs.

The hypothesis testing results demonstrate that capital access does not moderate the impact of financial literacy on the sustainability of MSEs in traditional markets. This study enhances the comprehension of the Resource-Based View theory (Barney, 1991), which posits that sustained competitive advantage arises not solely from resource availability, such as capital, but also from intrinsic capabilities, including knowledge, skills, and managerial competencies. In this context, financial literacy, as an intrinsic capability, significantly influences firm sustainability, independent of access to funds. This suggests that in a traditional market setting characterized by informal and experiential business systems, financial acumen is a vital asset that directly impacts business management and sustainability. This study's findings contradict those of previous research (Alharbi et al., 2022; Charfeddine et al., 2024; Frimpong et al., 2022; Lontchi et al., 2023; Masdupi et al., 2024; Meressa, 2023; Siddik et al., 2023; Yuliani et al., 2025), indicating that capital access may mediate the relationship between financial literacy and the sustainability of MSEs. The findings of this study demonstrate that while capital access is crucial, its effectiveness in fostering MSE sustainability is significantly contingent on the capacity of business actors to manage and utilize it effectively. When financial literacy is sufficient, MSE participants can make informed financial decisions, including efficient spending, effective cash flow management, and prudent risk management, without excessive dependence on external financing. The inadequacy of capital access as a mediating variable may stem from the preference of numerous MSE participants in traditional markets for more flexible and less complex informal financing options, such as familial loans or social savings, despite their sound financial knowledge.

This empirical study highlights the importance of enhancing financial literacy through instruction on effective and responsible capital management. The government and financial institutions must not only facilitate access to funding but also ensure that MSEs possess the actual financial skills to prevent the misuse or underutilization of available funds. Moreover, it is essential to create financing models that reflect the unique attributes of traditional markets, which are adaptable, readily accessible, and synchronized with daily business operations, to guarantee that available capital is effectively linked to the managerial competencies of financially literate micro and small enterprises.

The results of hypothesis testing demonstrate that capital access does not mitigate the impact of fintech P2P lending on the sustainability of MSEs in traditional markets. This study challenges the fundamental premise of Financial Intermediation Theory (Allen & Santomero, 1997), which posits that financial intermediaries, including fintech peer-to-peer (P2P) lenders, mitigate restricted capital access by utilizing efficient and inclusive technology. On the other hand, the emergence of fintech has not completely enhanced capital access, which directly affects the sustainability of micro and small enterprises in traditional markets. This may result from several impediments, including inadequate digital and financial literacy, the misalignment of fintech offerings with the requirements of traditional enterprises, or the incapacity of MSMEs to access, comprehend, and effectively manage financing from fintech sources (Zetzsche et al., 2020).

This empirical research indicates that while Fintech P2P lending is accessible and potentially expands funding alternatives, MSEs in traditional markets have not effectively leveraged it to enhance the sustainability of their businesses. Numerous traditional market entrepreneurs continue to depend on informal finance sources that are more socially and culturally accessible, such as family support and local cooperatives. This further substantiates the conclusions of Gozman et al. (2018). The adoption of fintech in the informal sector necessitates not only the availability of platforms but also the social, economic, and technological preparedness of the users. In light of this empirical evidence, the government must enhance the promotion of digital financial literacy and tailor its initiatives to the characteristics of micro and small enterprises in traditional markets, encompassing practical training in the use of fintech applications and understanding the risks associated with digital financing. Moreover, establishing an inclusive fintech ecosystem tailored to the requirements of micro and small enterprises in traditional markets, incorporating microloan programs, mentorship, and an assessment framework grounded in informal business history, is essential to ensure that fintech serves as a sustainable solution for capital accessibility. Cooperation among regulators, fintech providers, and local support institutions is crucial for connecting fintech with grassroots microenterprises to achieve shared objectives.

CONCLUSION

The research findings show that while financial literacy and peer-to-peer (P2P) lending via fintech enhance capital access for micro and small enterprises (MSEs) in traditional marketplaces, they do not significantly improve business sustainability. Access to capital fails to mediate the relationship between financial literacy, fintech, and MSE sustainability in DKI Jakarta, Indonesia. This suggests that financial interventions alone are insufficient; to foster long-term growth, MSEs, particularly those in informal sectors such as traditional markets, need improvements in managerial competencies and financial literacy.

These results challenge the notion that increased capital access is essential for firm sustainability, highlighting the need for policies that focus on enhancing capabilities rather than just capital access. Local governments, the Financial Services Authority, cooperatives, and fintech platforms should implement targeted financial literacy training that includes practical skills like financial reporting and transaction recording. Improving digital financial literacy tailored to the needs of MSEs is also critical, with a focus on fintech applications and associated risks. Moreover, establishing an inclusive fintech ecosystem that includes microloan programs, mentorship, and assessments based on informal business history is essential for making fintech a viable financing option for MSEs. Cooperation among regulators, fintech providers, and local institutions is necessary to connect financial technology with grassroots microenterprises.

This study has limitations, as it focuses solely on MSEs in Jakarta, making its conclusions less applicable to other regions in Indonesia with different socio-economic conditions. It also overlooks contextual factors such as entrepreneurial motivation and local culture. Future research should expand its scope to include MSEs from diverse regions and investigate the factors affecting the impact of capital access and the use of fintech by MSE operators.

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Do Coffee Exports Have an Impact on Economic Growth in Indonesia?

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ABSTRACT

Research Originality: The novelty lies in exploring an under-researched topic, with limited studies on the impact of coffee exports from 1993 to 2024, considering key events such as the Asian financial crisis and the COVID-19 pandemic.

Research Objectives: This study examines the short-term and long-term effects of exchange rates and coffee exports on economic growth.

Research Methods: This study utilizes data from 1993 to 2024 on exchange rates, coffee exports, recessions, and economic growth in Indonesia. The analysis is conducted using the ARDL model.

Empirical Results: Exchange rate depreciation has a negative impact on GDP in the short term, while past depreciation has a positive effect on economic growth. The value of coffee exports has a marginal positive effect on GDP, while the volume of coffee exports shows inconsistent impacts. Recession does not significantly affect GDP, likely due to policy responses. Long-term estimates show a stable relationship among the variables, with adjustments occurring at a rate of 35.43% per period.

Implications: The government should thoroughly evaluate existing policies with a focus on promoting economic growth, while enhancing the quality of Indonesian coffee exports to remain competitive globally.

Keywords:

coffee export; economic growth; exchange rate volatility; recession

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INTRODUCTION

Economic growth is a crucial indicator in measuring the level of social welfare and the success of a nation's development. According to Kuznets (1973), economic growth is defined as a long-term increase in a country's capacity to supply diverse economic goods to its population, achieved through technological progress, institutional adjustments, and improved production efficiency. In the context of developing countries like Indonesia, economic growth is influenced by the performance of the external sector, particularly international trade. The Export-Led Growth (ELG) theory posits that exports serve as the primary engine of economic growth. This theory is rooted in Adam Smith's classical notion of absolute advantage and David Ricardo's concept of comparative advantage, whereby nations benefit substantially when they specialize in the production of goods that can be efficiently exported (Salvatore, 2014). Through exports, countries earn foreign exchange that can be used to import capital goods and advanced technologies, stimulate investment, and expand national production capacity. In addition, Sultanuzzaman et al. (2019) argue that exports play a vital role in enhancing productivity across many developing economies.

Indonesia is among the largest producers and exporters of coffee worldwide, ranking within the top three in robusta coffee production and eleventh in arabica coffee production as of 2023. Coffee has a strategic role in the national economy, serving as a significant source of non-oil and gas foreign exchange. It is also a commodity that has a substantial influence on the performance of the agricultural sector. Coffee contributed to Indonesia's recovery of its Gross Domestic Product (GDP) in the post-pandemic period of 2021, driven by increased production and higher export volumes. In 2021, Statistics Indonesia (BPS) recorded total coffee production of 786.2 thousand tons, with export volumes reaching 384.5 thousand tons. This performance made coffee a significant contributor to GDP growth that year, as increased exports boosted foreign exchange earnings, which in turn strengthened national output. Erokhin et al. (2023) further note that coffee carries a relatively high economic value in supporting Kenya's economy when compared to other agricultural commodities.

Indonesia's coffee exports increased to 433.7 thousand tons in 2022, representing a 12.79 percent rise from 2021. Such growth has direct implications for GDP expansion as well as movements in the exchange rate. Table 1 presents annual data on exchange rates, coffee exports, and Indonesia's economic growth.

The data reveal notable fluctuations in both exchange rates and coffee exports, while economic growth declined during the pandemic but rebounded in the subsequent two years. Interestingly, in 2018 and 2022, the rupiah depreciated—moving from Rp13,380 per USD in 2017 to Rp14,236 in 2018 and to Rp14,849 in 2022—yet economic growth strengthened, rising from 5.07 percent to 5.17 percent and from 3.70 percent to 5.31 percent, respectively.

Pangestuti et al. (2022) argue that such conditions contradict the International Fisher Effect theory, which does not hold in the case of the rupiah's exchange rate against

the US dollar. In principle, fluctuations in Indonesia's economic performance should be reflected by the movements of the rupiah. The depreciation of the rupiah indicates a weaker economic outlook, as a declining exchange rate driven by the appreciation of the US dollar reduces the relative value of domestic assets. Consequently, foreign investors tend to withdraw or reduce investment allocations, leading to a decline in capital inflows. This reduction in investment hurts societal welfare and hinders national growth. Sugiharti et al. (2020) empirically confirmed that when the rupiah depreciates, economic growth tends to decline, whereas an appreciation of the rupiah corresponds with higher growth. A stable and strong currency is therefore crucial to stimulating investment and sustaining robust economic activity (Tang, 2015).

Table 1. Exchange Rate, Coffee Exports, and Economic Growth in Indonesia

Year	US Dollar Exchange Rate (Rp)	Coffee Exports (million USD)	Economic Growth (%)
2017	13380,83	1187,15	5,07
2018	14236,94	817,78	5,17
2019	14147,67	883,12	5,02
2020	14582,2	821,93	-2,07
2021	14308,14	858,55	3,70
2022	14849,85	1149,16	5,31
2023	15236,88	929,13	5,0
2024	15855,45	1638,11	5,0

Source: Statistics Indonesia (2023), World Bank (2023), Pacific Exchange Rate (2023)

The relationship between coffee exports and economic growth also exhibits inconsistencies. In 2018, coffee export values dropped from USD 1,175.3 million to USD 806.8 million, yet Indonesia's economic growth slightly increased to 5.17 percent. Similarly, in 2019, coffee exports rose to USD 872.3 million, but economic growth weakened to 5.02 percent. These results diverge from those of Ee (2016) and Grancay et al. (2015), who found that exports have a positive and significant impact on economic growth. Such discrepancies highlight the need to examine both the short-term and long-term impacts of exchange rates and coffee exports on Indonesia's economic growth.

Beyond exports, exchange rate stability also exerts a significant influence on growth. Exchange rates affect the competitiveness of domestic products in global markets. The Mundell-Fleming model posits that currency depreciation promotes exports by lowering the relative prices of domestic goods, thereby stimulating economic growth. Conversely, appreciation suppresses exports as domestic goods become more expensive internationally (Krugman et al., 2015). Clark (1973) and Bahmani-Oskooee & Aftab (2017) further emphasize that exchange rate volatility creates uncertainty in trade, reducing export and import volumes and ultimately slowing growth. Urgessa (2024) emphasizes that exchange rates can serve as a barometer of economic health, influencing multiple economic dimensions, including agricultural exports. In contrast, Boubaker & Mouna (2024)

highlight that exchange rate fluctuations have a significant impact on prices, investment, and overall stability in the global trading system.

Based on the foregoing, this study contributes new insights by focusing specifically on the impact of exchange rates and coffee exports on Indonesia's aggregate economic growth. Unlike prior research that analyzed exports broadly or examined other commodities, this study focuses on coffee as one of Indonesia's flagship agricultural exports, utilizing a long observation period spanning 1993–2022. This period encompasses major economic events, including the Asian financial crisis, commodity booms, and the COVID-19 pandemic. The study aims to provide a comprehensive understanding of the role of exchange rate fluctuations and coffee export performance in driving national economic growth, while offering policy recommendations for enhancing this relationship. Specifically, it examines the short- and long-term effects of exchange rates on economic growth, the short- and long-term impacts of coffee exports on economic growth, and the short- and long-term influence of recessions on Indonesia's economic trajectory.

METHODS

This research utilizes time series data, specifically data on exchange rates, coffee exports, recessions, and economic growth in Indonesia from 1993 to 2024. The period from 1993 to 2024 covers significant changes in Indonesia's economic landscape, including the Asian financial crisis (1997), economic reforms, fluctuations in global commodity prices (including coffee), and the COVID-19 pandemic. These events offer a rich context for understanding how external shocks, currency fluctuations, and shifts in global demand for exports impact the country's economic growth. In this research, the recession data are represented as a dummy variable, written in binary form with values 0 and 1. The data sources used in this research (Central Statistics Agency, World Bank, Ministry of Agriculture of the Republic of Indonesia, and the Pacific Exchange Rate) provide reliable and consistent data from 1993 onwards. This period ensures that the analysis captures the full range of economic cycles and global market shifts, which are crucial for understanding long-term and short-term dynamics.

The ARDL model was selected for this research due to its suitability for analyzing both short-term and long-term relationships among variables in the context of time series data. The ARDL model has several advantages that make it particularly appropriate for this study. The ARDL model allows for the inclusion of lagged values of both the dependent variable (GDP) and independent variables (exchange rate, coffee exports, recession). This helps capture the effects of past values of these variables on their current values, making the model dynamic. The ARDL model can handle variables that are integrated of different orders, some may be stationary at levels ($I(0)$), while others may be stationary after first differencing ($I(1)$). This is important for this study, as economic data, such as GDP, exports, and exchange rates, can exhibit both short-term fluctuations and long-term trends. In addition, ARDL is ideal for investigating cointegration, specifically whether a long-term

equilibrium relationship exists between variables such as GDP, exchange rates, and coffee exports. The model is used to assess both the short-term adjustments and the long-term equilibrium relationships between the variables.

In this research, the method used to carry out the unit root test is the Augmented Dicky Fuller (ADF) test and the Phillips-Perron (PP) test to determine the degree of stationarity. The decision-making criteria for the stationarity test are if the probability value (P-value) is smaller (<) than the significance level (5% for example), then the data is stationary. Then, if the probability value (P-value) is greater than the significance level (for example, 5%), the data is not stationary (Syamputri et al., 2021).

The aim of determining the optimal lag is to see the behavior and relationship of each variable. The optimal lag test also aims to eliminate autocorrelation problems in VAR systems implemented by several standards, such as Akaike's Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Standard (HQ), and final prediction error (FPE) (Syamputri et al., 2021). The decision-making criteria in the optimal lag test are based on the lag criteria that have the most asterisks (*) (Enders, 2004).

The method used for the cointegration test in this research is the Johansen Cointegration Test method. This method is based on the relationship between the rank of a matrix and its characteristic roots, which produces trace statistical values (Syamputri et al., 2021). The criteria for determining the outcome of the cointegration test are that if the trace statistic exceeds (>) the critical value, the data in the model equation exhibits a long-term relationship or is cointegrated. If the trace statistic value is less than (<) the critical value, it indicates that the data in the equation model lacks a long-term relationship or is not cointegrated.

The ARDL (Autoregressive Distributed Lag) model represents a dynamic framework within econometrics. By employing the standard OLS model, we will focus solely on the long term. Nonetheless, by employing the ARDL model, we can observe the impact of both dependent and independent variables across time, including the effect of the past value of the dependent variable on its current value. The ARDL model is expressed in the following manner:

$$GDP_t = a_0 + \sum_{i=1}^p a_1 GDP_{t-1} + \sum_{i=1}^q a_2 VEX_{xt-1} + \sum_{i=1}^r a_3 NEX_{t-1} + \sum_{i=1}^s a_4 KURS_{t-1} + \sum_{i=1}^t a_5 dDUMMYRESESI_{t-1} \quad 1)$$

Note: *GDP* = Economic Growth, *VEX* = Export Volume (000 tons), *NEX* = Export Value (million USD), *KURS* = Exchange Rate (Rupiah), *DUMMYRESESI* = Recession, α = Long-term dynamic coefficients, *et* = Standard Error

The method using the ARDL model requires a lag as in the equation above. The appropriate lag selection for the research model was determined using log likelihood (logL), Akaike's Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Standard (HQ), and final prediction error (FPE).

RESULTS AND DISCUSSION

This study focuses on analyzing the long-term and short-term relationships between exchange rates, coffee exports, and recession on Indonesia's economic growth. Fluctuations in coffee export values that are not in line with economic growth trends suggest that the positive relationship between exports and economic growth is not consistently observed across all periods, as found in previous studies (Gizaw et al., 2022; Kuloglu & Akar, 2024; Nugroho & Lakner, 2022). Some research findings also suggest that exports do not influence economic growth (Albiman Md & Suleiman, 2016; Quaicoe et al., 2017). Additionally, the impact of recessions—whether caused by the global financial crisis or the COVID-19 pandemic—serves as an external factor that can influence national economic performance in both the short and long term. Therefore, this discussion will comprehensively examine the influence of these variables, using an empirical approach to identify patterns of relationships that may differ from previous research findings.

To detect whether the data for each variable is stationary or not, the ADF test is used. The test criteria are if the probability value is < significance level ($\alpha=5\%$), then the data is said to be stationary. Based on the test in Table 2, it can be seen from the ADF test that only Export Volume (VEX), Kurs, and Recession dummy are stationary at their levels. In contrast, Export Value (NEX) and GDP variables are stationary at the first difference. Thus, the analysis can be carried out using the Autoregressive Distributed Lag (ARDL) model.

Table 2. ADF and Philips-Perron Stationarity Test

ADF Stationarity Test		
Variable	Level	First Difference
GDP	0.8550	0.0001
NEX	0.6185	0.0000
VEX	0.0158	0.0000
KURS	0.0389	0.0038
DUMMYRES	0.0032	0.0000

Source: Processed from the results of Eviews 13 (2024)

Table 3. Optimal Lag Test Results

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-32.60201	NA	1.01e-05	2.685858	2.923752	2.758585
1	95.89464	201.9233*	6.43e-09	-4.706760	-3.279398*	-4.270402
2	123.1702	33.12032	6.60e-09	-4.869300	-2.252470	-4.069309
3	145.5994	19.22503	1.39e-08	-4.685672	-0.879374	-3.522049
4	206.8152	30.60792	4.44e-09*	-7.272518*	-2.276751	-5.745262*

Source: Processed from the results of Eviews 13 (2024)

From Table 3, it can be seen that, based on the LogL, LR, FPE, AIC, SC, and HQ values, lag 4 produces the most asterisks. Thus, lag 4 is the most optimal. The aim of the optimal lag in this research is so that all research variables used in the equation influence each other for the subsequent two periods. Therefore, the reaction between the two variables will occur over the next four years. The results obtained are that export volume, export value, exchange rate, and recession can influence economic growth in the fourth lag. This means that when the volume of exports increases, economic growth will also increase over the next 4 years. Additionally, as the variables of export value, exchange rate, and recession rise, economic growth is expected to increase in the next 4 years.

Bound testing is employed to determine whether endogenous and exogenous variables are cointegrated in the long run. If the value of the F-statistic exceeds I0 and I1, it can be concluded that the variables exhibit long-term cointegration. Similarly, if the F-statistic value is less than the I0 and I1 values, then the variables do not exhibit long-term cointegration. The findings presented in Table 4 indicate that the F-statistic value is 26.198, exceeding the I0 Bound and I1 Bound values at the 10%, 5%, and 1% significance levels, thus allowing us to conclude that the variables in the tested model exhibit cointegration. Therefore, the research variables exhibit long-run cointegration.

When evaluating normality using the Jarque-Bera test, if the Jarque-Bera probability is greater than 0.05, the model is deemed to be normally distributed. Conversely, if the Jarque-Bera probability value is less than 0.05 or the 5% alpha level, the model deviates from a normal distribution. According to the results of the normality test presented in Figure 1, the Jarque-Bera statistic is recorded at 0.078932, with an associated probability of 0.961592, which is greater than 0.05. As a result, the data conforms to a normal distribution.

Table 4. Cointegration Test Results

Test Statistic	Value	K
F-statistic	26.198	3
Significance	I0 Bound	I1 Bound
10%	2.68	3.59
5%	3.27	4.30
1%	4.61	5.97

Source: Processed from the results of Eviews 13 (2024)

The heteroscedasticity test is utilized to assess the variance inequality of the residuals in the data observations. The Breusch-Pagan-Godfrey test was used for the statistical analysis. H0 is accepted when heteroscedasticity is absent. If the p-value is less than α , H0 is rejected, indicating the presence of heteroscedasticity. Table 5 displays a Chi-Square

probability value of 0.4351, which is greater than $\alpha = 0.05$. This indicates that H_0 is accepted, which means there is no heteroscedasticity present in the model.

Figure 1. Normality Test Results

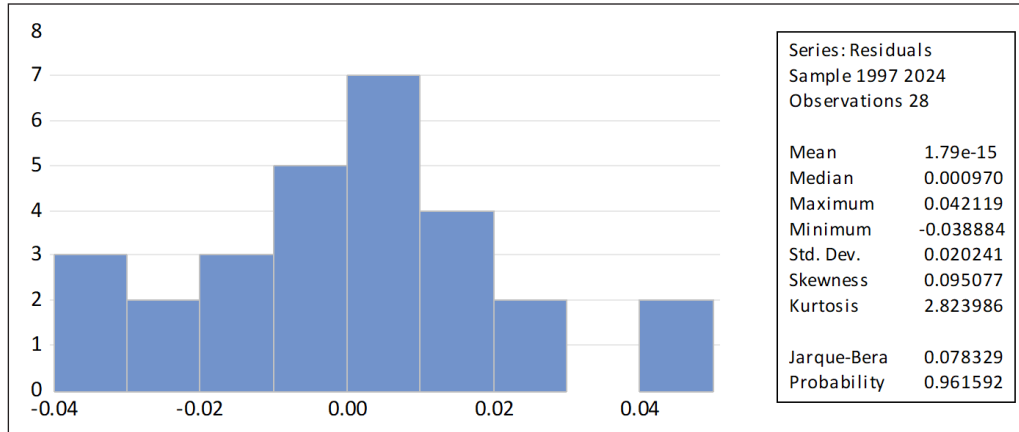


Table 5. Heteroscedasticity Test

F-Statistic	0.949242
Obs*R-squared	17.28727
Scales explained SS	2.010953
Prob. F (17,10)	0.5557
Prob. Chi Square (17)	0.4351

Source: Processed from the results of Eviews 13 (2025)

In the autocorrelation test for the variables to be analyzed, the Breusch-Godfrey test or LM test is used. H_0 is accepted if there is no autocorrelation. If the p-value < α , then H_0 is rejected, which means there is autocorrelation. According to the findings of the autocorrelation test presented in the table below, the Chi-Square probability value is 0.3688, which surpasses $\alpha = 0.05$. Thus, it can be inferred that the model does not exhibit any autocorrelation issues.

Table 6. Autocorrelation Test

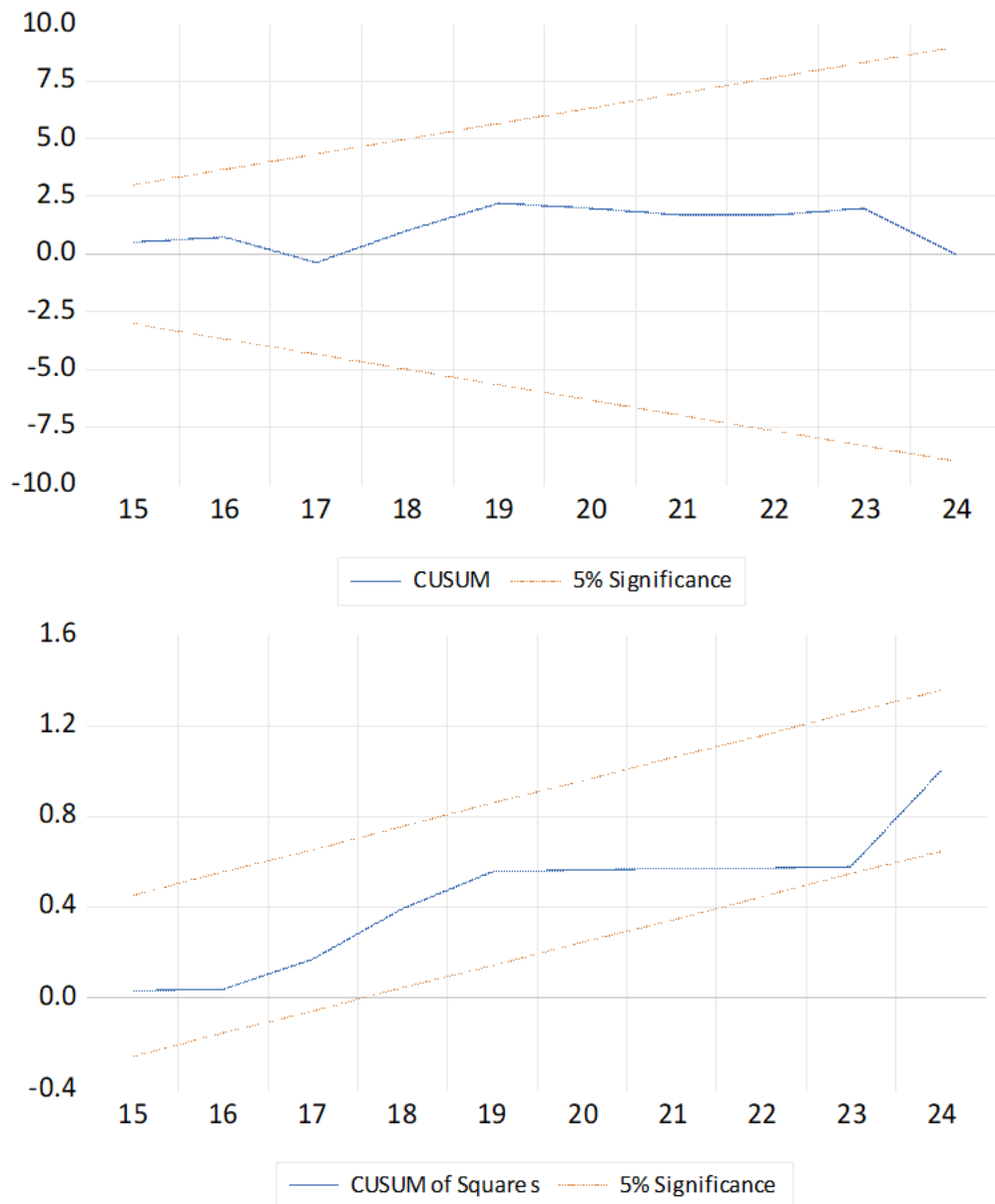
F-Statistic	1.127335
Obs*R-squared	8.702084
Prob. F (4,10)	0.3972
Prob. Chi Square (4)	0.0690

Source: Processed from the results of Eviews 13 (2024) *Model Stability Test*

Figure 2 displays the outcome of the CUSUM and CUSUM-Square tests. The CUSUM test findings indicate that the model remains stable for long-term decision-

making, as the CUSUM line falls between the 5% significance thresholds. In the meantime, the CUSUM-Square test outcomes remain stable as the CUSUM-Square line continues to be positioned between the 5% significance lines.

Figure 2. Cusum Test and Cusum of Squares Test



The results of the ARDL estimation will demonstrate the effect of independent variables and control variables on the dependent variable, both in the short term and the long term. If the variable's probability value is lower than the significance thresholds of 1%, 5%, or 10%, then the variable has a significant effect on the dependent variable. Conversely, if the variable's probability value exceeds the established significance level, then it does not significantly impact the dependent variable.

Table 7. Short-Term and Long-Term Estimation Results

Variable	Coefficient	Probability
CointEq(-1)	-0.354342	0.0000
GDP(-1)	0.645658	0.0004
VEX	-0.011502	0.8479
VEX(-1)	0.026456	0.7367
VEX(-2)	-0.034583	0.6917
VEX(-3)	-0.148446	0.0990
VEX(-4)	-0.181954	0.0553
NEX	0.151716	0.0783
NEX(-1)	0.111069	0.3100
NEX(-2)	0.098515	0.2740
NEX(-3)	-0.005998	0.9396
NEX(-4)	0.080465	0.2204
KURS	-0.852900	0.0000
KURS(-1)	0.577175	0.0001
KURS(-2)	0.168061	0.0211
KURS(-3)	0.145012	0.0891
KURS(-4)	0.120457	0.0943
RESESI	-0.022227	0.6263
C	2.607412	0.0161

Source: Processed from the results of Eviews 13 (2025)

Based on Table 7, the results of the short-term and long-term estimations are as follows.

$$GDP = 2.61 - 0.01VEX + 0.15NEX - 0.85KURS - 0.02RESESI$$

According to the estimates above, it is evident that if the export volume, export value, exchange rate, and recession remain constant in the short term, Indonesia's economic growth will increase by 2.61 percent. If the exchange rate increases by \$ 1, economic growth in the short term will decrease by 0.85%. If the export value increases by one percent, then economic growth increases by 0.15 percent. In contrast, the export volume is not a significant factor in affecting economic growth, as the probability exceeds 5%. Moreover, if a recession occurs, economic growth will decrease by 0.02 percentage points compared to the growth rate without a recession.

Based on the estimation results, there is a significant relationship between past economic conditions and current economic conditions. Each 1% increase in the previous period's Gross Domestic Product (GDP) contributes to a 0.646% increase in the current GDP. These findings suggest the presence of dependency effects or inertia in the Indonesian economy, indicating that past economic growth tends to persist into subsequent periods,

creating a momentum effect. The performance of the previous year's GDP can influence current investment decisions, consumption, and economic policies, thereby significantly impacting current economic growth.(Barument et al., 2012; Wang & Xiao, 2023).

The exchange rate variable (Rupiah to U.S. Dollar) exhibits a highly significant effect on GDP, indicating that the depreciation of the rupiah against the U.S. dollar has a strong negative impact on Indonesia's economy in the short term. Based on the research results, it is evident that the exchange rate variable has a negative impact on Indonesia's short-term economic growth. Empirical analysis suggests that a 1% increase in the exchange rate—reflecting a depreciation of the Indonesian rupiah relative to the US dollar—results in a 0.85% reduction in economic growth. Exchange rate depreciation can increase import costs and reduce domestic purchasing power, thereby lowering GDP. However, the effect of the rupiah exchange rate at KURS(-1) shows a significant positive relationship, with a coefficient of 0.5772 and a p-value of 0.0001. This suggests that changes in the exchange rate in the previous period can positively contribute to Indonesia's GDP. A depreciation that occurred in the past may enhance the competitiveness of Indonesian products in international markets, including coffee exports, thereby stimulating economic growth.

In the subsequent lags (KURS(-2), KURS(-3), KURS(-4)), although the coefficients remain positive, their magnitude gradually decreases. This suggests an adjustment process within the Indonesian economy to exchange rate fluctuations, whereby the effects of currency changes are not immediately realized but yield positive impacts after several periods. Arintoko et al. (2024), Mukhlis et al. (2020), and Thorbecke (2020) further emphasize that the depreciation of the rupiah hampers economic performance by reducing domestic purchasing power and undermining investor confidence. They argue that the decline in the rupiah's value against the U.S. dollar can be attributed, in part, to monetary policy actions undertaken by the United States government. Such policies include increases in the federal funds rate and the reduction of U.S. dollar liquidity in global financial markets, both of which strengthen the U.S. dollar and exert downward pressure on emerging market currencies, including the rupiah.

These dynamics highlight the sensitivity of Indonesia's economic performance to global monetary policy shifts, underscoring the importance of maintaining macroeconomic stability and implementing effective exchange rate management strategies to mitigate adverse impacts on growth. Sunariyah (2006) states that fluctuations in the Indonesian economy are reflected in changes in the rupiah exchange rate. The impact of this depreciation can lead to a decrease in the level of social welfare and has the potential to hinder economic growth. This condition means that the strengthening rupiah exchange rate is considered positive by global investors for the domestic economy, which can increase investors' risk appetite for domestic financial market assets. This can then encourage a sustainable inflow of foreign capital, which in turn can accelerate economic growth in Indonesia.

The coffee export volume (VEX) demonstrates an inconsistent effect on GDP in the short term. For VEX(-3) and VEX(-4), the coefficients are negative and significant

at the 10% and 5% levels, with p-values of 0.0990 and 0.0553, respectively. This result suggests that a decline in coffee export volume during these periods can lead to a reduction in GDP in the subsequent period. However, for other lags (VEX, VEX(-1), VEX(-2)), the effect is not significant, with p-values greater than 0.05. Scientifically, the negative impact of coffee export volume can be explained by fluctuations in global prices and demand. During the period 1999–2004, coffee prices reached their lowest real level, primarily due to oversupply. Consequently, when output/volume increases while demand remains stagnant, export value may decline (Ghoshray & Mise, 2025). In addition, internal factors also influence Indonesia's coffee export volume, such as coffee production, cultivated area, domestic coffee prices, and domestic consumption (Prajanti et al., 2020). state that when coffee consumption in destination countries increases, demand for Indonesian coffee rises. This can reduce domestic coffee availability, thereby increasing local prices and decreasing household consumption or downstream sector production, ultimately lowering domestic GDP (Ashardiono & Trihartono, 2024; Megautami & Utomo, 2023).

The coffee export value (NEX) exhibits a positive effect on GDP, with a coefficient of 0.1517 and a p-value of 0.0783. This finding suggests that an increase in the value of coffee exports can contribute to Indonesia's GDP growth. Although not statistically significant at the 5% level, the value of coffee exports remains a significant component of the national economy, particularly in generating state revenue. The positive coefficient highlights the significant impact of international coffee prices on Indonesia's economic performance. An increase in global coffee prices can raise the value of coffee exports, which in turn stimulates GDP growth. Megautami & Utomo (2023) emphasize that fluctuations in global coffee prices create uncertainty, which in turn influences the value of Indonesia's coffee exports. However, at other lags (NEX(-1), NEX(-2), NEX(-3), NEX(-4)), no statistically significant effects are observed. Suryana et al. (2024) further argue that exports in Indonesia do not exhibit a substantial impact on economic growth because they remain largely dominated by primary commodities and low-value-added products, which have limited capacity to drive substantial and sustainable economic expansion. This result aligns with Romer's (1994) perspective in endogenous growth theory, as presented in Chandra (2022), which highlights that value addition and innovation in export products are crucial drivers for accelerating economic growth. Since Indonesia's exports have yet to reach optimal levels in these aspects, their contribution to GDP remains relatively limited.

Recession does not have a statistically significant effect on GDP, with a coefficient of -0.0222 and a p-value of 0.6263. This suggests that, although recessionary conditions can influence the economy, their impact is not substantial enough to affect GDP within the framework of this model directly. In the context of the Indonesian economy, other factors—such as coffee export volume and value—play a more significant role in driving economic growth. The lack of statistical significance for the recession variable may be attributed to its effects being more long-term in nature or not fully captured by the variables employed in the model.

Syaifudin et al. (2024) note that Indonesia consistently implements rapid expansionary fiscal and monetary policies during periods of crisis, such as tax incentives, increased government spending, and interest rate reductions. These measures effectively mitigate output decline, thereby rendering the impact of recessions on GDP statistically insignificant. According to the Ministry of Finance (2025), Indonesia's economy benefits from a balanced combination of manufacturing, agriculture, and services sectors, which enhances resilience to global shocks. Furthermore, the country's large and relatively stable household consumption enables Indonesia to maintain positive growth or experience only minor contractions during global crises. In certain quarters, household consumption can account for more than 50% of total GDP.

The coefficient of CointEq(-1), valued at -0.354342 with a very small p-value (0.0000), indicates the presence of cointegration among the variables in this model. This finding suggests a stable long-term relationship between GDP, VEX, NEX, the exchange rate (KURS), and RECESSION. The negative and statistically significant CointEq(-1) coefficient implies that any long-term disequilibrium in this model will be corrected at an adjustment speed of 35.43% per period. In other words, when deviations from the long-term equilibrium occur, the model will adjust to correct these deviations significantly and within a relatively short time frame.

CONCLUSION

This study examines the short- and long-term impacts of the exchange rate, coffee export volume, and coffee export value on Indonesia's economic growth, as well as the influence of recessions. The findings suggest that the exchange rate has a significantly negative impact on economic growth in both the short and long term. In contrast, the value of coffee exports has a positive long-term influence on economic growth, although its short-term impact is neither consistently positive nor statistically significant. The coffee export volume demonstrates an inconsistent and statistically insignificant effect on GDP in the short term, and this effect remains insignificant in the long term. Interestingly, the recession does not exhibit a statistically significant effect on GDP in this model, likely due to the effectiveness of mitigation policies. These results underscore the importance of effective exchange rate management and the improvement of coffee export quality as key strategies for fostering sustainable economic growth in Indonesia.

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The Impact of Investment and Labor Force Participation on Poverty in Aceh: The Mediating Role of Per Capita Income

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ABSTRACT

Research Originality: Poverty remains a persistent challenge in Aceh Province despite multiple interventions. This study contributes to the literature by examining both the direct and indirect effects of investment and labor on poverty, as measured by per capita income, using path analysis.

Research Objectives: The study aims to examine the impact of Labor Force Participation Rate (LFPR), Domestic Investment (DI), and Foreign Direct Investment (FDI) on poverty, with per capita income (PCI) as a mediating factor.

Research Methods: Time-series data from 2009 to 2023 were analyzed using path analysis to identify direct and indirect relationships.

Empirical Results: Findings show that per capita income has the most substantial effect in reducing poverty. DI significantly influences poverty, both directly and indirectly, while LFPR and FDI exhibit no significant impact; however, both trends show a negative correlation with poverty.

Implications: Poverty alleviation strategies should prioritize income growth through domestic investment optimization and enhancing workforce quality.

Keywords:

labor force participation; domestic investment; foreign direct investment; per capita income; poverty reduction

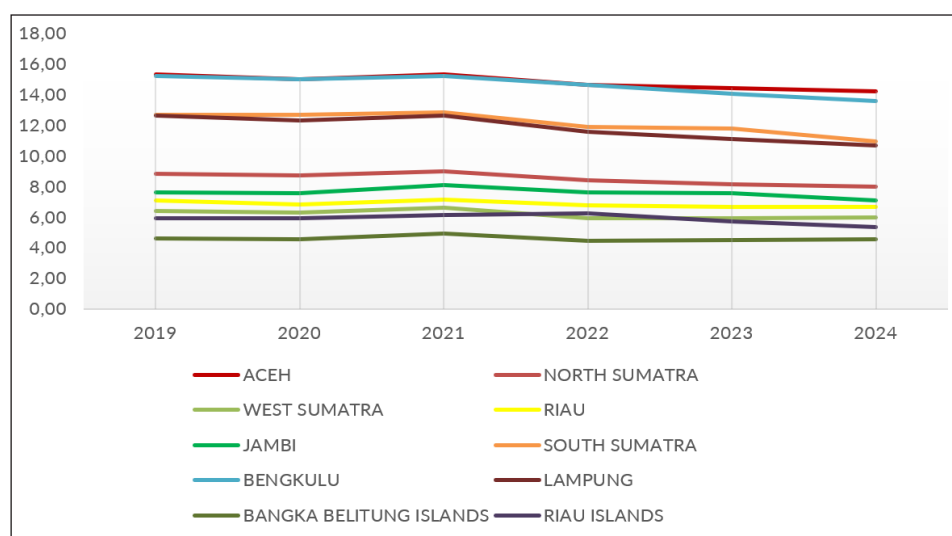
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INTRODUCTION

Poverty remains a persistent development challenge in Indonesia due to its wide-ranging impacts on access to education, health, and employment opportunities. At the aggregate level, poverty reduction has tended to slow down despite sustained economic growth, while income inequality has relatively increased (Purwono et al., 2021; Agussalim et al., 2024; Balasubramanian et al., 2023). This pattern is particularly evident in regions with fragile economic structures and unequal access to basic services, including Aceh, which, despite receiving substantial fiscal transfers, continues to record poverty levels above the national average.

Figure 1. Poverty Rate by Province in Sumatra, 2019–2024



Source: BPS Indonesia, 2025

Based on Figure 1, Aceh ranks as the province with the highest poverty rate in Sumatra, at approximately 14–15%. This figure is significantly higher than that of other provinces such as Bengkulu, Lampung, or South Sumatra, which remain at 12–13 percent, and more than double that of the Bangka Belitung Islands, which is only about 5 percent. This evidence highlights the structural nature of poverty in Aceh, which is more severe than in its neighboring provinces (BPS, 2025). It also suggests that growth-oriented strategies alone are insufficient; instead, a framework is required that explicitly links poverty transmission mechanisms through labor markets, investment flows, and income dynamics.

A growing body of research highlights structural barriers that undermine the poverty-reducing impact of growth. High income inequality limits the extent to which output expansion trickles down to lower-income groups (Hornok & Raeskyesa, 2024; Min & Rao, 2023). The dominance of the informal sector leaves many workers in vulnerable employment without social protection (Kataoka, 2019). Interregional disparities in access to basic services—particularly modern energy, health, education, and infrastructure

reinforce vulnerability (Rizal et al., 2024; Saputri et al., 2024). Evidence on energy poverty further suggests that such non-monetary deprivation undermines the productivity and quality of life of poor households (Rizal et al., 2024; Saputri et al., 2024). Meanwhile, demographic changes such as population aging and variations in local institutional capacity add complexity to poverty reduction efforts (Kudrna et al., 2022; Wulandari et al., 2023; Moyer et al., 2022).

From a labor market perspective, the most direct channels to poverty are the Labor Force Participation Rate (LFPR) and the quality of human capital. Increased participation, particularly among women and youth, can improve household welfare; however, the effect largely depends on the quality of the jobs absorbed (Kusumawardhani et al., 2023). Several studies indicate an educational mismatch: regions with a high share of secondary and tertiary graduates often experience educated unemployment, while regions with lower levels of education tend to be absorbed into low-productivity employment (Kataoka, 2019; Gehrke et al., 2025). On the other hand, social policies such as conditional cash transfers have been shown to improve health and education outcomes, including reductions in stunting and greater utilization of health services (Cahyadi et al., 2020; Ferraro & Simorangkir, 2020). Investments in human capital consistently contribute to reducing income inequality (Thye et al., 2022; Omar & Inaba, 2020). At the same time, financial inclusion and internet access have expanded labor force participation; however, without skill upgrading, this shift often leads to informal employment (Ekaputri et al., 2025; Kusumawardhani et al., 2023). Hence, both human capital quality and job quality are prerequisites for a genuinely higher LFPR to reduce poverty.

In terms of Domestic Investment (DI), evidence highlights the significant role of public spending (education, health, and basic infrastructure) and village transfers in reducing poverty and unemployment (Anam et al., 2023; Ernawati et al., 2021). The Village Fund program, for example, has been positively correlated with poverty reduction in many regions, although the magnitude of the effect varies depending on governance and targeting (Anam et al., 2023; Ernawati et al., 2021). However, long-term studies on domestic capital formation indicate efficiency limitations: without improvements in allocation and productivity, increases in DI do not automatically translate into pro-poor growth (Sijabat, 2022). This condition implies that DI must be directed toward high-value-added, labor-intensive sectors and expanded basic services in order for the growth-to-income channel to function optimally for poor households. Additional evidence suggests that government spending on education and health has a significant impact on reducing poverty (Agussalim et al., 2024).

The role of Foreign Direct Investment (FDI) in poverty reduction is conditional. On the one hand, FDI fosters productivity, value-chain integration, and job creation; several cross-country studies find a negative association between FDI and poverty rates (Ahmad et al., 2019; Daud et al., 2025). On the other hand, without sufficient human capital absorption capacity, FDI tends to favor skilled labor, raising wage premiums and sidelining less-skilled workers (Fazaaloh, 2024; Matsuura & Saito, 2023). Indeed,

restrictive FDI policies may increase the number of local firms and jobs, but not necessarily improve welfare if job quality remains low (Gehrke et al., 2025). Moreover, the effect of FDI on DI depends on institutional quality: it can crowd in under good governance or crowd out when institutions are weak (Magbondé et al., 2025; Sattar et al., 2022). Evidence from Indonesia suggests that infrastructure and human capital are key factors in attracting FDI, while the pandemic had only a temporary effect (Budiono & Purba, 2023; Sukhadolets et al., 2021).

Theoretically and empirically, per capita income is a crucial mediating channel through which LFPR, DI, and FDI affect poverty. Growth in average household income reduces poverty, but the size of the effect depends on distribution and inflationary pressures (Agussalim et al., 2024; Balasubramanian et al., 2023). Cross-provincial evidence from Indonesia shows a negative correlation between per capita growth and poverty levels (Purwono et al., 2021). Cross-country findings similarly indicate that the elasticity of poverty to growth is smaller in multidimensional poverty compared to monetary poverty (Balasubramanian et al., 2023; Jiménez, 2024). Positioning per capita income as a mediator, therefore, enables us to capture indirect effects; for instance, FDI/DI and LFPR may not only influence poverty directly but also through income growth.

Synthesizing these findings, a notable research gap exists in the scarcity of integrated studies that simultaneously assess LFPR, DI, and FDI, along with the mediating role of per capita income, within a regional context such as Aceh. Many studies have focused on single dimensions (e.g., Village Fund, energy, gender, or FDI) or examined Indonesia in aggregate (Ekaputri et al., 2025; Rammohan & Tohari, 2023; Rizal et al., 2024). However, for effective policymaking, decision-makers require a causal understanding: which factors have direct effects on poverty, and which operate through income. Recent literature further emphasizes the importance of making both FDI and DI more pro-poor by strengthening linkages with local sectors and enhancing human capital quality (Džogan et al., 2025; Yuldashev et al., 2023). Building on this gap, the present study employs path analysis to examine the direct and indirect effects of LFPR, DI, and FDI on poverty, with per capita income as the mediating variable. This approach is particularly relevant as it distinguishes between direct channels and income-mediated channels, aligns with empirical evidence that growth and investment operate differently across channels and income groups, and provides a stronger foundation for policy recommendations. Specifically, these include strengthening the quality and orientation of DI (education, health, basic infrastructure, and labor-intensive sectors), channeling FDI into sectors with strong domestic linkages while upgrading workforce skills, and expanding quality labor force participation (especially women and youth) so that the benefits of growth are more evenly distributed (Chizema, 2025; Fazaalloh, 2024; Xiao & Qamruzzaman, 2022).

METHODS

This study was conducted in Aceh Province, which is known as one of the regions with relatively high poverty levels in Indonesia (see Figure 2). The data employed are secondary time-series data covering the period from 2009 to 2024. The choice of this period aims to provide an up-to-date empirical picture of the relationship between labor force participation, investment, per capita income, and poverty in Aceh. Data sources are drawn from the official publications of Statistics Indonesia (BPS) and the Aceh Provincial Office of BPS. To strengthen the research context, we present a map of Indonesia that depicts the distribution of poverty rates across provinces, based on BPS data. Each province is shaded according to its poverty category: <5%, 5–10%, 10–15%, 15–20%, and >20%. Aceh is highlighted with a bold red outline, emphasizing its position as one of the provinces with the highest poverty levels in Sumatra.

Figure 2. Poverty Rate by Province in Indonesia – Aceh Highlighted



Source: author's calculation

The dependent variable is poverty, which is proxied by the percentage of the population living in poverty relative to the total population, as measured by the BPS. This indicator is consistent with previous studies by (Jiménez, 2024; Purwono et al., 2021; Shukla, 2023). The first independent variable is the Labor Force Participation Rate (LFPR), defined as the percentage of the working-age population who are employed or seeking employment, in line with Akhtar et al. (2020), Kataoka (2019), and Kis-Katos & Sparrow (2015). The second independent variable is Domestic Investment (DI), referring to realized domestic capital investment as reported by BPS, following a study by Degrit Nst & Sari (2024), Magbondé et al. (2025), and Wiganepdo & Sugiyanto (2022). The third independent variable is Foreign Direct Investment (FDI), measured from realized direct foreign investment according to BPS, as highlighted in Daud et al. (2025), Emako et al. (2023), and Matsuura & Saito (2023). In addition, this study incorporates Per Capita Income (PCI) as a mediating variable, measured using Gross Regional Domestic Product (GRDP) per capita. This variable reflects the average economic capacity of the population and has been applied in prior studies such as Jiménez (2024), Nizar et

al. (2023), and Shukla (2023). To stabilize variance, approximate normal distribution, and facilitate elasticity interpretation, PCI, DI, and FDI were transformed into natural logarithms (ln) prior to analysis.

Moreover, the selection of these variables is theoretically and empirically justified. Poverty is widely recognized as a multidimensional issue; however, its monetary measurement, as indicated by the proportion of poor households, remains the most widely used and comparable indicator across regions. LFPR is included to capture the role of labor supply and human resource utilization in poverty dynamics. At the same time, DI and FDI are used to represent domestic and external capital accumulation that can drive economic growth. PCI, meanwhile, serves not only as a mediating factor but also as a crucial outcome variable that reflects improvements in living standards. By incorporating these variables together in a path analysis framework, this study aims to provide a more comprehensive picture of both the direct and indirect channels through which labor, investment, and income interact to influence poverty reduction. The definitions, measurements, data sources, and references for each variable are summarized in Table 1.

Table 1. Operational Variables

Variables	Definitions	Measurements	Sources	References
Poverty	Percentage of the poor population relative to the total population	Poverty rate (%)	(BPS, 2024b)	(Jiménez, 2024; Purwono et al., 2021; Shukla, 2023)
Labor Force Participation Rate (LFPR)	Percentage of the labor force relative to the working-age population	LFPR (%)	(BPS, 2024e)	(Akhtar et al., 2020; Kataoka, 2019; Kis-Katos & Sparrow, 2015)
Domestic Investment (DI)	Realized domestic capital investment	Billion Rupiah (Rp)	(BPS, 2024c)	(Degrit Nst & Sari, 2024; Magbondé et al., 2025; Wiganepdo & Sugiyanto, 2022)
Foreign Direct Investment (FDI)	Realized foreign direct investment	Billion Rupiah (Rp)	(BPS, 2024d)/ (BI, 2025)	(Daud et al., 2025; Emako et al., 2023; Matsuura & Saito, 2023)
Per Capita Income (PCI)	Gross Regional Domestic Product per capita	Million Rupiah (Rp)	(BPS, 2024a)	(Jiménez, 2024; Nizar et al., 2023; Shukla, 2023)

The analytical method employed in this study is path analysis. This technique was first introduced by Wright (1934) as an extension of linear regression to explain causal relationships among variables. According to Streiner (2005), path analysis is appropriate when the study involves variables that can be directly observed and aims to decompose effects into direct, indirect, and total components. In this study, all variables analyzed—labor force participation, domestic investment, foreign direct investment, per capita income, and poverty—are directly measurable using BPS data. Path analysis is therefore

considered the most suitable method, as it can explain both the magnitude of effects and the mechanisms through which variables exert their influence, aligning with the research objectives. The path model structure consists of two sub-structures with model equations written as follows:

$$Z = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon_1 \quad (1)$$

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 Z + \varepsilon_2 \quad (2)$$

Description, Y = Poverty; α = Constant; $\beta_{1,2,3}$ = Regression Coefficient; X_1 = Labor Force Participation Rate (LFPR); X_2 = Domestic Investment (DI); X_3 = Foreign Direct Investment (FDI); Z = Per Capita Income (PCI).

The analytical procedure began with the collection of secondary data from BPS Indonesia and BPS Aceh. This was followed by diagnostic testing of basic assumptions, including normality, multicollinearity, autocorrelation, and linearity. The next step involved estimating sub-structure I and sub-structure II. Based on the estimation results, direct, indirect, and total effects were computed using path coefficients.

RESULT AND DISCUSSION

The path analysis conducted in this study generated several key findings. First, in Sub-structure I, it was found that Labor Force Participation Rate (LFPR), Domestic Investment (DI), and Foreign Direct Investment (FDI) were positively associated with Per Capita Income (PCI). However, none of these relationships was statistically significant. This result suggests that while these variables have the potential to increase income, their effects remain limited in the context of Aceh. Second, in Sub-structure II, PCI, DI, and FDI were found to significantly reduce poverty, whereas LFPR also exhibited a negative but statistically insignificant effect. Thus, PCI emerges as the primary channel for poverty reduction, while DI and FDI reinforce its role both directly and indirectly.

Table 2. Estimation Results of Sub-structure I

Variable Relationship	Coefficient	Significance
Constant	-2.796458	
LFPR → Per Capita Income	0.088566	0.0525
DI → Per Capita Income	0.030639	0.2755
FDI → Per Capita Income	0.048289	0.0806
R ²	0.721107	
Adj R ²	0.651384	
F-Statistic	10.34242	
Prob(F-Statistic)	0.001204	

Source: data processing results using Eviews, 2025

The estimation results of Sub-structure I show that the coefficients of LFPR, DI, and FDI on PCI are 0.088566, 0.030639, and 0.048289, respectively. All three coefficients are positive but statistically insignificant. Statistical significance was determined by comparing the p-values against a 5% significance level ($\alpha = 0.05$). Since all p-values exceeded 0.05, despite the positive signs, the effects are not statistically significant. This result indicates that although increases in LFPR, DI, and FDI tend to contribute to per capita income growth, the impacts are not strong enough to be empirically validated (Table 2).

From a theoretical standpoint, these results can be explained within the framework of endogenous growth theory, which emphasizes that capital accumulation and labor participation are essential but require complementary factors, such as technological progress and efficiency gains, to produce significant long-term effects (Aghion & Howitt, 2009). In line with labor market theory, higher labor force participation is expected to expand productive capacity and output (Borjas, 2023). Likewise, investment theory suggests that both domestic and foreign investment should enhance aggregate demand and capital stock, thereby increasing income. However, the statistical insignificance observed here implies that the theoretical expectations are not fully reflected in the estimated coefficients, highlighting that the contributions of LFPR, DI, and FDI to PCI are present in direction but insufficient in magnitude to reach conventional thresholds of significance. These findings are consistent with the notion that theoretical models often capture idealized mechanisms, whereas empirical outcomes may reveal weaker relationships when tested within specific contexts.

Table 3. Estimation Results of Sub-structure II

Variable Relationship	Coefficient	Significance
Constant	53.74037	
LFPR → Poverty	-0.297820	0.1795
DI → Poverty	-0.437937	0.0040
FDI → Poverty	-0.316370	0.0268
PCI → Poverty	-3.763530	0.0112
R ²	0.953912	
Adj R ²	0.937153	
F-Statistic	56.91843	
Prob(F-Statistic)	0.000000	

Source: data processing results using Eviews, 2025

The estimation results of Sub-structure II indicate that the independent variables tend to affect poverty, though their significance levels vary negatively. LFPR has a direct coefficient of -0.297820, indicating that higher labor force participation may reduce

poverty; however, the effect is not statistically significant, as its p-value exceeds 0.05. Conversely, DI exerts a significant impact, with a direct coefficient of -0.437937, demonstrating that higher domestic investment meaningfully reduces poverty. FDI also has a significant coefficient of -0.316370, showing that foreign investment contributes to poverty reduction. Meanwhile, PCI recorded a coefficient of -3.763530, which is both significant and substantially larger than the other variables (see Table 3).

Table 4. Direct, Indirect, and Total Effects of Variables

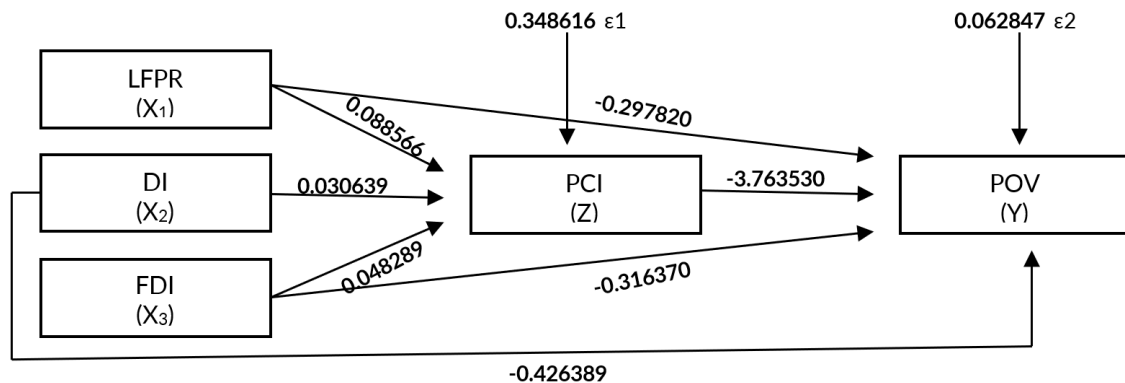
Variable Relationship	Direct	Indirect	Total
LFPR → PCI	0.088566	-	0.088566
DI → PCI	0.030639	-	0.030639
FDI → PCI	0.048289	-	0.048289
LFPR → Poverty	-0.297820	-0.333321	-0.631141
DI → Poverty	-0.437937	-0.115311	-0.553248
FDI → Poverty	-0.316370	-0.181737	-0.498107
PCI → Poverty	-3.763530	-	-3.763530

As shown in Table 4, PCI has the most significant total effect, at -3.763530, followed by DI and FDI, while LFPR has a negative but statistically insignificant effect. These results highlight that per capita income functions as the primary pathway through which changes in LFPR, DI, and FDI are transmitted into poverty reduction. In practical terms, it is not merely the existence of investment or workforce expansion that matters, but how effectively these factors translate into higher household incomes. The strong and significant role of PCI underscores the importance of inclusive growth: without ensuring that income gains reach poor households, the potential of LFPR, DI, and FDI to alleviate poverty will remain limited. Although DI and FDI display smaller coefficients than PCI, both variables show consistent and significant effects in reducing poverty, both directly and indirectly. This indicates that investment, whether domestic or foreign, contributes not only through job creation and capital formation but also by supporting income growth that amplifies its impact on welfare. Conversely, the weak role of LFPR reflects structural labor market issues in Aceh, such as skill mismatches and limited access to decent work. These findings reinforce theoretical expectations that income serves as a central mediator in the growth–poverty nexus, while also providing empirical evidence that targeted investment and productivity-oriented labor policies are crucial to achieving sustainable poverty reduction.

Figure 3 also displays the error terms (ϵ) for the dependent variables: ϵ_1 for PCI and ϵ_2 for poverty. These values represent the proportion of variation unexplained by the model, calculated as 1 minus the R-squared value. Accordingly, $\epsilon_1 = 0.348616$ indicates that approximately 34.86% of the variation in PCI is unexplained by LFPR, DI, and

FDI, while $\varepsilon_2 = 0.062847$ suggests that factors outside the model influence 6.28% of the variation in poverty.

Figure 3. Path Analysis Result Diagram



Overall, this study demonstrates that PCI is the primary channel for poverty reduction. Increases in PCI significantly reduce poverty, reinforcing the notion that economic growth is a critical driver of welfare improvement. However, in the context of Aceh, average income growth has not been fully inclusive, as reflected in poverty rates that remain higher than the national average. This highlights the need for growth policies in regions with relatively high inequality to ensure a more equitable distribution of benefits. (Agussalim et al., 2024; Jiménez, 2024; Purwono et al., 2021).

Additionally, investment plays a crucial role in alleviating poverty. DI contributes by creating jobs and providing basic infrastructure that supports the productivity of the poor, consistent with findings on the effectiveness of pro-poor public spending (Anam et al., 2023; Ernawati et al., 2021). Similarly, FDI significantly reduces poverty, aligning with empirical evidence from other developing countries (Chizema, 2025; Daud et al., 2025). Nevertheless, the direction of FDI matters: foreign investment concentrated in capital-intensive sectors may exacerbate inequality, whereas investment directed toward labor-intensive sectors is more effective in alleviating poverty (Handayani et al., 2022; Matsuura & Saito, 2023).

Unlike other variables, LFPR shows a negative but relatively weak relationship with poverty. This suggests that increasing labor force participation alone is insufficient without improvements in workforce quality and the availability of decent employment opportunities. The phenomena of skills mismatch and low female participation in Aceh further reinforce the argument that labor force participation will only have a substantial impact if accompanied by productivity improvements and expanded access to formal employment (Kataoka, 2019; Kusumawardhani et al., 2023; Rammohan & Tohari, 2023).

CONCLUSION

This study demonstrates that PCI serves as the primary pathway for poverty reduction in Aceh Province. Increases in PCI significantly reduce poverty, reinforcing the role of inclusive economic growth in improving household welfare. DI exerts both direct and indirect significant effects on poverty reduction through income growth. Meanwhile, LFPR and FDI both show negative but statistically insignificant impacts, indicating that labor force expansion and foreign capital inflows alone are insufficient without improvements in workforce quality, domestic linkages, and access to decent employment.

From a policy perspective, the findings highlight the importance of channeling DI into education, health, basic infrastructure, and halal tourism as a labor-intensive sector with strong local linkages. In addition, enhancing workforce skills—particularly among women and young people—is crucial to maximizing the poverty-reducing potential of growth and investment. These measures will help ensure that economic progress translates into more equitable and sustainable poverty alleviation in Aceh.

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Do Tourism-Related Sectors Drive Most of the Economy in Toba Regency? A RAS-based Regional Input-Output Analysis

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ABSTRACT

Research Originality: This study constructs the first regional Input–Output (RIO) table for Toba Regency in 2023, utilizing the iterative RAS technique to adapt provincial coefficients to local macroeconomic data.

Research Objectives: To estimate sectoral interlinkages, multiplier effects, and labor intensity for Toba Regency, and to identify strategic sectors that can drive regional economic growth and inform evidence-based policymaking.

Research Methods: The 2016 North Sumatra I–O table was regionalized into a 22-sector Toba Regency table through RAS, with row and column sums adjusted to match Toba Regency GRDP by industry and expenditure. The resulting table was analyzed to calculate backward and forward linkages, output multipliers, and labor intensity.

Empirical Results: The local economy is primarily driven by paper manufacturing, agriculture, and construction, while the tourism sector contributes only 6.2 percent of output and exhibits weak forward linkages. This finding suggests limited integration of tourism-related activities into the local supply chain. Electricity, business services, and agriculture emerge as growth drivers, while wage disparities persist in low-productivity service sectors.

Implications: The approach can guide other subnational governments in producing localized Input–Output (I–O) tables, thereby enhancing evidence-based policymaking.

Keywords:

Input-Output analysis; RAS technique; sectoral interlinkages; regional growth diagnostics; regional development policy

How to Cite:

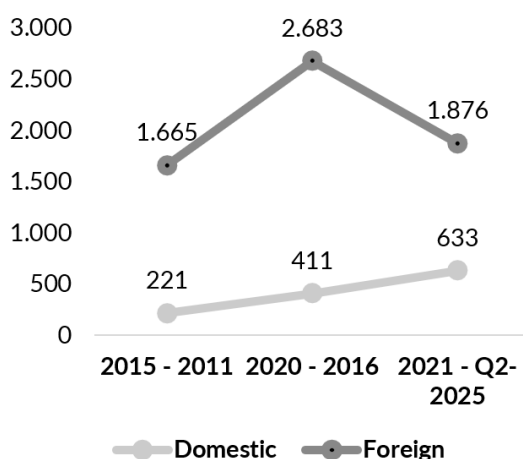
Susanti, H., Revindo, M.D., Iskandar, S.D., Nusantara, N., & Sabrina, S. (2025). Do Tourism-Related Sectors Drive Most of the Economy in Toba Regency? A RAS-based Regional Input-Output Analysis. *Signifikan: Jurnal Ilmu Ekonomi*, 14(2), 521-536. <https://doi.org/10.15408/sjie.v14i2.46490>.

INTRODUCTION

Regional development planning requires accurate and timely information on the structure of local economies and the interlinkages between sectors. Input-Output (I-O) analysis, first introduced by Leontief (1936), remains the most widely applied tool for this purpose, enabling policymakers to estimate the ripple effects of sectoral changes on output, employment, income, and regional supply chains. Its ability to reveal backward and forward linkages is valuable for identifying key sectors, quantifying multiplier effects, and assessing structural change (Dietzenbacher et al., 2019; Miller & Blair, 2009).

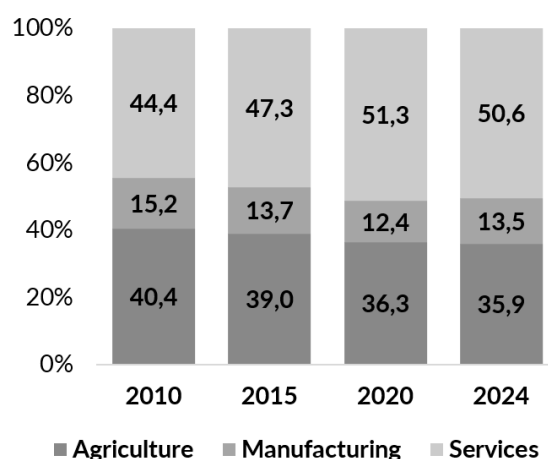
In Indonesia, official I-O tables are published by Statistics Indonesia (BPS) at the national and provincial levels. These tables are typically updated every five years and released with considerable delay. For example, the 2016 I-O table was released in 2020, and the 2020 table is expected in 2025. At the regency and city levels, I-O tables are rarely available because survey-based data collection is costly and complex, making subnational availability reliant on local government initiatives. As a result, policymakers at the regional and city levels often lack up-to-date transactional data to support their policymaking decisions. A small but growing set of local studies has begun to fill this gap. Examples include a 54x54 regional I-O (RIO) table for Tegal Regency, a 2020 RIO for Pangandaran Regency built from the West Java I-O table, and a recent RIO for Mataram City (Mumtaz & Sukarsih, 2021; Hendriany et al., 2024; Wibawanindah et al., 2024). These studies show that localized I-O is feasible and valuable, but coverage remains uneven.

Figure 1. Investment Realization in Toba Regency (IDR billion)



Source: CEIC

Figure 2. Contribution of Main Economic Activities to Toba Regency GRDP (%)



Source: CEIC

This study addresses the gap in the Toba Regency. Designated a Super Priority Tourism Destination in 2016, the region has experienced significant structural changes. Foreign direct investment surged in the early years, peaking during large tourism infrastructure projects, then declined as those projects concluded. Meanwhile, domestic

investment has expanded steadily and is now more than three times its pre-designation level, indicating greater reliance on local capital and a shift in resource allocation toward tourism-related development. These investment patterns align with the process of structural transformation. As shown in Figure 2, the share of the services sector (excluding construction) rose from 44.4 percent of Gross Regional Domestic Product (GRDP) in 2010 to 50.6 percent in 2024, while agriculture fell from 40.4 percent to 35.9 percent and manufacturing declined slightly from 15.2 percent to 13.5 percent. These dynamics reflect a gradual reorientation from primary and manufacturing activities toward a service-led growth, suggesting the need for a regency-level I–O table that captures evolving sectoral interlinkages and investment flows.

An RIO table would be constructed through a full or hybrid survey to measure intersectoral flows with the greatest accuracy (Stoeckl, 2012). However, such surveys are expensive and time-consuming, which makes them impractical for most regencies and municipalities. Consequently, regional economists often rely on non-survey methods to derive subnational I–O tables from national or provincial data. Among these, the Location Quotients (LQ) technique is the most common approach to adjust national coefficients based on the relative sectoral shares of regional and national output (Lampiris et al., 2020; Lamonica & Chelli, 2018), before applying the RAS technique to balance the RIO table. However, LQ methods assume identical production technologies across regions and often depend on outdated or incomplete sectoral share data. In rapidly evolving economies such as that of Toba Regency, where tourism-oriented policies are shifting production patterns, these assumptions can distort multiplier estimates and misrepresent both backward and forward linkages.

This study constructs a 2023 RIO table for Toba Regency to describe how the transformation driven by tourism is reshaping the economic structure. Existing work on Indonesia is primarily at the provincial level. To our knowledge, no study has reported sectoral linkages at the Toba Regency level or outlined a practical workflow that local governments can reuse when surveys are not feasible. Using updated subnational accounts and RAS balancing, we map sectoral linkages, multipliers, and labor intensity in Toba Regency. The table provides an initial map of where spillovers are strong and where supply chains remain shallow. The contribution of this study is both empirical and methodological, offering a reproducible template for regency-level I–O analysis and a baseline for tracking structural change in Toba Regency over time.

METHODS

This study covers the Toba Regency I–O analysis for the year 2023, utilizing a 22-sector classification. Sector detail is expanded from the standard Statistics Indonesia (BPS) report of 17 sectors to 22 sectors, allowing for the separate identification of pulp and paper, accommodation, food and beverage services, wholesale and retail trade (excluding motor vehicles), and the land transport sectors, which are significant in explaining the economic structure of Toba Regency. In developing the Toba Regency I–O table, we start

from 2016 North Sumatra I–O table as the parent matrix for technical coefficients and combine it with 2023 Toba Regency's GRDP by industry (to anchor primary inputs and sector structure) and GRDP by expenditure (to anchor the composition of final demand: households, Non-Profit Institutions Serving Households (NPISH), government, Gross Fixed Capital Formation (GFCF), inventory change, exports, and imports). Employment and wage statistics were also merged to construct labor-intensity indicators.

The I–O table is a foundational tool for studying the interrelationships among sectors in a complex economic system. It captures all transactions of goods and services between industries (intermediate demand), final users (final demand), and value-added components such as labor and profits. Table 1 illustrates the structure of the I–O table. Let X_{ij} denote the delivery of goods or services from the sector i to sector j for intermediate use; F_i the final demand for the output of sector i ; V_j the value added generated by sector j ; X_i the total output of sector i (row total); and X_j the total input of sector j (column total). The three quadrants, intermediate demand (Quadrant I), final demand (Quadrant II), and value added (Quadrant III), satisfy the balance conditions $\sum_j X_{ij} + F_i = X_i$ and $\sum_i X_{ij} + V_j = X_j$ for every sector. Accounting conventions follow Miller and Blair (2009) and BPS practice.

Table 1. Input-Output Model Framework

INPUT OUTPUT		INTERMEDIATE DEMAND (Quadrant I)				FINAL DEMAND (Quadrant II)	TOTAL OUTPUT
		SECTOR					
		1 ($j = 1$)	2 ($j = 1$)	...	n ($j = n$)		
SECTOR 1	($i = 1$)	X_{11}	X_{12}	...	X_{1n}	F_1	X_1
2	($i = 2$)	X_{21}	X_{22}	...	X_{2n}	F_2	X_2
...	...	...	...	...	...	...	...
n	($i = n$)	X_{n1}	X_{n2}	...	X_{nn}	F_n	X_n
GROSS VALUE ADDED (Quadrant III)		V_1	V_2		V_n		
TOTAL INPUT		X_1	X_2	...	X_n		

Source: BPS-Statistics Indonesia (2021)

Notation: X_{ij} : input from sector i used to produce output from sector j ; V_j : gross value added of sector j ; X_j : total input from sector j ; X_i : total output from sector i ; F_i : final demand from sector i

Since regency or municipal tables are rarely surveyed, the provincial table is regionalized to Toba using the RAS technique. RAS belongs to the iterative proportional fitting family and is widely used for non-survey regionalization. Nobel laureate Richard Stone formalizes the technique (Marangoni & Rossignoli 2016; Stone 1961). Given a base input coefficient matrix $A = (a_{ij})$ from the North Sumatra I–O table, RAS finds diagonal matrices $r = \text{diag}(r_i)$

(row multipliers) and $s = \text{diag}(s_j)$ (column multipliers) such that the updated matrix $A_t = rAs$ matches target row and columns sums (sectoral totals). Here r_i scales row i and s_j scales column j . For example, if $r_1 = 0.5$ and $r_2 = 2.0$ (with $s = 1.0$), the proportion of input 1 utilized in year t is reduced to half of its base-year level, while the use of input 2 doubles. If $s_j = 0.5$ for a given column, the intermediate inputs share decreases by half. Thus, to maintain the total proportion of both equal to 1, the amount of primary input must adjust accordingly.

Although the RAS technique is often regarded as a simplified approach that may not fully capture the detailed economic conditions of a region, it remains a practical alternative for updating I–O tables by incorporating various macroeconomic assumptions. Furthermore, this technique is a replicable and transparent solution for regionalizing I–O tables when detailed data are unavailable (Flegg & Tohmo, 2013; Lampiris et al., 2020).

Using the RAS technique, provincial technical coefficients serve as priors; row and column totals are reconciled to Toba's 2023 macroeconomic targets through alternating row and column scaling until all margins match. Primary inputs by sector are taken from GRDP by industry, with imported primary inputs proxied by applying provincial import-to-input ratios where regency data are unavailable. Final-demand totals are taken from GRDP by expenditure; their initial sectoral allocation follows the provincial pattern and is then adjusted during the balancing. The process proceeds in three linked stages: (1) an initial balance to align primary inputs and total output with Toba totals; (2) an adjustment of the sectoral allocation of final demand to match expenditure aggregates; and (3) a final balance to ensure consistency across intermediate flows, primary inputs, and final demand (see Figure 3). Convergence is assessed by the reduction of margin errors below preset tolerances, alongside checks for non-negativity and structural plausibility (e.g., reasonable input shares and import propensities).

From the balanced table, we compute output multipliers, linkage indices, and labor-intensity measures. The structure of IO table (**Table 1**) allows us to measure multipliers and linkages. Define technical coefficients $a_{ij} = X_{ij}/X_j$ i.e., the share of inputs in sector j sourced from sector i . Let $x = X_i$ be gross output and $f = [F_i]$ final demand. The demand-driven model is $x = Lf$ where $L = (I - A)^{-1}$ is the Leontief inverse. Type-I output (backward) multipliers for sector j are the column sums $\sum_i \ell_{ij}$ of L . For supply-side responsiveness, we also report forward effects using the Ghosh formulation, with allocation coefficients $b_{ij} = X_{ij}/X_i$ and the Ghosh inverse $G = (I - B)^{-1}$. To summarize intersectoral relationships, we use linkage indices with $L = \ell_{ij}$: (1) backward linkage (power of dispersion) for sector j :

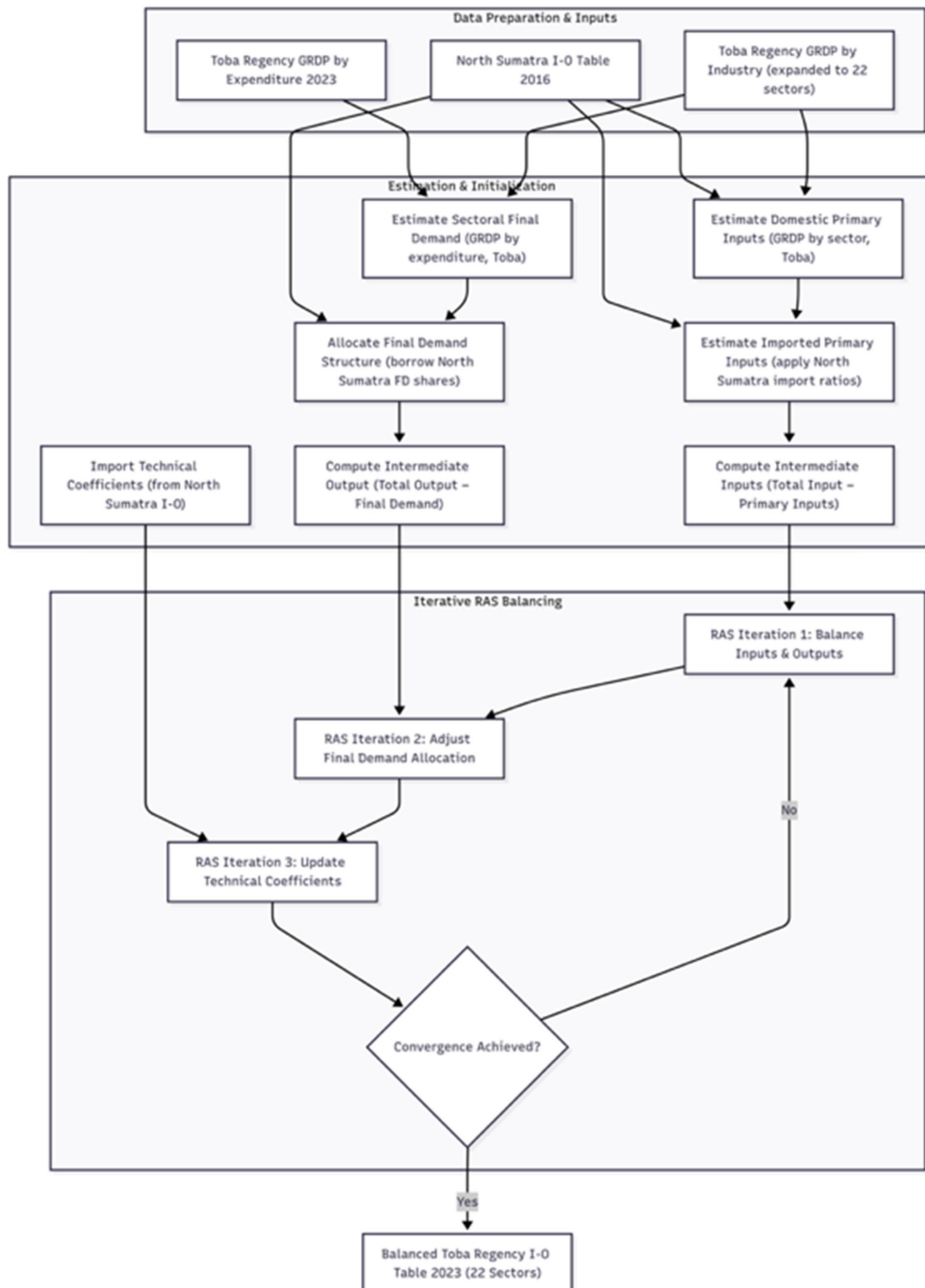
$$BL_j = \frac{n \sum_{i=1}^n \ell_{ij}}{\sum_{i=1}^n \sum_{j=1}^n \ell_{ij}}$$

BL_j quantifies the extent to which a particular sector stimulates outputs and income creation across all sectors through demand for its products. The forward linkage (degree of sensitivity), which measures how responsive a sector is to the demand for its products from other sectors, for sector i is formulated as:

$$FL_j = \frac{n \sum_{j=1}^n \ell_{ij}}{\sum_{i=1}^n \sum_{j=1}^n \ell_{ij}}$$

Sectors with values of BL and FL greater than one are classified as key sectors. Employment and wage effects of a final-demand vector f are obtained by premultiplying L by sectoral jobs or output and wage-bill or output coefficients.

Figure 3. Regionalization Using the RAS Technique Framework



Source: Authors' illustration (2025)

Moreover, the development of the RIO table for the Toba Regency also includes RAS convergence paths, margin matching errors, and sensitivity to import ratios. Nevertheless, we acknowledge that the main limitations of this technique are its reliance on provincial import or input profiles and the lack of survey microflows, which are typical constraints in non-survey regionalization. We mitigate these through robustness checks and transparent assumptions.

RESULTS AND DISCUSSION

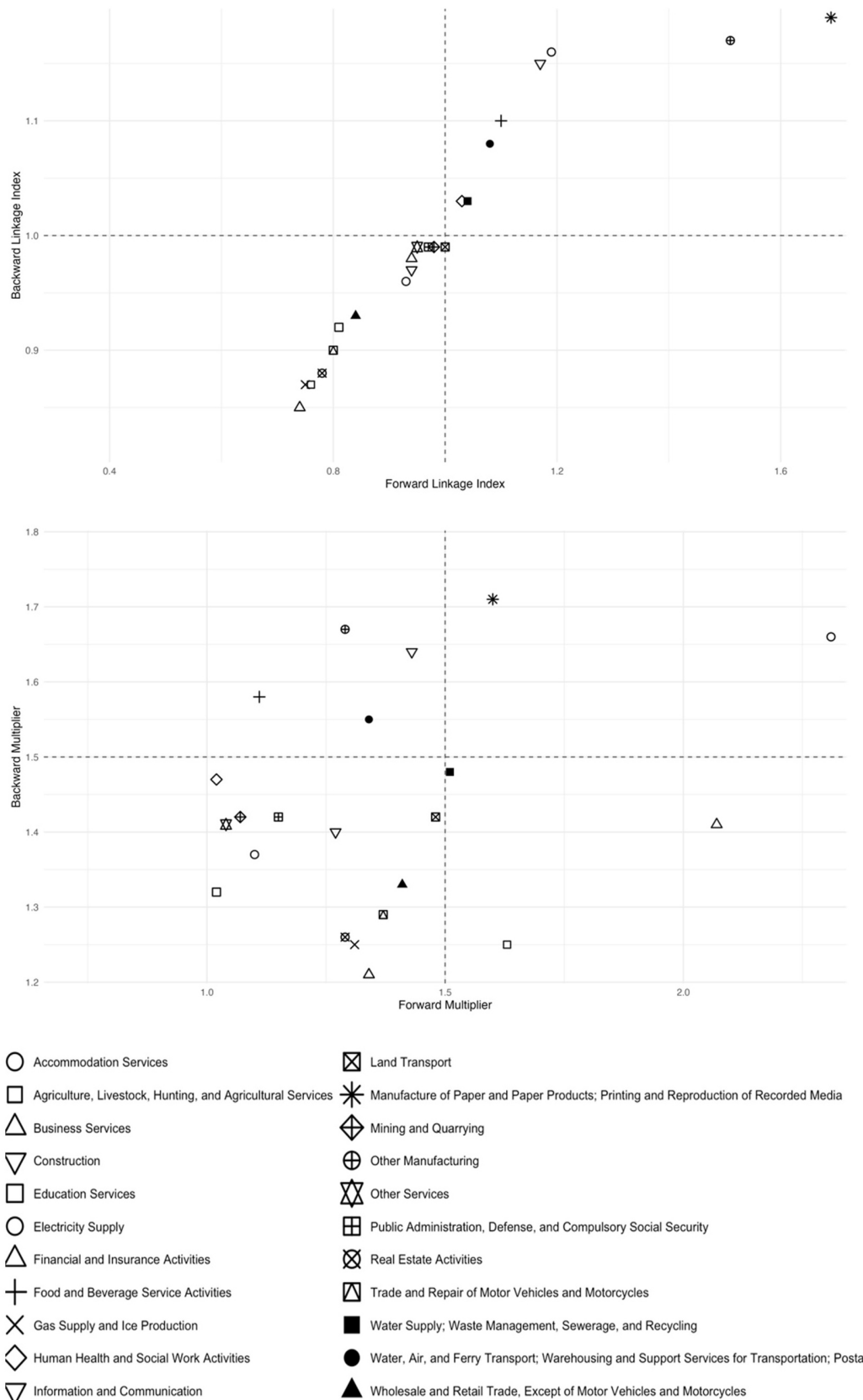
Regionalizing North Sumatra's I–O table with the RAS technique changes the story for Toba Regency. RAS preserves the provincial matrix structure while rebalancing row and column totals to local margins, thereby reducing the overestimation that can bias multiplier and linkage measures in lower-level jurisdictions (Lahr & de Mesnard, 2004; Miller & Blair, 2009). Recent evidence from Holý and Šafr (2023) also indicates that subnational RAS applications more effectively capture the economic structure of smaller economies, thereby producing more credible policy simulations.

The key finding is that tourism-related sectors do not yet drive most of Toba's economy. Accommodation, food and beverage services, land and water transport, and wholesale or retail together contribute only about 6.16 percent of the total supply. Instead, the economy is anchored by paper and paper products (22.4 percent), agriculture (21.8 percent), and construction (18.9 percent), which together account for more than half of the total supply. This finding is consistent with the literature, which notes how reliance on aggregated data for smaller jurisdictions can distort sectoral prioritization in economic planning (Jackson & Murray, 2004).

Final demand composition helps explain the result. Toba is mainly consumption and export-led. Household consumption accounts for roughly 38 percent of final demand and dominates basic goods and services (around 60 percent of agriculture's final demand and nearly 70 percent in food and beverages). Exports account for approximately 34 percent of the overall economy, with a notable concentration in the paper and agricultural sectors. GFCF is about 16 percent of total demand and is driven mainly by construction (83 percent of construction's final demand). Compared to the province, Toba Regency exhibits weaker investment intensity and a narrower export base, suggesting that applying provincial data directly would overstate the investment-led growth potential of the region.

Multiplier and linkage results further reflect the role of key productive sectors (see Figure 4). In the linkages graph, Quadrant I (high backward and high forward) is occupied by paper and paper products, and other manufacturing. These sectors both buy from many local suppliers and sell inputs to other sectors. However, no core tourism sector is located in this area. Quadrant II (high backward, low forward) encompasses construction and tourism-related services, with the strongest pull, as well as food and beverage services and transportation. They buy many inputs but sell few to other producers. Their effect can grow if hotels and restaurants buy more from

Figure 4. Sectoral Linkages and Multipliers Diagram (Quadrant I – IV, clockwise)



Source: Authors' calculation (2025)

local farms and SMEs. Quadrant III (low backward and low forward) encompasses accommodation and other services, such as education, health, finance, and real estate, which exhibit small production spillovers. Quadrant IV (low backward, high forward) typically includes wholesale or retail trade and water or waste management, which do not require significant capital investment. However, they support many other sectors in their operations.

In the multipliers chart, the most significant backward multiplier is in the paper and paper products sector, followed by other manufacturing, electricity, and construction. Extra demand in these sectors triggers the biggest upstream response. Within the tourism sector, food and beverages, as well as transport, exhibit above-average levels of backward integration, enabling them to strengthen local supply chains when sourcing is local. Accommodation sits lower, which matches its lighter use of intermediate inputs. On the forward side, paper manufacturing and other manufacturing are the most influential downstream enablers, followed by electricity supply, water supply, or waste management. These sectors provide essential inputs that many sectors need.

By contrast, sectors oriented toward final consumption, including education, health, accommodation, and food services, exhibit relatively modest forward multipliers, consistent with their limited role in supplying intermediate inputs. All in all, the combination of high multipliers and high linkage indices indicates priority sectors where investment can produce substantial ripple effects. Conversely, relatively weak linkage indices for agriculture and tourism-related services suggest opportunities to strengthen integration, such as connecting local farms to hospitality supply chains or developing logistics infrastructure to better link rural producers to urban markets.

Moreover, labor analysis adds another layer to the understanding of sectoral performance. Tourism-related sectors employ a large number of workers but have low labor compensation shares, particularly in the accommodation and land transport sectors. In contrast, wholesale and retail, agriculture, construction, and paper manufacturing allocate larger portions of value added to labor. Similar patterns, characterized by high employment and low wage shares in tourism, are observed in regional applications and help explain the modest inclusive-growth effects that can occur without complementary policies. The policy challenge is to raise productivity and wages among workers in many sectors, and to create pathways into higher-productivity segments that already have strong multipliers and linkages.

A brief comparison with Bali, Indonesia's most tourism-intensive province, shows why a tourism-led narrative does not yet fit Toba Regency. Tourism Satellite Account for Bali (built on an I-O base) reported tourism shares near 52 percent of output and 46 percent of GRDP in 2007, documenting a truly tourism-driven structure. More recent technical work for Bali continues to utilize I-O-based frameworks (including environmental extensions), highlighting the central role of tourism in the economy (Mohan et al., 2021). The 6 percent tourism supply share in Toba is still far from the benchmarks in Bali.

Why is the tourism role in Toba Regency still small despite its super priority status? The RAS results highlight four key practical reasons: leakages in critical inputs (imported food, beverages, fuels, and equipment), a shallow local supplier base, weak logistics, seasonality with a narrow product mix, and gaps in water, waste, and power management. International evidence suggests tourism only reshapes an RIO structure when the local production capacity is upgraded and procurement shifts to local firms (e.g., supplier certification, logistics warehouse near tourism clusters, and skills pipelines) (Gao, Su, & Wang, 2019). From a regionalization standpoint, systematically raising local content can also improve the empirical fit of technical coefficients over time (Flegg & Tohmo, 2013; Zhao & Choi, 2015).

The policy path for Toba Regency, therefore, should be a two-track. First, protect and upgrade the high multiplier paper manufacturing, construction, and utilities. Second, promote local content in tourism through local-procurement targets and utility upgrades, whose forward multipliers benefit both tourism and non-tourism activities. Product diversification can increase length of stay and visitor spending, dampening seasonality and improving the incentives for private investment.

Overall, the RAS table not only corrects for aggregation bias but also provides a granular foundation for strategic economic planning. By identifying sectors with both strong multipliers and linkage effects, policymakers can prioritize interventions with the greatest potential to stimulate growth, diversify the production base, and integrate underdeveloped sectors into the regional value chains of Toba Regency.

CONCLUSION

The 2023 RIO table of Toba Regency, developed with the RAS technique at each stage, can explain the input and output structure of the regency's economy. The table equips policymakers in Toba Regency with a practical tool to identify sectoral priorities, strengthen local value chains, and promote inclusive growth. It reveals a relatively balanced economy led by the paper and paper products manufacturing, agriculture, and construction sectors. Final demand dominates the economic activity, with most sectors driven by household consumption and exports (approximately 38 percent and 34 percent of final demand, respectively), while investment lags behind the provincial average. The relatively low share of intermediate demand indicates that many sectors are consumption-oriented and not yet fully integrated into regional production chains.

Despite their prominence in local development plans, tourism-related activities contribute only modestly to total output and demonstrate weak backward and forward linkages. Within the tourism sector, the food and beverage and transport sectors have above-average backward pull, but accommodation remains weak. By contrast, enabling sectors such as electricity, business services, and agriculture exhibit strong linkages and high multipliers, making them strategic targets for economic expansion. Labor market results also reveal significant wage and employment disparities, with a substantial

share of jobs concentrated in low-productivity service sectors, underscoring the need to enhance access to higher-value, more productive employment opportunities. Policy should follow a twin-track approach: (1) protect and upgrade the enabler sectors by improving utilities and cutting logistics costs; and (2) raise local content in tourism activities through supplier local purchasing targets, supplier and labor skills upgrading.

Although the RAS technique is effective for constructing RIO tables from limited data, it has inherent limitations. These limitations include the inability to capture technological progress or sectoral changes over time. To improve the reliability of regional economic planning, the RAS technique should be complemented with periodic surveys and stakeholder consultations. Nonetheless, the methodology and resulting framework presented in this paper can serve as a benchmark for other regencies or municipalities aiming to develop their own RIO tables. Regular updates using hybrid approaches that integrate RAS with targeted field data will further enhance the accuracy and utility of such models for formulating regional-level policies.

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Appendix 1. 2023 I–O Table of Toba Regency (in IDR million)

Economic Sector	Sector Code (22)	Agriculture, Livestock, Hunting, and Agricultural Services	Mining and Quarrying	Manufacture of Paper and Paper Products; Printing and Reproduction of Recorded Media	Other Manufacturing	Electricity Supply	Gas Supply and Ice Production	Water Supply; Waste Management, Sewerage, and Recycling	Construction	Trade and Repair of Motor Vehicles and Motorcycles	Wholesale and Retail Trade, Except of Motor Vehicles and Motorcycles	Land Transport	Water, Air, and Ferry Transport; Warehousing and Support Services for Transportation; Postal and Courier Services
		I-01	I-02	I-03	I-04	I-05	I-06	I-07	I-08	I-09	I-10	I-11	I-12
Agriculture, Livestock, Hunting, and Agricultural Services	I-01	580,150	2,596	736,231	34,279	19	22	186	198,259	1,179	268	-	55
Mining and Quarrying	I-02	16	248	22	13	27	0	0	1,944	178	17	48	13
Manufacture of Paper and Paper Products; Printing and Reproduction of Recorded Media	I-03	12,630	913	1,054,850	2,474	728	10	383	123,066	160,402	5,085	62,025	17,097
Other Manufacturing	I-04	1,675	24	2,115	434	87	0	6	6,185	3,445	95	954	458
Electricity Supply	I-05	445	62	896	110	10,948	1	15	22,586	5,650	333	316	522
Gas Supply and Ice Production	I-06	11	6	4	1	2	0	0	9	4	5	1	0
Water Supply; Waste Management, Sewerage, and Recycling	I-07	110	18	165	18	2	0	3	789	310	24	127	121
Construction	I-08	87,569	2,620	5,324	999	791	0	889	758,071	5,186	339	1,304	218
Trade and Repair of Motor Vehicles and Motorcycles	I-09	41,698	5,276	98,235	4,093	6,145	23	354	104,551	226,597	4,975	54,769	29,186
Wholesale and Retail Trade, Except of Motor Vehicles and Motorcycles	I-10	2,305	70	7,002	251	515	1	9	6,858	5,040	105	1,338	437
Land Transport	I-11	26,414	1,730	14,362	768	803	5	76	38,534	40,679	4,761	6,933	5,446
Water, Air, and Ferry Transport; Warehousing and Support Services for Transportation; Postal and Courier Services	I-12	4,139	241	2,686	160	353	1	13	9,274	5,109	599	501	6,005
Accommodation Services	I-13	187	272	448	31	58	0	20	6,463	1,988	119	103	1,181
Food and Beverage Service Activities	I-14	229	7	45	2	32	0	20	818	256	23	96	59
Information and Communication	I-15	278	224	801	105	256	1	13	6,161	13,676	457	4,258	1,815
Financial and Insurance Activities	I-16	3,557	14	267	39	881	0	13	5,706	12,821	374	3,943	101
Real Estate Activities	I-17	-	265	3,898	94	-	-	29	9,009	31,015	1,278	4,930	768
Business Services	I-18	2,323	616	3,415	156	3,616	3	50	39,784	28,178	2,712	7,608	1,895
Public Administration, Defense, and Compulsory Social Security	I-19	1,945	0	-	67	335	-	254	118,650	-	-	14	455
Education Services	I-20	26	24	141	10	11	0	4	589	1,057	36	17	125
Human Health and Social Work Activities	I-21	503	1	55	2	5	0	1	82	48	2	13	24
Other Services	I-22	46	9	45	4	0	0	1	263	80	5	13	18
Total Domestic Intermediate Demand	190d	766,257	15,238	1,931,009	44,108	25,615	67	2,341	1,457,651	542,897	21,613	149,310	66,001
Total Imported Intermediate Demand	2000	241,359	9,415	1,111,451	12,363	26,866	50	952	658,111	314,938	10,098	127,880	33,504
Total Intermediate Demand	1900	1,007,616	24,653	3,042,460	56,471	52,481	117	3,293	2,115,762	857,835	31,711	277,190	99,505
Labor Compensation	2010	923,691	9,234	622,374	4,275	1,473	9	479	563,943	753,979	24,810	43,187	29,041
Gross Operating Surplus (including mixed income)	2020	2,043,843	16,659	293,939	23,097	7,490	247	3,611	770,172	1,061,187	39,815	203,398	44,416
Taxes less subsidies on other production	2040	23,356	107	140,215	1,600	(3,050)	0	20	17,446	5,385	84	498	180
Gross Value Added	2090	2,990,890	26,000	1,056,528	28,972	5,914	256	4,110	1,351,560	1,820,551	64,709	247,083	73,637
Total Input	2100	3,998,506	50,653	4,098,988	85,443	58,395	373	7,403	3,467,322	2,678,386	96,420	524,272	173,142

Hera Susanti

Do Tourism-Related Sectors Drive Most of the Economy in Toba Regency?

Economic Sector	Sector Code (22)	Accommodation Services	Food and Beverage Service Activities	Information and Communication	Financial and Insurance Activities	Real Estate Activities	Business Services	Public Administration, Defense, and Compulsory Social Security	Education Services	Human Health and Social Work Activities	Other Services	Total Intermediate Demand
		I-13	I-14	I-15	I-16	I-17	I-18	I-19	I-20	I-21	I-22	1800
Agriculture, Livestock, Hunting, and Agricultural Services	I-01	6,549	17,445	0	16	-	-	13,383	8,047	16,780	1,994	1,617,458
Mining and Quarrying	I-02	9	2	9	6	6	13	74	11	6	1	2,664
Manufacture of Paper and Paper Products; Printing and Reproduction of Recorded Media	I-03	18,757	696	13,624	6,191	6,935	16,445	96,169	30,491	9,824	431	1,639,226
Other Manufacturing	I-04	654	85	98	51	33	133	479	185	355	17	17,569
Electricity Supply	I-05	2,913	17	323	106	476	434	1,221	365	242	22	48,003
Gas Supply and Ice Production	I-06	24	1	0	0	0	2	11	3	1	0	87
Water Supply; Waste Management, Sewerage, and Recycling	I-07	699	5	73	18	59	113	48	89	20	5	2,817
Construction	I-08	2,212	40	24,886	13,450	28,529	347	112,216	10,870	4,044	2,876	1,062,780
Trade and Repair of Motor Vehicles and Motorcycles	I-09	55,638	1,157	3,692	2,396	4,055	8,851	27,151	7,052	9,091	459	695,444
Wholesale and Retail Trade, Except of Motor Vehicles and Motorcycles	I-10	731	100	123	74	54	183	882	313	442	19	26,851
Land Transport	I-11	2,167	158	553	431	992	4,660	23,464	1,911	1,657	91	176,596
Water, Air, and Ferry Transport; Warehousing and Support Services for Transportation; Postal and Courier Services	I-12	748	33	147	135	237	1,004	10,967	428	265	16	43,062
Accommodation Services	I-13	2,268	4	69	88	141	1,129	11,132	3,214	1,619	127	30,662
Food and Beverage Service Activities	I-14	770	5	15	10	20	148	1,028	167	52	9	3,811
Information and Communication	I-15	4,297	25	1,711	559	415	730	2,413	878	363	30	39,465
Financial and Insurance Activities	I-16	818	4	96	513	1,244	667	12,411	1,618	2,645	21	47,754
Real Estate Activities	I-17	1,527	140	1,494	187	17,994	1,375	1,486	988	738	158	77,373
Business Services	I-18	1,383	259	1,461	923	1,001	1,971	11,570	1,710	993	119	111,747
Public Administration, Defense, and Compulsory Social Security	I-19	27	0	0	217	1,327	1,547	3,774	271	261	0	129,144
Education Services	I-20	111	2	116	121	5	323	1,004	1,278	206	10	5,215
Human Health and Social Work Activities	I-21	32	1	1	11	2	7	41	61	2,299	9	3,199
Other Services	I-22	65	1	12	4	22	36	22	52	25	29	752
Total Domestic Intermediate Demand	190d	102,400	20,181	48,505	25,506	63,547	40,120	330,946	70,000	51,927	6,444	5,781,681
Total Imported Intermediate Demand	2000	53,070	5,943	28,117	14,228	35,274	18,468	110,975	34,093	23,096	2,355	2,872,608
Total Intermediate Demand	1900	155,470	26,124	76,622	39,734	98,821	58,588	441,921	104,093	75,023	8,798	8,654,289
Labor Compensation	2010	47,699	7,910	23,116	52,413	12,242	41,085	473,417	158,212	32,743	5,544	3,830,876
Gross Operating Surplus (including mixed income)	2020	171,003	10,487	95,768	97,219	245,772	47,475	310,903	73,385	47,744	8,530	5,616,159
Taxes less subsidies on other production	2040	11,794	157	456	218	10,176	329	-	143	44	56	209,215
Gross Value Added	2090	230,496	18,554	119,340	149,850	268,190	88,890	784,320	231,740	80,530	14,130	9,656,250
Total Input	2100	385,966	44,678	195,962	189,584	367,011	147,478	1,226,241	335,833	155,553	22,928	18,310,539

Economic Sector	Sector Code (22)	Household	Non-profit Institutions Serving Households (NPISHs)	Government	Gross Fixed Capital Formation - (GFCF)	Inventory Changes	Exports	Total Final Demand	Total Output
		3011	3012	3020	3030	3041	3080	3090	3100
Agriculture, Livestock, Hunting, and Agricultural Services	I-01	1,432,960	-	-	16,360	91,544	840,184	2,381,048	3,998,506
Mining and Quarrying	I-02	33	-	0	8	1,255	46,693	47,989	50,653
Manufacture of Paper and Paper Products; Printing and Reproduction of Recorded Media	I-03	505,002	21	6,009	1,380	(42,212)	1,989,562	2,459,762	4,098,988
Other Manufacturing	I-04	26,571	22	245	69	2,495	38,473	67,874	85,443
Electricity Supply	I-05	10,374	-	-	0	-	19	10,392	58,395
Gas Supply and Ice Production	I-06	5	-	0	0	(27)	307	286	373
Water Supply; Waste Management, Sewerage, and Recycling	I-07	3,200	-	100	0	12	1,274	4,586	7,403
Construction	I-08	406,315	-	1	1,991,883	(71)	6,415	2,404,542	3,467,322
Trade and Repair of Motor Vehicles and Motorcycles	I-09	969,545	132	1,557	3,376	46,035	962,297	1,982,941	2,678,386
Wholesale and Retail Trade, Except of Motor Vehicles and Motorcycles	I-10	37,499	10	124	270	3,673	27,993	69,569	96,420
Land Transport	I-11	271,504	11	127	289	3,851	71,894	347,676	524,272
Water, Air, and Ferry Transport; Warehousing and Support Services for Transportation; Postal and Courier Services	I-12	79,363	3	83	76	718	49,838	130,080	173,142
Accommodation Services	I-13	49,252	3,007	7	5	64	302,969	355,304	385,966
Food and Beverage Service Activities	I-14	28,533	9,853	15	2	9	2,455	40,867	44,678
Information and Communication	I-15	117,687	1	531	129	176	37,974	156,497	195,962
Financial and Insurance Activities	I-16	64,538	-	1,616	1	7	75,667	141,830	189,584
Real Estate Activities	I-17	266,228	-	-	-	-	23,410	289,638	367,011
Business Services	I-18	7,567	0	2	160	61	27,939	35,731	147,478
Public Administration, Defense, and Compulsory Social Security	I-19	2,162	-	1,077,508	40	-	17,388	1,097,098	1,226,241
Education Services	I-20	158,289	73,185	93,422	1	15	5,705	330,618	335,833
Human Health and Social Work Activities	I-21	63,148	52,981	22,388	3	37	13,796	152,354	155,553
Other Services	I-22	3,169	18,667	32	2	11	296	22,176	22,928
Total Domestic Intermediate Demand	190d	4,502,944	157,893	1,203,765	2,014,053	107,652	4,542,550	12,528,858	18,310,539
Total Imported Intermediate Demand	2000	690,946	11,317	80,135	97,687	22,998	90,700	993,782	3,866,390
Total Intermediate Demand	1900	5,193,890	169,210	1,283,900	2,111,740	130,650	4,633,250	13,522,640	22,176,929
Labor Compensation	2010								
Gross Operating Surplus (including mixed income)	2020								
Taxes less subsidies on other production	2040								
Gross Value Added	2090								
Total Input	2100								

Currency Risk and Debt Maturity: Their Effects on the Resilience of Indonesia's Foreign Exchange Reserves

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ABSTRACT

Research Originality: This study uncovers the unexpected negative impact of long-term external debt on Indonesia's foreign exchange reserves, challenging conventional beliefs about debt stability.

Research Objectives: This study provides important—and occasionally surprising—new insights into the dynamics of Indonesia's external debt and its impact on the country's foreign exchange reserves.

Research Methods: Using recent time series data from 2013–2024 and the tried-and-true OLS regression method, this study provides a thorough and timely analysis of the relationship between Indonesia's foreign exchange reserves and the structure of its external debt.

Empirical Results: The empirical results indicate that long-term debt has a negative impact on foreign exchange reserves, whereas Rupiah and foreign currency-denominated debts have positive effects. Notably, short-term debt shows no significant impact. These findings offer practical guidance for Indonesia's external debt management, supporting better debt prioritization and enhanced financial resilience.

Implications: These novel insights offer valuable guidance for optimizing debt management to strengthen Indonesia's financial resilience and economic stability.

Keywords:

external debt; exchange rate risk; macroeconomic stability; debt structure

How to Cite:

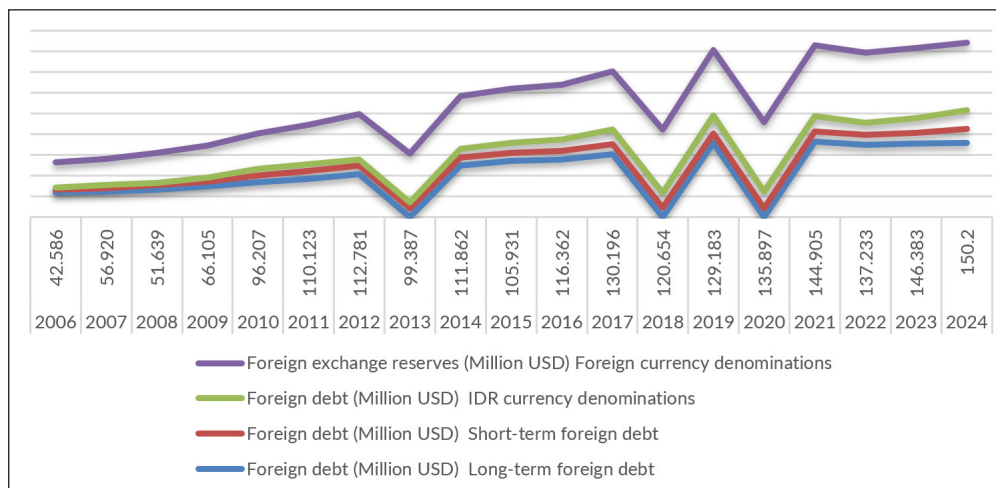
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INTRODUCTION

Foreign exchange reserves are one of the leading indicators of a country's macroeconomic stability. Their primary functions are maintaining external liquidity, supporting exchange rates, and meeting international payment obligations. In this context, managing foreign exchange reserves is greatly influenced by various economic factors, including the structure of external debt. Foreign debt, as part of capital flows, is a significant source of financing. However, it also carries risks that can strain foreign exchange reserves, particularly when principal and interest payments are due.

Foreign debt or foreign loans can impact foreign exchange reserves, as foreign debt is an inbound fund from outside countries that helps cover a country's balance sheet deficit. In contrast to Mahmood (2005), the relationship between foreign debt and the balance of payments is negative, where the higher the foreign debt, the lower the balance of payments will be, or create a current account deficit caused by external debt. It is intended to facilitate debt accumulation, the level of financing needed to meet import payments. The development of Indonesia's external debt, or foreign loans, from 2006 to 2016. It can be observed that Indonesia's external debt has exhibited an increasing trend annually, with significant or slight increases from the previous year (see Figure 1). The highest increase in Indonesia's external debt occurred in 2008, with a growth rate of 13.50 percent due to the global financial crisis (Trading Economics, 2025).

Figure 1. The Development of Indonesia's External Debt or Foreign Loans



Although previous literature has helped improve our understanding of the relationship between external debt and foreign exchange reserves in aggregate (Nailil et al., 2021; Ridho, 2015; Yuliani et al., 2024). Most existing literature ignores differences in debt characteristics, such as the term (short-term or long-term), currency denomination, and type of lender. The composition of external debt plays an important role in determining the pressure level on a country's foreign exchange reserves. Studies by Gergely et al. (2012) demonstrate that debt management policies can yield suboptimal solutions on a consolidated basis if adequate reserves are not factored into the decision-making process for issuing foreign currency debt.

In addition, increased foreign currency debt issuance and EU/IMF loans are the primary factors driving the growth of foreign exchange reserves. According to Tille (2003), the exchange rate plays a crucial role in the movement of foreign loan positions; fluctuating exchange rate movements significantly impact a country's foreign loan position. Widharma et al. (2013) stated that if the rupiah exchange rate appreciates against the US dollar, it will be followed by a decrease in debt or loans denominated in rupiahs. Conversely, the depreciation of the rupiah exchange rate will cause the amount of foreign debt to increase, as Indonesia pays its foreign debt in foreign currency. Studies by Jannah and Shidiqi (2017) also showed that exchange rates can have a negative impact on foreign debt and its fluctuations.

Although the overall influence of external debt on developing countries, such as Indonesia, is widely recognized, and studies like Dawood et al. (2020) have emphasized the vulnerability of foreign exchange reserves to exchange rate volatility and debt repayment pressures, substantial research gaps remain. More recent empirical work by Koh (2020) finds that the rapid buildup of debt, both public and private, increases the likelihood of a financial crisis, as does a larger share of short-term external debt, higher debt repayment coverage, and lower reserve coverage. Countries facing extreme crises generally deploy an unworkable combination of fiscal, monetary, and financial sector policies, and often suffer from structural and institutional deficiencies. Meanwhile, Mouandat (2022) underlined that it is better to issue more local currency debt and less foreign currency debt, as long as domestic interest rates are lower than international debt risk premiums. Similarly, Elkhalfi et al. (2024) demonstrated an increase in external debt stocks that initially supported growth; however, excessive debt accumulation led to a decline in returns and a negative impact on growth. These results underscore the importance of prudent debt management, particularly in the context of globalization, where developing countries are increasingly vulnerable to external shocks.

Despite extensive studies on external debt, existing research often overlooks the detailed impact of debt structure on foreign exchange reserves, typically focusing on aggregate debt measures. This study addresses this gap by providing a novel and comprehensive analysis of Indonesia's external debt disaggregated by both maturity (short-term vs. long-term) and currency denomination (Rupiah vs. foreign currency). Unlike prior work, it reveals how these specific dimensions distinctly affect the country's foreign exchange reserves, offering granular insights that have not been thoroughly explored in the Indonesian context. This contribution advances the academic debate on external debt management and delivers critical guidance for emerging economies navigating volatile global financial conditions.

METHODS

This research employs a quantitative methodology centered on Indonesia, utilizing time series data spanning from 2013 to 2024. The dependent variable is foreign exchange reserves, and the independent variables consist of short-term debt, long-term debt, foreign currency-denominated debt, and local currency-denominated debt. These variables are

chosen because Indonesia's ongoing dependence on foreign borrowing to address budget deficits and its vulnerability to currency risk, particularly from exchange rate volatility, necessitate their consideration. Information regarding the external debt structure and currency denomination is sourced from Bank Indonesia, while data on foreign exchange reserves is obtained from BPS (Statistics Indonesia).

The study employs the Ordinary Least Squares (OLS) multiple regression method to analyze the association between debt structure and reserves. To guarantee model reliability, standard classical assumption tests are performed, encompassing assessments for autocorrelation, multicollinearity, normality, and heteroscedasticity. This methodology facilitates a precise evaluation of the impact of external debt composition on Indonesia's foreign exchange reserves over time. The variable relationship model is analyzed based on regression equations. The mathematical equation in this research is as follows:

$$R_t = \beta_0 + \beta_1 UJP_t + \beta_2 UJL_t + \beta_3 DMF_t + \beta_4 DMD_t + \epsilon_t R_{-t}$$

Where:

R_t : Foreign exchange reserves.

UJP_t : Short-term debt.

UJL_t : Long-term debt.

DMF_t : Foreign currency-denominated debt.

DMD_t : Domestic currency-denominated debt.

RESULTS AND DISCUSSION

The empirical results summarized in Table 1 offer valuable insights into how various debt components impact the stability of foreign exchange reserves. The model demonstrates strong explanatory power, with an R-squared value of 0.9655, indicating that approximately 96.5% of the variation in Indonesia's foreign exchange reserves is explained by the selected independent variables. The overall model is highly statistically significant, as indicated by an F-statistic of 97.94, confirming that at least one predictor has a meaningful effect on foreign exchange reserves.

Long-term external debt has a negative impact on foreign exchange reserves. This counterintuitive result suggests that increases in long-term debt, holding other factors constant, are associated with a reduction in reserves. This challenges the conventional view that long-term debt is inherently more stable or less burdensome. Short-term debt has no statistically significant effect on foreign exchange reserves. This finding is noteworthy as it questions the common assumption that short-term debt exerts a more immediate and volatile pressure on reserves.

Debt denominated in Rupiah exhibits a positive effect on foreign exchange reserves. This finding suggests that an increase in Rupiah-denominated external debt is associated with higher foreign exchange reserves, possibly reflecting capital inflows or a reduced need to draw down reserves for debt servicing. Foreign currency-denominated debt also shows

a positive and statistically significant relationship with foreign exchange reserves. Despite potential exchange rate risks, foreign currency debt inflows may contribute positively to reserve accumulation. Overall, these findings highlight the complex and nuanced relationship between the composition of external debt and foreign exchange reserves in Indonesia. They provide important implications for policymakers aiming to optimize external debt management and safeguard reserves.

Table 1. The Result of Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.16757	8.118359	1.498773	0.1561
JKPJG	-2.091018	0.774814	-2.698735	0.0173
JKPDK	-0.231689	0.626615	-0.369747	0.7171
DENIDR	2.447717	0.876599	2.792289	0.0144
DENMTASG	2.119548	0.727256	2.914447	0.0113
R-squared	0.965498	Mean dependent var		108.6607
Adjusted R-squared	0.955641	S.D. dependent var		32.90707
S.E. of regression	6.930766	Akaike info criterion		6.930752
Sum squared resid	672.4973	Schwarz criterion		7.179289
Log-likelihood	-60.84214	Hannan-Quinn criteria		6.972814
F-statistic	97.94445	Durbin-Watson stat		1.137954
Prob(F-statistic)	0.000000			

Our discovery that short-term debt exerts no statistically significant influence on foreign exchange reserves is crucial and necessitates further examination. Traditionally, it has the potential to trigger a financial crisis. The indirect effects suggest that short-term foreign debt during banking crises, combined with exchange rate misalignments corrected by currency crises, increases the likelihood of a sovereign default. Countries with substantial debt exposure are vulnerable to economic and financial disruptions that may precipitate sovereign defaults. Supporting this, Babecký et al. (2014) found that sovereign defaults raise the probability of subsequent currency crises, though the reverse relationship does not hold.

Reverse causality may also arise when the domestic banking sector holds significant government debt on its balance sheets (Gennaioli et al., 2014; Sosa-Padilla, 2018; Thaler, 2021). Initially, growing foreign debt stocks can stimulate economic expansion; however, excessive debt accumulation eventually leads to diminishing returns and negatively impacts growth. These findings underscore the importance of prudent debt management, particularly in the context of globalization, where developing countries remain highly susceptible to external shocks. This dynamic is especially relevant in studies examining the influence of external debt on the economic growth of emerging nations.

However, our results reveal a more complex reality for Indonesia over the 2013–2024 period, where short-term debt appears to have limited relevance for foreign exchange reserves.

Indonesia's authorities, including Bank Indonesia and the Ministry of Finance, have likely implemented robust policies and oversight mechanisms to manage short-term debt effectively. These may include stricter regulations on short-term lending, enhanced monitoring of private sector short-term debt, or a policy emphasis on government short-term borrowing rather than private sector alternatives. Recent data (DJPPR, 2025) indicate that Indonesia's external debt stock is predominantly composed of long-term maturities, which likely diminishes the influence of the relatively small short-term debt component on reserves.

Contrary to the view that short-term debt inherently reduces moral hazard, evidence suggests that under financial frictions and fair debt pricing, short-term debt can actually encourage risk-taking. In a theoretical model where firms are financed through equity and short-term loans but face refinancing constraints, operational and rollover losses can elevate default risk. In such scenarios, shareholders may increase asset risk to improve interim debt repricing and avoid inefficient liquidation. Notably, these risk-taking incentives tend to dissipate when debt maturities are sufficiently extended.

If short-term debt is channeled into highly productive sectors that generate quick returns and foreign exchange earnings, repayments may not substantially deplete reserves. This condition aligns with policy recommendations advocating for strategic and prudent short-term debt usage. Potential negative impacts from short-term debt repayments may be neutralized by other foreign exchange inflows, such as foreign direct investment and export revenues, or through sophisticated hedging practices employed by borrowers. These factors can collectively render the net effect of short-term debt on aggregate reserves statistically insignificant over the period studied.

Overall, these findings challenge the conventional wisdom that all short-term debt is inherently unstable and detrimental to foreign exchange reserves in developing countries. They emphasize the critical role of effective debt management and sound economic fundamentals in enabling a country to sustain and service its debt without significantly depleting its reserves. The most notable finding is the negative impact of long-term debt on foreign exchange reserves. This outcome contradicts the commonly accepted notion that long-term debt, due to its prolonged maturity structure, provides enhanced stability and reduces immediate strain on foreign exchange reserves. This consequence for Indonesia demands meticulous contemplation:

Long-term debt ultimately matures, necessitating the repayment of principal and interest. The enormous growth in long-term debt, as evident in Indonesia's rising debt levels (Asnawi et al., 2023; CEIC Data, 2024), suggests that the significant quantity of scheduled repayments, even when distributed over time, may consistently deplete foreign exchange reserves. This is especially applicable when the projects funded by this debt fail to produce adequate foreign exchange returns or when the debt is denominated in foreign currency (Widharma et al., 2013).

The allocation and productivity of long-term debt suggest that some of Indonesia's long-term external debt may not be consistently directed towards sectors that directly generate foreign exchange or substantially enhance export capabilities. If long-term debt funds domestic consumption, import-heavy initiatives, or yield suboptimal returns, it may

result in a heightened need for foreign currencies for servicing, without a corresponding rise in foreign exchange earnings. Recent studies have highlighted that external debt can bridge investment-saving gaps for growth, but its advantages depend on its allocation to productive sectors to prevent a 'debt trap' (e.g., Van Bon, 2015; Marimuthu et al., 2021).

Although the model distinguishes between currency denominations, the total long-term debt amount is likely to include a substantial component denominated in foreign currency. A depreciating Rupiah over time would elevate the Rupiah equivalent of foreign currency debt, thereby amplifying the stress on Bank Indonesia to stabilize the currency, which could indirectly result in reserve depletion despite the debt being long-term. Tille (2003) emphasizes that fluctuations in exchange rates can have a profound impact on a nation's foreign debt status.

It is essential to evaluate whether this trend signifies a departure from earlier periods in which long-term debt may have exhibited a more favorable correlation with reserves. The period from 2013 to 2024 may indicate emerging issues or strategies in debt management. This discovery necessitates a reassessment of Indonesia's long-term debt policy, emphasizing the effective use and a meticulous examination of its eventual impact on foreign exchange liquidity.

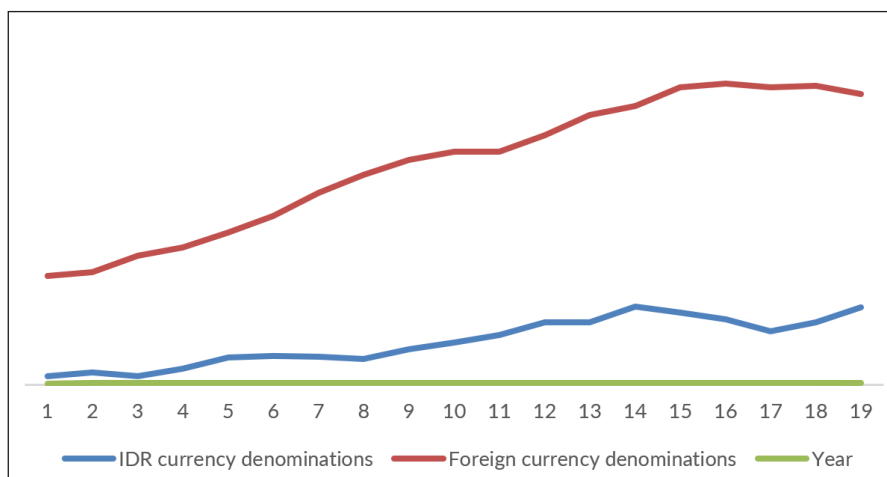
The findings indicate a positive effect of both Rupiah-denominated debt and foreign currency-denominated debt on foreign exchange reserves. This result suggests that regardless of whether the debt is denominated in local or foreign currency, its denomination aspect generally enhances reserves. The Rupiah denomination (IDR) in Indonesia's external debt showed a mixed trend from 2013 to 2024. In 2013, the amount of debt denominated in Rupiah was still relatively small, accounting for around 2.26% of total external debt. 14.35% in 2017 and 16.27% in 2018. After that, the proportion of rupiah-denominated debt is expected to stabilize until 2023, with a slight decline in 2024.

Indonesia's external debt is primarily denominated in foreign currencies, with the US dollar being the most common. However, debt is also in other currencies, such as the Japanese yen and the euro. The Indonesian Rupiah (IDR) denomination and foreign currencies are closely tied to the country's foreign exchange reserves. A stronger IDR, or an increase in the IDR's value, typically results in higher foreign exchange reserves. This is because reserves are held in foreign currencies, and the exchange rate affects their value in IDR. Conversely, a weaker IDR could deplete reserves if the value of the foreign currency held declines. A stronger IDR means that each unit of foreign currency is worth fewer IDR, potentially reducing the value of the reserves (see Figure 2).

The positive coefficient for foreign currency-denominated debt (DENMTASG). When the government or private entities borrow foreign currency from international markets, these monies immediately enhance the nation's foreign exchange reserves or are converted to Rupiah, subsequently entering the local economy and indirectly bolstering the reserve base. It is a direct result of external borrowing serving as a source of foreign cash. Recent research on the currency composition of reserves and trade and financial connections has shown that these factors influence the attractiveness of primary reserve currencies (ECB, 2021), thereby affirming that such inflows constitute a direct element of reserves.

The beneficial effect of Rupiah-denominated external debt is a significant observation. This generally pertains to foreign investors acquiring Rupiah-denominated government bonds or other domestic securities. When foreign entities purchase Rupiah-denominated bonds, they must initially convert their foreign currency into Rupiah, resulting in an influx of foreign exchange into Indonesia's financial system and ultimately augmenting the country's foreign exchange reserves. The possibility for local currency debt to serve as a stable source of foreign exchange, thereby mitigating direct foreign currency risk for the issuer (Widharma et al., 2013). currency rate risk on the government's balance sheet.

Figure 2. Development of Foreign Debt and Foreign Exchange Reserves 2006-2024



The combined benefits of Rupiah and foreign currency loans show the importance of having a well-managed and appealing loan market in both segments to help build foreign exchange reserves. However, foreign currency debt must be handled carefully, as it comes with long-term repayment costs and exchange rate risks. Overall, these findings indicate that the structure of external debt is more significant than its total amount. The negative impact of long-term debt, the limited effect of short-term debt, and the positive role of both types of currency reveal a complex relationship. This challenges common assumptions and provides a solid foundation for more targeted and effective debt management policies.

Putri et al. (2017) found that external debt did not significantly affect Indonesia's foreign exchange reserves from 1988 to 2017 because the borrowed funds were not used productively and failed to generate high returns. Rahim et al. (2019) confirmed this result, while Ardianti and Swara (2018) showed that net exports had a more substantial impact on reserves. This suggests that external factors, such as trade performance, contribute more to reserve growth than external borrowing.

The effect of external debt on economic growth also depends on its maturity. Chen et al. (2019) and Biqiong et al. (2020) found that short-term debt can support growth, whereas long-term debt may increase the fiscal burden if not invested in productive sectors such as infrastructure or technology. Therefore, developing countries must manage their debt structure carefully to prevent it from becoming a source of economic weakness.

Kose et al. (2020) emphasized the need to maintain a balance between foreign exchange reserves and short-term debt. Similarly, Moreno Brieva et al. (2019) warned that short-term debt is volatile and prone to sudden capital outflows, which can lead to currency or banking crises. Therefore, both short-term and long-term foreign debt policies should follow principles of prudence, efficiency, and long-term economic stability.

Putri et al. (2017) found that foreign debt had a positive but insignificant effect on Indonesia's foreign exchange reserves between 1988 and 2017. In theory, productively used debt can increase reserves, but in practice, Indonesia's debt has not been managed efficiently enough to yield strong returns. Rahim et al. (2019) reported similar findings, while Ardianti and Swara (2018) showed that net exports have a significant positive impact on reserves. This means export performance contributes more to reserve growth than foreign borrowing. Overall, these studies highlight the interconnected roles of external debt, trade, and reserves in shaping economic stability. Strong export performance supports reserve accumulation, which in turn promotes faster economic growth (Azar & Aboukhodor, 2017).

The consumption of the Indonesian government has a direct and considerable positive effect on the change in the country's domestic foreign exchange reserves. The increased consumption will also significantly increase the country's foreign exchange reserves. The expanding domestic community consumption of goods and services generated in the local real market will promote the acceleration of increased output per capita and annually. This innovation by academics demonstrates that macroeconomic variables, such as consumption expenditure, have a positive impact on the increase of foreign currency reserves in Indonesia. This condition will enhance productivity, including bidding on export products overseas, thereby driving Indonesia's net export performance. Surely, it supports foreign exchange reserves (Rangkuti & Hidayat, 2021).

CONCLUSION

Our analysis of Indonesia's external debt from 2013 to 2024 reveals several key insights. Long-term debt shows a negative effect on foreign exchange reserves, challenging the assumption that longer maturities automatically bring stability. This finding calls for a reassessment of borrowing practices and how debt is used to support productive activities. In contrast, both Rupiah- and foreign currency-denominated debts contribute positively to reserves, showing the importance of capital inflows in any form. The insignificant effect of short-term debt suggests that current management practices are largely effective.

These results provide practical guidance for policymakers. First, ensure that long-term debt is used productively and avoid excessive borrowing. Second, maintain a balanced mix of Rupiah and foreign currency debt to manage risk and attract capital. Third, keep strong oversight of short-term debt and apply hedging when necessary. Finally, enhance debt monitoring and risk management systems to strengthen financial resilience.

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The Impact of Zakat, Agricultural Output, and Poverty on Indonesia's Food Security

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ABSTRACT

Research Originality: The originality of this research lies in integrating zakat as an Islamic financial instrument into the analysis of food security in Indonesia, a topic that has rarely been explored. Furthermore, it links the concept of maqashid sharia with the Sustainable Development Goal 2 (Zero Hunger), thus offering a novel contribution both theoretically and practically to the food security literature.

Research Purpose: This study aims to assess the likelihood of food security across Indonesian provinces and investigate the role of zakat solutions.

Research Methods: Employing a quantitative methodology, panel data on zakat utilization, agricultural output, and poverty levels from 34 Indonesian provinces (2013-2022) were analyzed using EViews 9.

Empirical Results: The findings reveal that agricultural output and zakat utilization have a positive and significant impact on food security, whereas poverty has a negative effect.

Implications: More effective policies are necessary to manage zakat utilization, enhance food production, and alleviate poverty, thereby ensuring Indonesia has a more stable and sufficient food supply for all.

Keywords:

food security; zakat utilization; agricultural production; poverty

How to Cite:

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INTRODUCTION

One of the 17 Sustainable Development Goals (SDGs) is “Zero Hunger,” which emphasizes the global commitment to eradicating hunger and malnutrition. In many developing countries, including Indonesia, food and nutrition insecurity remain critical issues (Sekabira et al., 2022). The Economist Group (2022) ranks Indonesia 60th out of 113 countries in terms of food security. National data further reveal that 70 out of 416 Indonesian districts still fall within the low Food Security Index (FSI) category (Bapanas, 2023). Low FSI scores reflect inadequate access to safe, nutritious, and sufficient food, which contributes to health issues such as stunting, malnutrition, and non-communicable diseases. As emphasized by Sen (1981), food insecurity is not solely a supply issue but also relates to entitlement and access.

Indonesia faces significant gaps between food needs and actual consumption. According to Badan Ketahanan Pangan (2021), food availability, accessibility, and utilization are critical for a healthy and productive society. Inadequate food consumption can reduce work productivity and elevate poverty rates. This condition creates a vicious cycle that perpetuates food insecurity and undermines human development.

From a theoretical standpoint, this study is grounded in two major frameworks: Sen’s Entitlement Theory and the *Maqashid Shariah* framework. Sen’s (1981) entitlement approach argues that hunger arises not only from food shortages but also from individuals’ lack of access and purchasing power to obtain food. This view reframes food insecurity as an issue of socio-economic exclusion. In parallel, the *Maqashid Shariah* theory developed by Islamic scholars such as Al-Ghazali emphasizes the holistic fulfillment of human needs, particularly the protection of life (*nafs*) and wealth (*maal*), under which food security is categorized. From this perspective, *zakat* is not only a spiritual obligation but also an economic mechanism designed to address structural poverty and redistribute wealth, ensuring access to necessities such as food.

These theoretical lenses help explain why food security in Indonesia must be addressed through a combination of economic production, poverty alleviation, and Islamic social finance mechanisms such as *zakat*. However, existing literature tends to treat these dimensions in isolation. For example, studies by Appiah-Twumasi and Asale (2022) and Syakirotin et al. (2022) focus on agricultural productivity as a determinant of food security. Others, such as Kim and Choi (2023) and Ouoba and Sawadogo (2022), highlight the impact of poverty. While Dirie et al. (2023) and Shahid et al. (2023) examine the potential of *zakat* for achieving food-related SDGs, they do not empirically integrate *zakat* into regional food security models.

This study addresses the research gap by integrating the entitlement theory and Islamic economic principles to assess the impact of *zakat* utilization, agricultural production, and poverty levels on food security in Indonesia. While previous studies have investigated these variables separately, this research is among the first to combine them within a comprehensive empirical framework using provincial-level panel data from 2013 to 2022.

The novelty of this research lies in three main aspects. First, it offers a cross-paradigmatic theoretical integration of Sen's entitlement theory and the Maqashid Shariah framework to analyze food security from both socio-economic and spiritual perspectives. Second, it introduces zakat utilization as a formal economic variable that directly influences food access, an element that is often overlooked in conventional food security models. Third, this study utilizes a longitudinal panel dataset covering 34 provinces in Indonesia over ten years (2013–2022), enabling a comprehensive analysis of regional disparities and long-term trends in food security.

Therefore, this study aims to investigate the impact of zakat utilization, agricultural production, and poverty levels on food security across various provinces in Indonesia. By combining economic and faith-based perspectives within a unified analytical framework, this research aims not only to fill a gap in existing studies but also to offer meaningful insights for real-world solutions. The findings are expected to support the creation of food security policies that are not only effective and inclusive but also aligned with local values and spiritual principles, especially by recognizing the potential of Islamic social finance, such as zakat, to reduce structural poverty and improve access to food at the community level.

METHODS

This study employs balanced panel data from 34 provinces in Indonesia spanning the years 2013 to 2022. The dependent variable is the Food Security Index (FSI), which captures three core components: food availability, accessibility, and utilization. This index is sourced from the National Food Agency (Bapanas), which publishes annual data at the provincial level. The key independent variables include zakat utilization, agricultural output, and poverty rates. Zakat utilization data are collected from the National Zakat Board (BAZNAS), reflecting the amount of zakat distributed across provinces each year. Agricultural output is measured using provincial-level gross regional domestic product (GRDP) for the agricultural sector at constant prices, obtained from Statistics of Indonesia. Meanwhile, the poverty rate is defined as the percentage of people living below the national poverty line, which is also sourced from Statistics Indonesia. To ensure consistency, all monetary values are adjusted for inflation using constant prices.

To analyze the relationship between zakat, agriculture, poverty, and food security, this study applies panel data regression techniques. Panel analysis is chosen because it allows for the examination of both cross-sectional and time-series variations while controlling for unobserved heterogeneity across provinces. A series of diagnostic tests is conducted to determine the most appropriate model specification. The Chow test is used to compare the pooled ordinary least squares (OLS) model and the fixed effects model (FEM), while the Hausman test is applied to determine whether to use fixed effects or random effects. Based on the outcomes of these tests, the fixed effects model is selected as the most suitable method for this study. This approach helps isolate within-province changes over time, providing more accurate estimates of the relationships between the variables.

The mathematics of this research model are:

Basic model research (Pooled OLS)

$$Y_{it} = \beta_0 + \beta_1 X_{1,it} + \beta_2 X_{2,it} + \beta_3 X_{3,it} + u_{it} \quad (1)$$

Fixed effect model

$$Y_{it} = \alpha_0 + \beta_1 X_{1,it} + \beta_2 X_{2,it} + \beta_3 X_{3,it} + \varepsilon_{it} \quad (2)$$

Notation:

Y = Food security level

X_1 = Zakat utilization rate

X_2 = Agricultural production level

X_3 = Poverty rate

The empirical model includes the Food Security Index as the dependent variable, with zakat utilization, agricultural output, and poverty rates as explanatory variables. This methodological approach enables a comprehensive assessment of the structural and institutional factors that shape regional food security in Indonesia.

Figure 1. Conceptual Framework

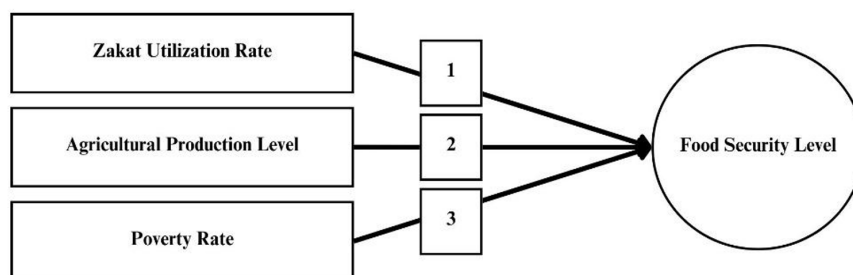


Figure 1 presents the conceptual framework of this study, showing how zakat utilization, agricultural output, and poverty are expected to influence food security in Indonesia. These three variables are chosen based on both economic theories and Islamic welfare principles. The arrows in the diagram reflect the direction of the relationships: zakat utilization and agricultural output are expected to improve food security, while poverty is expected to reduce it. By combining faith-based redistribution and economic development factors, this framework helps explain why food security levels may vary across regions.

RESULTS AND DISCUSSION

The Chow test was used to compare the Common Effect Model and the Fixed Effect Model. The result shows a p-value of $0.000 < 0.05$, suggesting that the Fixed Effect Model is preferable. This suggests that differences across provinces have a significant impact on the model, and these effects must be considered. The following are the results of the Chow test. Based on the Table 1 Chow test results above, it can be seen that the

cross-section chi-square probability value is 0.000, which is smaller than the alpha value of 0.05. This indicates that the test results reject H0 and accept Ha. This means that the Fixed Effect Model is a more appropriate model to use than the Common Effect Model.

Table 1. Result of the Chow test

Test cross-section fixed effects			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	9.939206	(32,228)	0.0000
Cross-section Chi-square	230.570563	32	0.0000

Source: Author's compilation (2024).

The Hausman test was conducted to choose between the Fixed Effect and Random Effect models. Based on Table 2, it can be seen that the cross-section random probability value is 0.000 or smaller than 0.05, which is considered the significance value. This indicates that the test results reject H0 and accept Ha. This means that the Fixed Effect Model is the most appropriate model to use in this study.

Table 2. Result of the Hausman test

Test cross-section random effects			
Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	48.326968	3	0.0000

Source: Author's compilation (2024).

To assess multicollinearity, a correlation matrix was used. Since all correlation coefficients were below 0.8, multicollinearity is not a concern in this model. This means the independent variables are sufficiently distinct to be included in the regression. Based on Table 3 and the multicollinearity test results, it is evident that all variables have coefficients below 0.8. Therefore, it can be concluded that the data in this study are not infected with multicollinearity.

Table 3. Result of the Multicollinearity test

	X1	X2	X3
X1	1	-0.00583	0.05824
X2	-0.00583	1	-0.71221
X3	0.05824	-0.71221	1

Source: Author's compilation (2024).

Heteroscedasticity was tested using the Glejser method. All variables showed p-values above 0.05, indicating homoscedasticity. Therefore, the variance of the residuals

is stable across observations, fulfilling one of the classical assumptions for panel regression (Baltagi, 2021). Based on Table 4, the results of the heteroscedasticity test indicate that the probability value for each variable is greater than 0.05. The probability of variable X1 is $0.5382 > 0.05$. The probability of the X2 variable is $0.7312 > 0.05$. The probability of variable X3 is $0.4712 > 0.05$. Thus, it can be concluded that the data in this study do not have heteroscedasticity problems.

Table 4. Result of the Heteroscedasticity test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	54.39138	10.99627	4.946347	0.0000
X1	-0.004586	0.007438	-0.616531	0.5382
X2	0.037143	0.108005	0.343897	0.7312
X3	-4.801918	0.780148	6.155134	0.4712

Source: Author's compilation (2024).

This model is estimated using the Fixed Effects Model (FEM), based on the results of the Chow and Hausman tests. The regression equation presented above summarizes the estimated relationship between zakat utilization, agricultural output, poverty rate, and food security in Indonesia. The statistical output from the panel regression analysis, as shown in Table 5, provides the detailed coefficients, standard errors, t-statistics, and significance levels used to interpret this model. These results are from the empirical basis for assessing the magnitude and direction of each variable's effect on food security across provinces during the 2013–2022 period.

Table 5. Panel Regression Output

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	255.5849	31.89627	8.013002	0.0000
X1	0.017059	0.021575	0.790682	0.0300
X2	0.079289	0.313285	0.253089	0.0004
X3	-18.54140	2.262933	-1.193529	0.0000
Cross-section fixed (dummy variables)				
R-squared	0.748491	Mean dependent var		67.86929
Adjusted R-squared	0.709882	S.D. dependent var		51.33653
S.E. of regression	3.492400	Akaike info criterion		7.847373
Sum squared resid	3.011315	Schwarz criterion		8.335002
Log likelihood	-2.85320	Hannan-Quinn criterion		8.043317
F-statistic	0.086550	Durbin-Watson stat		1.771623
Prob(F-statistic)	0.000000			

Source: Author's regression output using EVIEWS (2024).

Based on Table 5, the R-squared value of 0.748 indicates that nearly 75% of the variation in food security across provinces can be attributed to these three variables. The model is therefore quite strong—the remaining influence is due to other factors, such as education, infrastructure, food prices, or climate change. The empirical findings of this study identify three key factors that significantly affect food security across Indonesia: zakat utilization, agricultural production, and poverty levels. Using panel data from 34 provinces between 2013 and 2022, the regression analysis, based on a Fixed Effects Model selected through Chow and Hausman tests, shows that all three variables are statistically significant at the 5% level. Zakat utilization and agricultural output have positive coefficients, meaning that improvements in these areas are associated with better food security outcomes. On the other hand, poverty has a strong negative effect, indicating that higher poverty levels are consistently linked to reduced access to adequate and nutritious food.

These results confirm that the interaction between economic productivity, social equity, and faith-based redistribution mechanisms shapes food security in Indonesia. Strengthening public policies in these areas, particularly in the productive management of zakat and poverty alleviation, could substantially improve people's ability to meet their basic food needs (Sen, 1981; Hafandi & Helmy, 2021; Hsiao, 2022). In this context, zakat emerges not only as a spiritual obligation but also as a strategic tool for inclusive development and long-term food resilience.

To better understand how each of these factors contributes to food security, the following sections provide a more detailed interpretation of the empirical results. First, the regression results show that zakat utilization has a significant and positive impact on food security in Indonesia. A 1% increase in zakat utilization is associated with an improvement in the Food Security Index (FSI), indicating that zakat plays a significant role in enhancing access to adequate and nutritious food. This finding supports studies by Shahid et al. (2023) and Dirie et al. (2023), who demonstrate that productively distributed zakat can strengthen the purchasing power of mustahik (zakat recipients) and reduce vulnerability to hunger. Similarly, Amuda and Faizah (2020) emphasize that zakat-based empowerment programs help improve household food access, particularly in rural and agricultural communities. These outcomes are also consistent with the Maqashid Shariah framework, which places the protection of life (*nafs*) and wealth (*maal*) at the core of Islamic socioeconomic objectives (Dusuki & Abozaid, 2007).

Beyond its spiritual significance, zakat has tangible economic value. When well-managed, it not only offers short-term relief but also supports long-term improvements in household welfare, food access, and productivity (Hafandi & Helmy, 2021). By channeling resources from wealthier individuals (*muzakki*) to those in need (*mustahik*), zakat enhances access to food, education, and healthcare, which are fundamental components of human development. In this way, zakat can be seen not only as an instrument of faith but also as a strategic policy tool for inclusive development and food security. Its role becomes especially critical in Muslim-majority countries like Indonesia, where zakat management institutions have expanded significantly in recent years.

These results are consistent with previous studies. Sumarni et al. (2019) reported that productive zakat allocation significantly improves household food security in Indonesia. Similarly, Salim et al. (2024) highlighted that zakat-based urban farming programs in Malaysia successfully enhanced both food security and financial inclusion at the community level. Ibrahim et al. (2018) further emphasized that zakat aid is directly linked to achieving food security among beneficiaries in Malaysia. In addition, Ismail and Hasan (2019) argue that zakat expenditure can serve as a fiscal instrument to strengthen sustainable food systems.

This study contributes empirical evidence to a growing body of literature that advocates for zakat as a sustainable financing mechanism for social welfare. However, the effectiveness of zakat depends heavily on the quality of its governance. As noted by Nurjanah et al. (2019), zakat does not always lead to significant reductions in poverty or food insecurity, particularly in regions with poor distribution systems and weak institutional capacity. These differences may reflect local variations in transparency, targeting, and responsiveness to community needs.

By using provincial-level panel data from 2013 to 2022, this study captures broader structural patterns across time and geography, offering more generalizable insights. The findings reaffirm that zakat, when integrated into formal policy frameworks and implemented with accountability, can serve as both a religious duty and a powerful tool for economic justice. As such, policymakers should give greater attention to strengthening zakat governance and aligning it with regional food security strategies. As a policy implication, zakat institutions should prioritize productive-based programs, especially those targeting the agricultural sector and rural microenterprises, to create long-term improvements in food security rather than short-term consumptive assistance.

Second, the findings of this study confirm that agricultural production plays a central role in strengthening food security across Indonesian provinces. A positive and significant relationship was found between agricultural output and the Food Security Index (FSI), suggesting that increased agricultural productivity enhances the physical availability of food, one of the core pillars of food security defined by the FAO. This finding aligns with classical development economics (Todaro & Smith, 2011). It is supported by empirical studies, such as Appiah-Twumasi and Asale (2022) and Syakirotin et al. (2022), which emphasize the importance of agricultural growth in reducing hunger, particularly in rural communities.

Furthermore, recent studies emphasize the importance of innovation and efficiency in agricultural systems. Backer and Billing (2024) and Hasibuan (2023) argue that adopting new technologies can reduce production costs and increase access to affordable food. However, agricultural productivity alone is not always enough to guarantee food security. As Rosenzweig et al. (2021) and Chau & Scrimgeour (2023) caution, climate shocks such as floods, droughts, and unpredictable weather patterns can undermine productivity gains. Therefore, increasing resilience to environmental risks through improved irrigation systems, climate-smart practices, and early warning mechanisms is essential to maintaining food system stability.

The study also situates Indonesia's agricultural development within a broader international context, as noted by Finger (2024). Climate-oriented agricultural transitions in Europe could lead to increased food imports from countries like Indonesia. While this could create export opportunities, it also risks greater environmental pressure and unsustainable land use if not managed carefully. Cross-border cooperation and the adoption of ethical trade and environmental standards are therefore crucial to ensure that food production growth does not come at the cost of ecological degradation or public health.

Moreover, Todaro and Smith (2011) highlight that agricultural development must be approached holistically. Beyond increasing output, effective agricultural policy must also address institutional reforms, equitable pricing mechanisms, and access to local and global markets. Global disruptions, such as the COVID-19 pandemic (Raitt et al., 2022) and political instability (Adhikari et al., 2023), have demonstrated that even regions with high productivity are vulnerable if their supply chains and distribution systems are weak. Overall, this study underscores that while agriculture is a key engine of food security, its success depends on broader systems of economic, environmental, and institutional support.

This result aligns with Appiah-Twumasi and Asale (2022), who argue that agricultural performance is critical for national food security. Research in East Java revealed that technical efficiency in agriculture, enhanced through irrigation and government support, significantly strengthens household food security (Hakim et al., 2021). Globally, Dibba et al. (2019) demonstrated that the adoption of improved rice varieties (NERICA) in The Gambia improved food security outcomes. However, agricultural output is also vulnerable to climate shocks and market fluctuations (Herath, 2014; Kulkarni & Manogna, 2025), highlighting the need for sustainable farming systems and technological innovation. Policymakers should emphasize agricultural modernization, technological innovation, and climate-resilient farming practices to ensure sustainable productivity and food availability.

Third, the study confirms a significant and negative relationship between poverty and food security, aligning closely with Amartya Sen's Entitlement Theory (1981). According to this framework, hunger arises not only from food scarcity but also from the inability to access food due to lack of income or resources. The regression results in this study support this theory, indicating that a 1% increase in poverty is associated with a substantial decline in the Food Security Index. This finding aligns with previous studies by Kim and Choi (2023), Aguilera and Jatmiko (2022), and Ouoba and Sawadogo (2022), which emphasize that low-income households often struggle to meet their basic nutritional needs, regardless of the availability of food.

Moreover, the findings reveal structural inequalities in many parts of Indonesia, particularly in rural and remote regions, where poverty is multifaceted and multidimensional. As Wado et al. (2019) point out, poor communities often face overlapping disadvantages, limited access to clean water, sanitation, healthcare, and education, which deepen food insecurity. Poverty tends to reproduce itself through cycles of poor health, low productivity,

and unemployment (Sunde, 2024). Kamruzzaman (2021) adds that malnutrition and illness among the poor further reduce their capacity to work and escape poverty. These interrelated conditions make food insecurity not only more persistent but also more challenging to address with isolated interventions.

These findings are consistent with those of Wado et al. (2019) and Kim and Choi (2023), who also highlight poverty as a primary determinant of food insecurity in developing countries. Schneider et al. (2022) further emphasize that diet affordability remains a critical barrier to achieving nutritional adequacy among low-income households. Poverty alleviation strategies must be integrated with food security initiatives to achieve effective results. Programs such as conditional cash transfers, food vouchers, and zakat-based social protection schemes can enhance economic access to food and improve household resilience against food insecurity.

From a policy perspective, the study emphasizes the importance of adopting integrated and multi-sectoral approaches to poverty reduction. Braun and Hendriks (2023) suggest one potential path: internalizing social and environmental costs in food pricing to support sustainable production. However, they also caution that this could unintentionally raise food prices, making them less affordable for people experiencing poverty. More practical solutions include expanding targeted cash transfers, promoting zakat-based empowerment programs, and improving access to affordable local markets (Pasaribu & Adhikari, 2020; Adhikari et al., 2023). Such strategies can help break the cycle of poverty and ensure access to basic food, even in low-income settings.

In conclusion, this study provides strong empirical evidence that poverty is not just an economic issue but a significant barrier to achieving food security in Indonesia. It affects access to food through multiple channels: income, health, education, and employment. Policymakers should therefore prioritize comprehensive poverty alleviation strategies that address both structural inequalities and immediate needs. Doing so will not only improve food security outcomes but also promote long-term human development and social inclusion.

Building on these findings, the overall effectiveness of the regression model is assessed to determine how well these three key variables — poverty, zakat utilization, and agricultural production — collectively explain variations in food security across regions. The coefficient of determination (R^2) from the panel regression model is 0.748, indicating that approximately 74.8% of the variation in food security across Indonesia's provinces can be explained by the three main variables in this study: zakat utilization, agricultural production, and poverty. This level of explanatory power suggests that these factors are strongly associated with food security outcomes, reinforcing their relevance as policy targets. The adjusted R^2 , which accounts for the number of variables in the model, is slightly lower at 0.709, confirming that the model remains robust even after adjusting for complexity. These findings are consistent with other empirical studies that link multidimensional development factors, especially agricultural growth and poverty alleviation, to food access and availability (Appiah-Twumasi & Asale, 2022; Kim & Choi, 2023).

Prior research highlights that geographic disparities (Wado et al., 2019), inflation and food price volatility (Ouoba & Sawadogo, 2022), income distribution (Adhikari et al., 2023), and infrastructure quality (Rosenzweig et al., 2021) can all influence food security. Moreover, climate change, education levels, and market access are likely to interact with the variables studied. Future research should consider integrating these additional dimensions to provide a more holistic view of what drives food security across regions. Nevertheless, the current model provides strong empirical support for the notion that faith-based redistribution mechanisms, agricultural productivity, and poverty reduction are foundational pillars for achieving sustainable food security in Indonesia.

CONCLUSION

The findings of this study provide clear answers to the research objectives. By employing panel data regression across 34 Indonesian provinces from 2013 to 2022, this research demonstrates that zakat utilization and agricultural output significantly enhance food security, while poverty weakens it. These results confirm that food security is not only determined by agricultural productivity but also by effective resource redistribution through zakat and the socio-economic conditions of the population. Integrating zakat into the analysis offers a new perspective, showing that Islamic financial instruments can serve as strategic tools to support Sustainable Development Goal 2 (Zero Hunger).

This research proposes several policy recommendations. First, zakat management institutions should prioritize productive programs that directly enhance food availability and access, particularly in vulnerable regions. Second, the government needs to implement policies that promote agricultural innovation, ensure fair distribution channels, and improve resilience against climate risks. Third, poverty alleviation programs must be integrated with food security initiatives so that households not only receive social protection but also have the capacity to achieve long-term economic independence. Strengthening collaboration between zakat authorities, agricultural stakeholders, and policymakers will be crucial for achieving sustainable food security in Indonesia.

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Substitution or Complementarity? Sukuk–Bank Performance Resilience in Indonesia’s Dual Banking System

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ABSTRACT

Research Originality: This study examines whether sukuk serves as a substitute or complement to banks, offering new insights into the resilience and vulnerability of Indonesia’s dual banking system under macroeconomic shocks.

Research Objectives: To examine the evolving sukuk–bank performance relationship before and after the 2020 global recession, and its implications for financial stability.

Research Methods: Quarterly data (2015–2023) from 6 Islamic and 15 conventional banks are analyzed using a dynamic panel System GMM model to address endogeneity and bank-specific heterogeneity.

Empirical Results: Prior to the crisis, the development of the sukuk market significantly reduced the profitability of Islamic banks, indicating a substitution effect. After the crisis, the negative impact on Islamic banks weakened, suggesting partial complementarity. Inflation widened margins, money supply reduced them, and GDP growth benefited only conventional banks.

Implications: Aligning sukuk market growth with banking strategies can strengthen resilience, enhance competitiveness, and support stability in dual banking systems.

Keywords:

sukuk market development; dual banking system; bank performance; Islamic banking; macroeconomic shocks

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INTRODUCTION

Over the past two decades, sukuk has rapidly evolved from a niche Islamic finance product into a globally recognized, Sharia-compliant alternative to conventional bonds. This transformation reflects not only the accelerating development of Islamic finance but also a growing international demand for ethical, asset-based financial instruments (Azmat et al., 2015; Emec et al., 2024; Kenourgios et al., 2016; Mimouni et al., 2019; Mohamed et al., 2015; Nagano, 2016, 2017; Naifar et al., 2017). The increasing availability of diverse financing instruments, including sukuk, introduces new opportunities for capital mobilization and investment diversification while also presenting structural challenges that may influence the future dynamics of global financial markets (Emec et al., 2024; Ibrahim, 2015; Ryan Rahmah Maulayati & Sri Iswati, 2023). In Indonesia, the sukuk market has experienced steady growth, driven by supportive regulatory frameworks and increased investor interest (Ariyana et al., 2020; Muslim et al., 2023; Noor & Wulandari, 2025). At the same time, the development of Islamic banking—operating alongside conventional banks in a dual banking system—presents a unique context for analyzing how sukuk interacts with the financial intermediation role of banks within a mixed-market structure.

The coexistence of Islamic and conventional banks within Indonesia's dual banking system creates a unique environment for assessing the role of sukuk in shaping the performance of the banking sector. Under the Financial Intermediation Theory, banks address market imperfections—such as transaction costs, information asymmetry, and risk misalignment—by pooling and reallocating funds, reducing intermediation costs, and facilitating risk distribution (Balke et al., 2021; Boďa & Zimková, 2021; Ghossoub, 2012; Gu, 2021). In Islamic finance, these functions operate under Sharia principles of risk-sharing and asset-backing, which distinguish Islamic banks from their conventional counterparts. Within this framework, sukuk emerges as a Sharia-compliant capital market instrument that can either complement or compete with banks in performing intermediation functions (Berger & Boot, 2024; Saleem et al., 2021). Its asset-based nature aligns closely with Islamic banking principles, yet its non-bank structure positions it as an alternative channel for mobilizing and allocating funds (Alshater et al., 2021). In Indonesia, sukuk issuance has expanded substantially, supported by strong regulatory initiatives and increasing investor demand, making it an integral component of the national financial market (Mseddi, 2023; Noor & Wulandari, 2025; Smaoui & Nechi, 2017). This dual growth of Islamic banking and sukuk presents an important question: do these two pillars of Islamic finance operate in synergy, in competition, or through a process of co-evolution within the dual banking framework?

In parallel with the expansion of Islamic banking and growing public interest in Sharia-compliant financial services, academic attention has increasingly focused on comparing the performance of Islamic and conventional banks. Studies such as Belanès et al., (2015); Čihák & Hesse, (2010); Olson & Wu, (2011); D. Olson & Zoubi, (2017), and more recently Blundell & Bond, (2023), have explored differences in efficiency, profitability, and risk profiles across both banking models. Building on these discussions, the relationship between sukuk issuance and the financial performance of Islamic and

conventional banks presents an important area of inquiry, particularly given the role that sukuk plays in capital market development and Sharia-based intermediation. At the same time, the Financial Fragility Theory highlights how financial institutions are vulnerable to macroeconomic shocks, with crises such as the 2020 global recession often prompting more conservative lending behavior and amplifying economic downturns (Cardona-Montoya et al., 2022; El-Shagi & Turcu, 2021). In such contexts, Islamic banks—grounded in asset-based financing and ethical principles—may demonstrate greater resilience (Ashraf, 2021; Hashem & Abdeljawad, 2018). However, sukuk issuance during crises could also undermine bank profitability by offering alternative financing channels outside traditional banking. This complex interplay between sukuk and bank performance, particularly during periods of economic stress, remains underexplored and warrants deeper empirical investigation (Aman et al., 2021).

Sukuk and Islamic banking have emerged as vital pillars of Islamic finance, prompting growing interest in understanding how sukuk issuance interacts with banking sector performance. Empirical evidence reveals a clear academic debate, with divergent views on whether sukuk serves as a substitute or a complement to traditional banking intermediation. Mimouni et al. (2019) and Smaoui et al. (2017). For example, identify a substitution effect, suggesting that sukuk issuance may reduce Islamic banks' market share and profitability. In contrast, Hassan et al. (2017) and Badawi et al. (2019) propose that sukuk supports broader financial development and complements the banking sector. While these studies provide valuable insights, they primarily focus on global or GCC contexts and often overlook the structural differences between Islamic and conventional banks. Moreover, few have examined how this relationship behaves during periods of macroeconomic stress, such as financial crises, or employed robust econometric methods capable of capturing dynamic, crisis-sensitive interactions. These limitations highlight the need for a context-specific analysis, particularly in Indonesia's dual banking environment, where sukuk and Islamic banking continue to grow in parallel.

Understanding the relationship between sukuk and the banking sector is crucial, particularly given the growing interconnectivity between the bond market—both conventional and Islamic—and financial intermediation. This interaction raises important questions about whether sukuk functions as a complement to bank financing, competes with it, or co-evolves alongside it. A more nuanced analysis of this dynamic, especially the comparative effects on Islamic and conventional banks, is necessary to provide objective insights into how these institutions respond to the development of sukuk markets (Badawi et al., 2019; Hassan et al., 2017; Mseddi, 2023; Saad et al., 2016).

The broader literature on financial intermediation reveals two competing perspectives. On one hand, some studies argue that non-bank financial instruments, such as sukuk, compete with banks by diverting resources, thus reducing the role of traditional financial intermediation (Balke et al., 2021; Ghossoub, 2012; Gu, 2021; Mertzanis, 2017). On the other hand, several scholars suggest that capital markets and banking systems can complement each other through a co-evolutionary process, in which both sectors interact and evolve simultaneously to meet the growing and diverse financial needs of their

customers (Arize et al., 2018; Hoffmann et al., 2018; Ledhem, 2022). These conflicting views underscore the need for context-specific empirical analysis, particularly within Indonesia's dual banking framework, where the growing sukuk market and the presence of both Islamic and conventional banks create a unique environment for exploring these interactions.

Although the theoretical foundation regarding the interaction between financial markets and banking systems has advanced considerably, empirical evidence remains mixed and context-dependent. For instance, T. D. Q. Le and Nguyen (2020), Mahmood (2025), Pawłowska (2016), Petria et al. (2015), and Rumler and Waschiczek (2016) argue that financial structure does not independently influence bank performance, suggesting that the presence of financial markets may not significantly alter banking outcomes. Conversely, Astrauskaite and Paškevičius (2014), Shuto et al. (2017), Taguchi and Bolormaa (2019), and Eichengreen and Luengnaruemitchai (2004) find evidence that banks and bond markets function as complements, working together to support financial development. In contrast, other studies highlight a more competitive relationship, where banks and bond markets may substitute for one another in providing financing options, thereby exerting pressure on each other's performance and market share (Dickie & Fan, 2013). These divergent findings reinforce the importance of conducting empirical research in specific institutional settings, such as Indonesia's dual banking system, to determine whether sukuk development supports, competes with, or co-evolves with the banking sector.

Building upon the varied findings in the literature, this study investigates the complex relationship between sukuk—a rapidly expanding Islamic financial instrument—and the performance and profitability of both Islamic and conventional banks. Specifically, it seeks to determine whether the interaction between the sukuk market and the banking industry is characterized by competition, complementarity, or co-evolution. The analysis is grounded in the context of the 2020 global economic recession triggered by the COVID-19 pandemic, which significantly disrupted both banking operations and capital markets worldwide.

The decision to focus on the 2020 recession is motivated by its unprecedented scale and its distinct impact on financial systems, including sukuk markets and dual banking sectors. Prior research consistently shows that economic downturns tend to tighten credit conditions and constrain loan supply, negatively affecting bank performance (Fielding & Rewilak, 2015; Lo, 2012; Thakor, 2015). In contrast, studies by Kenourgios et al. (2016), Naifar et al. (2017), and Mimouni et al. (2019) suggest that sukuk instruments exhibit relative resilience during global shocks, providing diversification benefits and financial stability. El-Shagi and Turcu (2021) emphasize that the 2020 recession was not only a global crisis but a defining economic event that reshaped financial interactions, particularly in terms of inflation, money supply, exchange rates, and growth (Bialowolski et al., 2021; Chhatwani & Mishra, 2021; Conesa et al., 2020).

This study extends the literature by examining both the pre-recession (2015–2019) and post-recession (2020–2023) periods to capture the dynamic effects of crisis and

recovery on the interaction between sukuk and bank performance. Rather than focusing solely on a single crisis point, the study compares financial conditions before and after the shock, offering a longitudinal perspective on how Islamic financial instruments respond across different economic phases. In doing so, it contributes to a more comprehensive understanding of the role of sukuk in financial stability and intermediation—particularly in crisis-prone environments—while addressing key gaps in the empirical literature on.

While prior studies have examined the relationship between sukuk markets and banking sector performance, most focus on global or GCC contexts, overlooking Indonesia's distinctive dual banking system. Evidence remains scarce on whether sukuk markets strengthen or weaken the *shock-resilience* of Islamic and conventional banks, particularly across the contrasting pre- and post-crisis conditions surrounding the 2020 recession. Few have integrated sukuk development with key macroeconomic indicators—such as GDP, inflation, money supply, and exchange rates—within a dynamic, bidirectional framework.

The novelty of this study lies in its context-specific, longitudinal comparison of Islamic and conventional banks across distinct economic phases, explicitly assessing the persistence of profitability (NIM and NPM) as a measure of resilience to macroeconomic shocks. Building upon the varied findings in the literature, the study investigates the complex relationship between sukuk—a rapidly expanding Islamic financial instrument—and the performance and profitability of both Islamic and conventional banks, specifically determining whether the interaction is characterized by competition, complementarity, or co-evolution. Grounded in the context of the unprecedented 2020 global economic recession, the analysis utilizes panel data from 6 Islamic and 15 conventional banks in Indonesia, spanning the period from 2015 to 2023. To address potential endogeneity and unobserved bank-specific characteristics—such as differences in risk preferences—the study applies a dynamic panel model with the Generalized Method of Moments (GMM) estimator (Arellano & Bond, 1991; Arellano & Bover, 1995). This approach leverages lagged variables as instruments to mitigate simultaneity bias, control for unobserved heterogeneity, and produce more reliable estimates than conventional techniques. The findings are expected to advance the academic debate on sukuk-banking interactions and provide policy-relevant insights for enhancing the resilience, stability, and competitiveness of Indonesia's financial system.

METHODS

This study adopts a quantitative research approach to empirically examine the relationship between bank performance, sukuk market development, and selected macroeconomic indicators, while controlling for relevant bank-specific variables. The dataset is a quarterly unbalanced panel covering both Islamic and conventional banks in Indonesia. The research sample was determined using purposive sampling with the following criteria: (1) Banks actively participating in the sukuk market during the observation period; (2) Operating within Indonesia's dual banking system; (3) Availability of complete quarterly financial statements for the entire study period.

The final sample consists of 6 Islamic banks and 15 conventional banks. This study utilizes secondary data obtained from BI, OJK, and BPS, including data on sukuk issuance, GDP growth, inflation, money supply, exchange rates, and bank financial reports. The panel dataset spans from Q1 2015 to Q4 2023 and is divided into two periods: the pre-recession period (Q1 2015 – Q4 2019) and the post-recession period (Q1 2020 – Q4 2023). A total of approximately 740 observations are available.

Operational definitions and measurement methods for all variables are summarized in Table 1 and are briefly described here. The study employs two dependent variables: Net Interest Margin/Net Profit Margin (NIM/NPM), which serves as the primary measure of bank performance, and Return on Assets (ROA), used as an alternative dependent variable for robustness testing to ensure the consistency and reliability of the results. The five independent variables include Sukuk Development (SKD), GDP Growth (GROWTH), Inflation (INF), Money Supply (M2), and Foreign Exchange Rate (FER). In addition, seven control variables—Capital Adequacy Ratio (CAR), Loan Loss Reserves (LLR), Managerial Efficiency (ME), Liquidity Risk (LIQUID), Size (SIZE), Overall Riskiness (RWATA), and Market Power (LERNER)—are incorporated to capture bank-specific characteristics that may influence performance.

Table 1. Definition of Variables

Variable	Definition	Label	Ratio
Dependent			
Bank Performance	Net Interest Margin	NIM	% (Percentage)
	Return on Assets	ROA	% (Percentage)
Independent			
Sukuk Development	Accumulation of Sukuk Issuance	SKD	
Macroeconomic Indicators	Annual real GDP growth rate	GROWTH	% (Percentage)
	Inflation Rate	INF	% (Percentage)
	Money Supply	M2	
	Foreign Exchange Rate	FER	
Control			
Capital Ratio	Capital Adequacy Ratio	CAR	% (Percentage)
Asset Quality	Loan-Loss reserves/ gross loans	LLR	% (Percentage)
Managerial Efficiency	Cost-to-income Ratio	ME	% (Percentage)
Liquidity Risk	Liquid Assets/deposits & Short-term funding	LIQUID	% (Percentage)
Size	Log (Total Size)	SIZE	
Overall Riskiness	Risk-weighted Assets to total assets	RWATA	% (Percentage)
Market Power	Lerner Index	LERNER	% (Percentage)

The study applies the System Generalized Method of Moments (GMM) to address endogeneity, autocorrelation, and heteroskedasticity in the dynamic panel model. The empirical model is specified and presented. The analysis follows these sequential steps:

data collection, data cleaning, descriptive statistics, correlation & multicollinearity checks, panel unit root tests, System GMM estimation, diagnostic tests (Hansen/Sargan, AR(1), AR(2)), and interpretation of results.

In the next section, Model (1) visually illustrates how Generalized Methods of Moments (GMM) are applied in research, encompassing the entire process from data collection to statistical analysis. Each step is designed to assess the impact of changes in the Sukuk market, GDP, inflation, the amount of money in circulation, and the exchange rate on the operations of both conventional and Shariah banks, and to provide insights into the phenomenon under study.

Ho and Saunders (1981) The model that this research uses. We employed dynamic regression techniques, a common approach in the empirical literature on bank performance, to investigate the factors influencing bank profitability in both conventional and Islamic samples. Such as Athanasoglou et al. (2008), Demirguc-Kunt & Huizinga (2001), Kasman et al. (2010), Yanikkaya et al. (2018) have all contributed to this field. We explain the dynamic panel model as follows:

$$BP_{ijt} = \beta_0 + \delta BP_{ijt-1} + SKD_{ijt} + GRWTH_{ijt} + INF_{ijt} + M2_{ijt} + FER_{ijt} \sum_{k=1}^7 \beta^k BS_{ijt}^k + \mu_{ij} + \varepsilon_{ijt} \quad (1)$$

Where BP_{ijt} shows the bank's performance (NIM or ROA) for banks in Indonesia in year t ; The BP_{ijt-1} is the lag in the bank's performance; SKD_{ijt} is the accumulation of the number of sukuk issuances; $GRWTH_{ijt}$ is the annual real GDP growth rate; INF_{ijt} is the inflation rate; $M2_{ijt}$ is the money supply; FER_{ijt} is the exchange rate; The control variable BS_{ijt}^k is explained in Table 3.1 above. β_0 , δ , and β are regression parameters; μ_{ij} indicates the effect of unobserved bank performance control variables, and ε_{ijt} is the residual term.

The use of micro-panel data, which consists of both cross-sectional and time-series bank information, introduces two potential problems: unobservable heterogeneity and the endogeneity of explanatory variables. Unobservable heterogeneity refers to time-invariant characteristics specific to each bank, such as the degree of risk aversion, internal policies, and corporate governance. These characteristics are an integral part of the model's random component. Endogeneity arises from the potential impact of bank performance on capital ratios. Endogeneity is further exacerbated by including the dependent variable as a lagged explanatory variable in model (1).

Therefore, OLS estimates of the parameters of interest are biased and inconsistent. Furthermore, static panel estimators (fixed effects or random effects estimators) are unsuitable for estimating Model (1) due to the residual correlation between the lagged dependent variable. To address these econometric issues, this study employs the two-step system GMM estimator proposed by Arellano and Bover (1995) and Blundell and Bond (2023). It is important to note that the consistency of the system GMM estimator depends on two tests. The first is the Hansen (1982) test for the orthogonality of the instruments used. Instruments are considered exogenous if the null hypothesis cannot be rejected. The second test is the Arellano and Bond (1991) test for the presence of second-order serial correlation in the transformed errors. The moment conditions are valid if the null hypothesis cannot be rejected.

RESULTS AND DISCUSSION

Results

The regression estimates using the Generalized Method of Moments (GMM) reveal that sukuk development (SKD) has a negative and statistically significant effect on the Net Interest Margin/Net Profit Margin (NIM/NPM) in the full sample and Islamic banks. In contrast, the effect on conventional banks is not significant. Specifically, prior to the 2020 economic crisis, a 1% increase in sukuk development was associated with a 0.12% decrease in NIM/NPM for Islamic banks, while holding other factors constant. Macroeconomic indicators, such as inflation (INF) and money supply (M2), generally exhibit positive and significant coefficients at the 10% level. In contrast, control variables, including the Capital Adequacy Ratio (CAR), liquidity (LIQUID), and bank size (SIZE), consistently display NEGATIVE and significant effects on profitability. These results highlight structural differences between Islamic and conventional banks in their responses to the expansion of the sukuk market, even before the onset of the crisis period.

Table 2. GMM Estimation Using NIM Variable as the Dependent Variable Before the 2020 Economic Recession

	Full Sample		Conventional Banks		Islamic Banks	
	Coef.	P > z	Coef.	P > z	Coef.	P > z
LDEP	.1584321***	.000	.1258436***	.000	.2158436***	.008
Independent Variable: Sukuk Development						
SKD	-.01285**	.037	-.0000843	.200	-.2158000***	.009
Independent Variable: Macroeconomic Indicators						
GROWTH	.0021589	.609	.0018432	.893	.0032158	.802
INF	.0102584*	.078	.0084321*	.072	.0158432*	.085
M2	-.0105000*	.085	-.1850000*	.070	-.0185000*	.084
FER	-.0035843	.707	-.0028436	.072	-.0048436	.890
Control Variable						
CAR	-.0235843**	.011	-.0184321**	.034	-.0321584*	.082
LLR	-.0000015	.604	.0000012	.291	-.0000021	.182
ME	.0158432	.473	.0125843	.272	-.0215843	.118
LIQUID	-.072500***	.017	-.0000584***	.003	.0001025	.378
SIZE	-.456000***	.011	-.334800***	.002	-.6524600***	.008
RWATA	.0003215	.825	-.0002584	.477	.0004321	.736
LERNER	.0525843*	.082	.0432158*	.075	.0658432*	.082
AR2	.695		.826		.176	
HANSEN	.572		.110		.613	

Using the dynamic panel model, the table presents the regression estimation findings for 6 Islamic and 15 conventional banks prior to the 2020 crisis. We use the net interest margin (NIM) as the dependent variable. LDEP represents the lag of the dependent variable. The independent variable is defined in Table 1. This study employs a two-step approach to GMM to calculate robust standard errors. The estimated coefficient is displayed next to the p-value. In that order, the symbols *, **, and *** have significance levels of 1%, 5%, and 10%.

The processed regression models showed no autocorrelation among the residuals, which indicates that we can proceed to the next stage of processing the panel data model. Additionally, we conducted the Hansen test on the data to ensure the overall validity of the instruments. Table 2 presents the data processing results for the GMM test estimation prior to the 2020 economic recession, using the NIM variable as the dependent variable.

The data processing results show that the SKD coefficient is negative and statistically significant at the 5% level across the sample. As a result, the Sukuk issue may reduce the banking system's market share, causing banks to lower their intermediation profits. The study's findings revealed that the NIM/NPM reduced by 0.12% in response to a 1% increase in sukuk development, provided all other factors remained constant. The results of Islamic and conventional banks showed significant variances. We conclude that the sukuk development variable has a negative impact on Islamic banks but not on conventional banks. The variables INF (inflation) and M2 (money supply) are statistically significant, with positive values at the 10% level for the entire sample and both subsamples.

The results for the other control variables in Table 2 reveal that the coefficients on the lag NIM/NPM are positive and highly significant. These findings are consistent with prior empirical research (Cao & Chou, 2022; Le & Ngo, 2020; Liu et al., 2025; Velliscig et al., 2023), indicating stable bank profits. We can attribute this resilience to the implementation of bank capital ratio restrictions, market competition barriers, and sensitivity to external shocks (Saona, 2016; Velliscig et al., 2023).

The Capital Adequacy Ratio (CAR) variable has a negative and significant impact on NIM/NPM in both the complete sample and the Islamic and conventional bank subsamples. The LIQUID variable (bank liquidity) has a negative and substantial impact on NIM/NPM in the sample. Liquidity and associated risks are reduced when banks keep more liquid assets (Chen et al., 2025; Khan et al., 2017; Mairafi et al., 2018). The conventional bank subsample primarily causes this influence, while Islamic banks do not experience any significant impact. The SIZE variable has a negative effect on NIM/NPM for the entire sample and both subsamples of conventional and Islamic banks.

The GMM estimation for the post-2020–2023 crisis period reveals that sukuk development (SKD) continues to have a negative impact on NIM/NPM in the full sample and Islamic banks, while the effect remains insignificant for conventional banks. Notably, a 1% increase in sukuk development is associated with a 0.15% decrease in NIM/NPM for Islamic banks, holding other variables constant. The interaction term (CRISIS*SKD) has a positive impact on Islamic banks, suggesting that the magnitude of SKD's negative impact on profitability has lessened in the post-crisis period. In contrast, CRISIS*SKD is not significant for conventional banks, indicating that sukuk instruments do not directly compete with their intermediation activities. Macroeconomic variables, such as inflation (INF) and money supply (M2), generally exhibit positive and significant relationships with profitability. In contrast, CAR, LIQUID, and SIZE maintain their NEGATIVE and significant effects across most model specifications. These results confirm structural differences between Islamic and conventional banks in their post-crisis responses to developments in the sukuk market.

The following data processing employs the same variables but pertains to a new timeframe, specifically the era following the 2020-2023 economic recession (crisis). This study defines a dummy variable (crisis) with a value of 1 for 2020 and subsequent years, and 0 for earlier years, to investigate the crisis's influence on the performance of Islamic and conventional banks. We combine the SKD and crisis dummy variables to form the CRISIS*SKD variable. This variable aims to discover potential shifts in Sukuk's impact on bank performance after the crisis. Table 3 indicates that the results are consistent with those in Table 3. SKD negatively influences NIM/NPM for the complete and Islamic bank samples, while the effect is not substantial for the conventional bank sample. This study supports the finding that the issuance of Sukuk has a negative impact on the profitability of Islamic banks.

Table 3. GMM Estimation Using NIM Variable as the Dependent Variable After the 2020 Economic Recession

	Full Sample		Conventional Banks		Islamic Banks	
	Coef.	P > z	Coef.	P > z	Coef.	P > z
LDEP	.1843215***	.000	.1458215***	.000	.2584321*	.077
Independent Variable: Sukuk Development						
SKD	-.158976**	.040	-.5731128	.136	-.284302***	.001
Independent Variable: Macroeconomic Indicators						
GROWTH	-.0028432	.762	-.0025843	.921	.0358433	.454
INF	-.0125893**	.037	-.0112584*	.080	-.0184321**	.053
M2	-.0125500*	.078	-.0112350*	.080	-.02153960*	.080
FER	-.0038436	.805	-.0032158	.082	-.0058432	.087
CRISIS*SKD	.165375	.142	.44478	.238	.29963**	.037
Control Variable						
CAR	-.0284321**	.053	-.0215843*	.078	-.0384321**	.024
LLR	-.0812800	.156	.0301140	.520	-.0235298	.565
ME	.0084321	.712	.0145821	.746	-.0258432	.166
LIQUID	-.0000843	.242	-.0272658***	.000	.0001258	.159
SIZE	-.2401000***	.0092	-.3167568***	.001	-.457367**	.012
RWATA	-.0003589	.985	-.0002843	.387	.4843573	.659
LERNER	-.0584321	.121	-.0484321**	.025	-.0725843**	.059
AR2	.092		.392		.131	
HANSEN	.362		.885		.693	

Using the dynamic panel model, the table presents the regression estimation findings for 6 Islamic and 15 conventional banks, including crisis effects. We use the net interest margin (NIM) as the dependent variable. LDEP represents the lag of the dependent variable. The independent variable is defined in Table 1. This study employs a two-step approach to GMM to calculate robust standard errors. The estimated coefficient is displayed next to the p-value. In that order, the symbols *, **, and *** have significance levels of 1%, 5%, and 10%.

In the conventional bank sample, CRISIS*SKD is not statistically significant. Table 3 shows that Sukuk does not directly compete with conventional banking firms, as expected. However, for Islamic banks, CRISIS*SKD has a positive impact, implying that SKD's post-crisis negative impact on their performance is less. The data processing results show that the SKD coefficient has a negative impact at the 5% level across the sample. As a result, we can deduce that the Sukuk issue may reduce the banking system's market share, causing banks to lower their intermediation profits. The study's findings demonstrate that the NIM/NPM decreased by 0.15% in response to a 1% increase in sukuk development, provided all other variables remained constant. The results of Islamic and conventional banks showed significant variances.

We conclude that the coefficients of both sukuk development variables have a negative influence on Islamic banks but not on conventional banks. The variables INF (inflation) and M2 (money supply) are statistically significant, with positive values at the 10% level for the entire sample and both subsamples. Table 3 shows the results for the other control variables. The lag NIM/NPM coefficients are positive for the entire sample and both subsamples. We consider all samples to be resistant to the effects of the treatment. We can attribute this resilience to the implementation of bank capital ratio requirements, market competition obstacles, and external shock sensitivity (Saona, 2016; Velliscig et al., 2023).

The Capital Adequacy Ratio (CAR) variable has a negative and significant impact on NIM/NPM in both the complete sample and the Islamic and conventional bank subsamples. The LIQUID variable (bank liquidity) has a negative and substantial impact on NIM/NPM in both the full and conventional bank samples. Liquidity risk and associated premiums reduce when banks keep more liquid assets (Kosmidou, 2008). The subsample of conventional banks primarily drives this influence, while the effect on Islamic banks is negligible. The SIZE variable has a negative and statistically significant impact on NIM/NPM for the entire sample and both subsamples of conventional and Islamic banks.

Robustness Checks

We conduct this robustness test to confirm the validity of the previous results. The results of this test can be used to determine whether data processing results remain consistent when using alternative performance measures. The robustness check for the pre-crisis period, using Return on Assets (ROA) as an alternative performance measure, confirms the main findings from the NIM/NPM estimations. Sukuk development (SKD) continues to show a negative relationship with bank profitability for the full sample. In contrast, the effect on conventional banks remains statistically insignificant. GDP growth (GROWTH) becomes positive and significant for the full sample and conventional banks, suggesting that higher economic growth enhances profitability in these segments. Management efficiency (ME) also shows a negative effect across all models, indicating that effective cost management contributes to improved returns. Most other control variables

retain their coefficient signs from the NIM/NPM results, with minor changes in statistical significance. Overall, these robustness results reinforce the earlier conclusion that sukuk market expansion tends to reduce profitability in Islamic banks before the 2020 crisis, while conventional banks are less affected.

This test uses the same data as the previous test, but the dependent variable will be replaced with ROA. It will also investigate whether SKD's impact on profitability has changed structurally after the crisis. The results in Table 4 confirm those in Table 2. The issuance of Sukuk has a negative influence on bank performance for the entire sample. According to prior NIM/NPM data, the SKD coefficient is negative and significant at the 5% level for both the complete sample and the Shariah bank subsample.

Table 4. GMM Estimation Using ROA Variable as the Dependent Variable Before the 2020 Economic Recession

	Full Sample		Conventional Banks		Islamic Banks	
	Coef.	P > z	Coef.	P > z	Coef.	P > z
LDEP	.3584321**	.045	.2843215**	.049	.3258432**	.017
Independent Variable: Sukuk Development						
SKD	.1621585***	.000	.0956538	.161	-.114321**	.045
Independent Variable: Macroeconomic Indicators						
GROWTH	.0384342***	.004	.0235891**	.037	.0584632	.253
INF	.0084321	.692	-.0158432	.311	.0284321	.724
M2	-.0000158*	.075	-.0000125*	.078	-.0000321*	.082
FER	-.0052584	.082	-.0042158	.077	-.0084321	.082
Control Variable						
CAR	-.0042584	.835	.0358436***	.007	-.0025843	.742
LLR	-.0324332	.651	-.012521***	.008	.153743	.146
ME	-.0358432**	.012	-.0284321***	.000	-.0432158***	.000
LIQUID	.01458212	.200	-.0001128	.448	.0021586	.355
SIZE	.1324776	.229	.1053698	.089	-.1017012	.531
RWATA	-.0525892	.710	.0421543	.087	.2516843	.817
LERNER	-.0925843	.538	-.0084321**	.045	.1025843	.990
AR2	.255		.882		.374	
HANSEN	.204		.831		1.00	

The table illustrates the regression estimation findings for 6 Islamic and 15 conventional banks before the 2020 crisis. We use ROA as the dependent variable in this analysis. LDEP represents the lag of the dependent variable. The independent variable is defined in Table 1. This study employs a two-step approach to GMM to calculate robust standard errors. The estimated coefficient is displayed next to the p-value. In that order, the symbols *, **, and *** have significance levels of 1%, 5%, and 10%.

Other control variables in Table 4 either retain the coefficient's sign (as in Table 2) or become statistically insignificant, with a few exceptions. The credit risk variable has a negative impact on ROA for the conventional bank subsample. Furthermore, the management efficiency variable has a negative impact on the entire sample and both subsamples, demonstrating that excellent management can increase revenues while lowering

overall expenses. Kasman et al. (2010). Finally, the GDP growth coefficient (GROWTH) became positive and significant for the entire sample and a subsample of conventional banks. Thus, Indonesia's greater GDP growth rate (GROWTH) boosts bank profitability.

The robustness check for the post-crisis period, using ROA as an alternative performance measure, confirms the main findings from the NIM/NPM estimations. Sukuk development (SKD) continues to have a negative effect on the profitability of Islamic banks, while its effect on conventional banks remains statistically insignificant. The interaction term (CRISIS*SKD) is positive and significant for Islamic banks, indicating that the NEGATIVE impact of sukuk issuance on profitability has moderated after the crisis. However, it has not been eliminated. GDP growth (GROWTH) retains a positive and significant coefficient for the full sample and conventional banks. At the same time, management efficiency (ME) shows a consistent negative and highly significant effect across most models. The signs of other control variables remain broadly consistent with the NIM/NPM results, with only minor shifts in statistical significance. Overall, the robustness results suggest that the choice of profitability measure does not materially change the study's conclusions, reinforcing the structural differences between Islamic and conventional banks in their post-crisis responses to sukuk market developments.

Table 5. GMM Estimation Using ROA as the Dependent Variable After the 2020 Economic Recession

	Full Sample		Conventional Banks		Islamic Banks	
	Coef.	P > z	Coef.	P > z	Coef.	P > z
LDEP	.1843215**	.037	.2584321*	.077	.2584321**	.048
Independent Variable: Sukuk Development						
SKD	-.2791853***	.001	.07891258	.970	-.287984	.012
Independent Variable: Macroeconomic Indicators						
GROWTH	.0423582 ***	.003	.0321581**	.034	.0038432	.370
INF	.0128432	.675	-.0158432	.633	-.0158432	.881
M2	-.0000125*	.078	-.0000185*	.083	-.0158432*	.083
FER	-.0036821	.080	-.0048436	.089	-.0062584	.083
CRISIS*SKD	.1509345**	.063	-.0567326	.834	.2180472	.030
Control Variable						
CAR	-.0258436	.723	.0352275	.145	-.0458432	.799
LLR	-.0123285	.885	-.011258**	.031	.1499238	.110
ME	-.0184321**	.072	-.0258432***	.000	-.0284321***	.000
LIQUID	.0225843**	.038	-.0001258	.643	.0001358	.277
SIZE	.1115345	.384	.0908867	.775	-.0847218	.539
RWATA	-.0703589	.701	.0004843	.875	.0005258	.967
LERNER	-.0584321	.547	-.0725843	.231	-.0875843	.493
AR2	.255		.992		.323	
HANSEN	.5		.992		.999	

The table displays the regression estimation results using the dynamic panel model for a sample of 6 Islamic banks and 15 conventional banks from 2020 to 2023. In this example, the dependent variable is the return on assets (ROA). Table 1 shows the definition of the independent variable. This study employs a two-step approach to GMM to calculate robust standard errors. The p-value is shown next to the estimated coefficient. *, **, and * correspond to 1%, 5%, and 10% significance levels, respectively.

Table 5 verifies the findings in Table 3 regarding the impact of the crisis (CRISIS*SKD). Following the crisis, the NEGATIVE effects of SKD on ROA for Islamic banks decreased, although it did not entirely offset the negative coefficient of SKD. Tables 4 and 5 demonstrate that the data processing results in Tables 2 and 3 are consistent, even when different profitability indicators are employed. It does not matter which performance metrics are chosen.

Discussion

The study shows apparent differences in how sukuk development affected bank performance before the 2020 economic recession. Overall, sukuk growth had a negative impact on profitability, especially for Islamic banks, while the effect on conventional banks was not significant. This supports the substitution effect hypothesis, meaning sukuk competes with Islamic banks for Sharia-compliant investors and borrowers, which reduces their market share and profit margins. The more substantial negative impact on Islamic banks is likely due to their limited product range and heavy reliance on Sharia-compliant financing, making them more vulnerable to sukuk competition.

Before the crisis, supportive regulations and growing investor confidence in sukuk may have intensified this competition. Conventional banks, however, were largely unaffected, indicating that Islamic and conventional markets remain somewhat distinct. Policymakers should help Islamic banks adapt by improving efficiency, diversifying products, and coordinating sukuk development with banking stability.

The study confirms the first hypothesis: sukuk development has a significant impact on bank performance for the full sample and Islamic banks, but not for conventional banks. This supports findings from previous studies (Ledhem, 2022; Mimouni et al., 2019). The negative effect on Islamic banks aligns with the substitution effect (Smaoui et al., 2017), meaning that sukuk competes with Islamic bank products for Sharia-compliant investors and borrowers, thereby reducing their market share and profit margins. The effect is more substantial for Islamic banks because they offer fewer products and benefited less from pre-crisis incentives that boosted sukuk growth (Al-Mekhlafi, 2023; Smaoui & Ghouma, 2020). To respond, Islamic banks should focus on innovation and diversify their funding sources beyond deposits, for example, by offering new Sharia-compliant investment products. Policymakers can also encourage collaboration by allowing banks to act as sukuk arrangers or underwriters, turning competition into a partnership.

For GDP growth (GROWTH), results using NIM show no significant effect for any group, consistent with Ledhem (2022). However, using ROA, GDP growth has a positive and significant effect for the full sample and conventional banks, but not for Islamic banks. This means that economic growth improves overall profitability, mainly through non-lending activities—such as fees, investments, and market gains—which are stronger in conventional banks (Al-Harbi, 2019; Davis et al., 2024; Le & Ngo, 2020; Saklain & Williams, 2024; Trihardianto & Hartanti, 2022). Islamic banks, with their

limited income diversification, benefit less. Before the crisis, this pattern shows that growth raised asset returns but did not significantly increase lending margins, especially under conditions of tight competition or interest rate controls (Azad et al., 2023; Haddou & Boughrara, 2025; Paltrinieri et al., 2021; Šeho et al., 2024). Policymakers should help conventional banks expand their non-interest income, while Islamic banks should develop growth-linked Sharia-compliant financing to capture the benefits of economic expansion more effectively.

Inflation (INF) has a positive impact on bank performance for all samples and both types of banks, as indicated by the NIM/NPM and ROA results. This supports the inflation pass-through effect, where banks raise lending rates faster than deposit rates during periods of inflation, thereby widening their profit margins and protecting returns (Montes & Monteiro, 2014). It also reflects the cost channel of monetary policy, as higher inflation expectations lead banks to price loans more aggressively (Silalahi & Falianty, 2023; Sobol et al., 2023). Although the overall effect is positive, differences across models show that not all banks adjust equally well. In response, banks should employ flexible pricing strategies to maintain profits during periods of inflation, while regulators must ensure fair pricing that protects borrowers and maintains financial stability.

In contrast, the money supply (M2) exhibits a negative relationship with NIM, indicating that as liquidity in the financial system increases, competition rises, lending rates fall, and profit margins narrow. This aligns with the loanable funds theory (Tsiang, 1989), which states that a larger supply of funds lowers lending rates and reduces profitability (Hsieh et al., 2024). Thus, while more liquidity can boost lending, it can also erode margins if not managed effectively. Policymakers should strike a balance between liquidity support and measures to prevent excessive margin compression, such as targeted interventions or macroprudential policies that maintain healthy lending conditions.

The exchange rate (FER) shows no significant effect on banking performance across all samples in the pre-crisis period. This absence of impact likely reflects the limited foreign currency exposure within the banks' balance sheets, which reduces their sensitivity to exchange rate fluctuations. Nevertheless, maintaining robust foreign exchange risk management frameworks remains essential, as greater market openness or external shocks could increase vulnerability to currency volatility in the future (Mamonov et al., 2024; Sikarwar, 2018).

Bank-specific variables show consistent patterns. The negative and significant coefficient of the capital adequacy ratio (CAR) supports Brock & Franken's (2019) view that higher capital buffers lead to safer, but less profitable, asset allocation. The negative SIZE effect is consistent with the "quiet life" hypothesis (Corbae & D'Erasmus, 2021; Färe et al., 2015; Igan et al., 2021; Berger & Humphrey, 1997; Altunbas et al., 2017; Regehr & Sengupta, 2016), suggesting that larger banks may prioritize stability over profit maximization. The Lerner Index, while negative, is insignificant for the overall sample.

From a policy perspective, these pre-crisis findings suggest that Islamic banks need to strengthen product diversification, develop competitive Sharia-compliant investment alternatives, and leverage sukuk issuance as part of their funding strategy to mitigate competitive displacement. Regulators may consider aligning sukuk and Islamic banking product regulations to promote complementarity rather than substitution. Moreover, macroprudential policies should account for the asymmetric effects of inflation and liquidity expansion on bank profitability, ensuring that both monetary stability and sectoral competitiveness are preserved.

Before the crisis, sukuk issuance created intense competition for Islamic banks, reducing their profitability, while conventional banks were unaffected. This shows that in dual-banking systems, the growth of Sharia-compliant market instruments can have uneven impacts, especially when Islamic banks have limited product diversity and operate in niche markets.

Following the crisis, the relationship between sukuk and bank performance changed. Sukuk still had a negative effect on Islamic bank profits, but the impact became smaller. In some cases, the interaction between the crisis and sukuk (CRISIS*SKD) even turned positive and significant. This shift reflects post-crisis reforms, improved product diversification, and Islamic banks' strategic use of sukuk for funding purposes. As sukuk evolved from a competitor into a complementary financing tool, the pressure on Islamic banks' margins eased, creating a more balanced market. From a policy perspective, regulators should align the development of the sukuk market with Islamic banking strategies to enhance financial stability. Meanwhile, Islamic banks should utilize sukuk to effectively manage capital and liquidity, while maintaining their core lending activities.

The post-crisis results show that the negative impact of sukuk issuance on Islamic banks' profitability has weakened compared to the pre-crisis period. A likely explanation is that the banking system underwent significant reforms and innovations after the crisis, making it more competitive and aggressive in capturing market share (Mennawi & Ahmed, 2020; Ariss, 2010; Beck et al., 2019; Claessens & Laeven, 2014). Furthermore, in recent years, banks have increasingly issued sukuk to strengthen their capital base, support expansion, and maintain adequate capital ratios (Alandejani, 2022; Maulayati & Iswati, 2023). This shift suggests that sukuk, which previously acted mainly as a competitor to Islamic bank products, has become part of their strategic funding mix, turning a former source of market share erosion into a complementary instrument for capital management and liquidity planning (Ledhem, 2022; Mimouni et al., 2019; Smaoui & Ghouma, 2020). Well-functioning sukuk markets can also help Islamic banks extend liability maturities and diversify funding sources (Al-Mekhlafi, 2023; Alandejani, 2022; Eğri & Orhan, 2020; Maulayati & Iswati, 2023). Following the crisis, sukuk development continues to have a negative but more negligible impact on the profitability of Islamic banks compared to the pre-crisis period. In some cases, the crisis interaction term becomes positive. This suggests that Islamic banks have adapted by integrating sukuk into their capital-raising and liquidity strategies, thereby shifting the relationship from one of pure substitution to one

of partial complementarity (Ben Jedidia & Guerbouj, 2021; Igan et al., 2021; Khanfar & Khanfar, 2023; Ledhem, 2022; Mimouni et al., 2019). The implication is that Islamic banks should continue to leverage sukuk as part of their long-term funding mix, while diversifying income streams beyond traditional intermediation to reduce vulnerability to margin pressure. Regulators, in turn, should ensure that the growth of the sukuk market is harmonized with Islamic banking regulations to prevent destabilizing competition and enhance systemic resilience.

GDP growth from 2020 to 2023 exhibits a positive relationship with ROA for the full sample and conventional banks, but not for Islamic banks. This result suggests that post-crisis economic expansion supports profitability mainly through non-interest income channels—such as fee-based services and investment returns—that are more developed in conventional banks. Islamic banks' muted response may stem from limited diversification into these revenue streams. Strengthening Islamic banks' capacity to capture economic growth benefits requires expanding into trade finance, Sharia-compliant investment products, and market-based income sources. At the same time, policymakers can incentivize product innovation and facilitate broader market access.

During the 2020–2023 period, inflation (INF) retained a positive relationship with NIM. When inflation rises, banks generally increase lending rates more quickly than deposit rates, widening the net interest margin (Silalahi & Falianty, 2023). From an inflation pass-through perspective, this reflects the ability of banks to protect real returns in a high-inflation environment, particularly when a significant portion of the loan portfolio uses floating interest rates (Varela et al., 2020). Inflation may also increase credit demand as firms and households require more funds to finance costlier activities, allowing banks to charge higher interest rates on loans (Mishchenko et al., 2021). Inflation maintains a positive relationship with NIM during the post-crisis period, consistent with the inflation pass-through mechanism, where banks adjust lending rates more quickly than deposit rates, thereby widening their net interest margin. This enables banks to protect real returns in an inflationary environment, particularly when a significant portion of the loan portfolio features floating interest rates. While moderate inflation can be beneficial, persistent inflation poses credit risk if borrowers' repayment capacity weakens (Hao et al., 2023; Lestari et al., 2021; Mundra & Bicchal, 2023). Therefore, both Islamic and conventional banks need to strengthen credit risk management during inflationary periods, and regulators should maintain macroprudential measures to ensure that rising non-performing loans do not offset temporary margin gains.

The money supply (M2) shows a negative effect on NIM, suggesting that greater liquidity in the financial system intensifies competition, compresses lending rates, and reduces margins. This is consistent with the loanable funds framework (Tsiang, 1989), where an outward shift in the supply of funds lowers equilibrium lending rates; in a competitive market, this can erode profitability even in the absence of credit risk shocks (Hsieh et al., 2024; Tsiang, 1989). Increased liquidity may also encourage banks to alter

their asset composition, potentially lowering the average return on assets (Hong et al., 2021). Post-crisis liquidity injections have stabilized markets, but can erode profitability if not accompanied by adequate loan demand and risk-adjusted pricing strategies (Ashraf, 2021; Kreamer, 2022). Monetary authorities should strike a balance between liquidity provision and measures to maintain healthy loan margins. At the same time, banks need to adjust asset-liability management and target niche markets or specialized financing to optimize returns in high-liquidity environments.

Exchange rate movements remain statistically insignificant for banking performance post-crisis, possibly reflecting effective hedging strategies, limited foreign currency exposure, or relative stability in exchange rates. Despite the lack of direct impact in the sample period, banks should maintain prudent FX risk management to prepare for potential volatility from global shocks, supported by regulatory frameworks that enhance transparency and access to hedging tools (Ho & Saunders, 1981; Selmi et al., 2023).

Bank-specific factors remain influential. The negative relationship between the capital adequacy ratio (CAR) and profitability suggests that higher capital buffers often result in safer but less profitable asset allocations. Larger banks, consistent with the “quiet life” hypothesis, may prioritize stability over aggressive profit-seeking. The Lerner Index remains negative but insignificant, suggesting no firm evidence of market power effects on margins. Optimizing capital deployment while sustaining prudent risk management will be key for banks in the post-crisis period, and competition-enhancing policies from regulators can promote efficiency without compromising financial stability (Corbae & D’Erasmo, 2021; Färe et al., 2015; Igan et al., 2021; Berger & Humphrey, 1997; Altunbas et al., 2017; Regehr & Sengupta, 2016).

In the context of the financial fragility theory, Islamic banking has demonstrated resilience in crisis conditions, despite facing competition from sukuk. The moderation of sukuk’s negative impact post-crisis indicates adaptive capacity, where Islamic banks have not only absorbed competitive pressures but also leveraged sukuk markets to enhance funding stability (Ahmed & Elsayed, 2019; Aman et al., 2021; Bahloul & Mathlouthi, 2022). However, this resilience does not eliminate macroeconomic vulnerabilities: high inflation can temporarily boost nominal returns, while persistent money supply expansion may undermine margins and increase exposure to external shocks (Cafferata et al., 2023; Cardona-Montoya et al., 2022).

From a policy perspective, the post-crisis experience suggests that regulators and bank management should treat sukuk markets not solely as competitors but as integrated components of the Islamic financial ecosystem. Policy coordination between sukuk issuance frameworks and Islamic banking regulations could strengthen system-wide stability. Moreover, monetary authorities need to balance inflation control with liquidity management, ensuring that profitability gains from inflation do not come at the cost of long-term margin compression from excess liquidity. Islamic institutions should exercise caution when managing sukuk issuance, as it can harm their market share and profitability. Improving operational efficiency and diversifying financial products are

critical strategies for mitigating this effect. Both Islamic and conventional banks must closely monitor inflation, given its impact on banking performance and net interest margins (NIM). To maintain system stability, policymakers and financial institutions should prioritize managing inflation and money supply. Conventional banks should focus on growth-oriented strategies to increase their return on assets (ROA), while both banking sectors should adapt their products to meet evolving market demands. Future research should examine in greater detail how macroeconomic factors such as inflation, money supply, and exchange rates interact with sukuk issuance to influence the stability of Islamic and conventional banks, as well as how external shocks—such as pandemics or geopolitical events—differentially affect these institutions, with emphasis on the role of sukuk and other Sharia-compliant products in crisis management.

CONCLUSION

This study examined whether sukuk market development acts as a substitute or a complement to bank performance in Indonesia's dual banking system, and whether this relationship reflects resilience or vulnerability to macroeconomic shocks. The results show that, prior to the 2020 global recession, the development of the sukuk market significantly reduced the profitability of Islamic banks—measured by NIM/NPM and ROA—while having no significant impact on conventional banks. This study confirms a substitution effect and indicates a state of vulnerability for Islamic banks, as limited product diversification and high dependence on Sharia-compliant financing left them more exposed to competitive pressure from sukuk.

During the post-crisis period, the negative impact on Islamic bank profitability weakened, indicating a shift toward partial complementarity. This change reflects greater resilience, as Islamic banks adapted through product diversification, regulatory reforms, and the strategic use of sukuk for funding and liquidity management. Even so, resilience remains incomplete: macroeconomic pressures persist, with inflation consistently widening margins for both bank types, while money supply growth compresses margins, GDP growth benefits only conventional banks, and exchange rates exert no significant influence.

Overall, the findings indicate that sukuk can evolve from a source of vulnerability into a contributor to resilience in Indonesia's dual banking system. In summary, sukuk acted as a source of vulnerability for Islamic banks prior to the crisis, but evolved into a partial source of resilience in the post-crisis period—its stabilizing role, however, depends on strategic integration with banking operations and supportive regulatory alignment.

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Factors of Halal Industry Ecosystem Development: A Study on the Islamic Hospital Industry in Indonesia

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ABSTRACT

Research Originality: This study offers originality by examining Islamic hospitals, a sector that has been rarely explored in halal industry research. It employs a quantitative approach to analyze how knowledge and perception influence public intention, with preference serving as a mediating variable, providing new empirical evidence for strengthening the halal ecosystem in healthcare services.

Research Objectives: This study aims to investigate the impact of knowledge and perception factors on public intentions to use sharia-certified hospitals, with preference serving as a mediating variable.

Research Method: A quantitative descriptive approach was employed, utilizing primary data collected through questionnaires and analyzed using the Structural Equation Modeling-Partial Least Squares (SEM-PLS) method. Respondents consisted of individuals living in areas with the presence of Islamic hospitals.

Empirical Results: The results showed that knowledge and perceptions have a significant influence on community preferences. Perceptions and preferences are also proven to affect people's intentions in choosing Islamic hospitals, while knowledge does not show a direct impact on intentions. Preference acts as a mediator in the relationship between knowledge, perception, and intentions.

Implications: The findings underscore the significance of education in enhancing public knowledge, promoting positive perceptions, and developing effective marketing and regulatory strategies to strengthen the position of Islamic hospitals within the halal ecosystem development in Indonesia.

Keywords:

halal industry; Islamic hospitals; knowledge; perception; preference; intention

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INTRODUCTION

The global halal industry is experiencing rapid growth, particularly in the food, cosmetics, tourism, and healthcare sectors. As a country with the largest Muslim population, Indonesia has significant potential to become a global hub for the halal industry. According to a report by The Royal Islamic Strategic Studies Center (RISSC), Indonesia has the largest Muslim population in the world. RISSC recorded Indonesia's Muslim population at 240.62 million in 2023. This number represents 86.7% of the total national population of 277.53 million. This large population is correlated with high consumption of halal products (Sukoso et al., 2020). The government is increasingly active in supporting the development of the halal ecosystem through strategic policies and initiatives. However, the lack of public knowledge about Islamic hospitals is an obstacle to the development of the halal industry. Islamic hospitals incorporate Islamic principles into their management, medical ethics, and patient care services. Although the public's understanding of this service is increasing, it remains relatively low. Data from BPJPH indicate that many people lack understanding of the criteria and benefits of Islamic hospitals, leading to low interest in these services.

Various issues hinder public awareness of Islamic hospitals, including a lack of adequate information, misconceptions about the modernity of services, and limited access to information. The lack of education also reduces people's appreciation of the added value of sharia-based services. These misconceptions create the perception that Islamic services are limited and lack innovation. To overcome this, efforts are needed to increase public knowledge through information campaigns and educational programs. Additionally, access to information should be expanded through social media and local communities. Introducing flagship programs that highlight positive Sharia values can also improve public perception of Islamic hospitals.

Religious values, personal beliefs, service quality, and social environment influence public preference for Islamic hospitals. Compliance with Sharia principles, trust in service quality, and availability of Sharia-compliant facilities are the main driving factors. These preferences are also often influenced by personal beliefs and values. Demand for sharia-based health services is increasing in Indonesia. However, the public perception of Islamic hospitals remains low, which has an impact on public interest. Hakim et al. (2022) found that although some people were aware of the existence of Islamic hospitals, not all had positive perceptions regarding the quality of services and the professionalism of the staff.

A lack of promotion and information is the primary reason for the low public preference for Islamic hospitals. Many people believe that these services prioritize religious aspects over medical quality. A study shows that a lack of understanding of the advantages of Islamic hospitals causes people to tend not to choose them as their primary health facility (Windasari et al., 2021). This condition confirms the gap between the advantages of Islamic services and public knowledge. With an increase in public knowledge, perceptions, and preferences towards Islamic hospitals, the halal industry ecosystem in Indonesia can develop more optimally. Effective education and promotion strategies from the government

and related institutions are necessary to enhance public awareness of the benefits of Islamic hospitals.

Numerous studies have been conducted on the development of the halal industry in Indonesia, encompassing various sectors and approaches. Asri and Ilyas (2022) examined the halal industry in a broad scope, while Andini and Darmawan (2023) focused on public preferences for Islamic hospitals, by examining the factors that influence decisions to use sharia-based health services. Then, Sumarlin et al. (2024) examined the ecosystem of halal products and services in Indonesia, while Amalia et al. (2024) analyzed the success factors for the development of halal industrial estates, particularly in the Bintan Inti Industrial Estate. Research from Annisa (2019) emphasizes the importance of building an integrated halal ecosystem to encourage Islamic economic growth, and Haryono (2023) highlights the role of public perception and institutional governance in supporting the halal ecosystem. In addition, Haqiqotus (2022) emphasizes the position of Islamic hospitals as an integral part of the halal ecosystem, covering aspects of services, food, and pharmaceuticals.

Furthermore, several studies have discussed the development of the halal industry in the context of hospitals or the Islamic health sector. Nasution et al. (2024) examined the business development strategy of Islamic hospitals for Islamic educational institutions with a SWOT approach, while Minarni et al. (2025) used a similar approach to assess the contribution of Islamic hospitals to the halal industry ecosystem. (Warsidi Warsidi, Abdurrahman Raden Aji Haqqi, 2024) mapped the operational aspects of Islamic hospitals that have obtained certification, focusing on strategy and operations based on qualitative analysis. On the other hand, Wilda et al. (2024) adopted a quantitative approach to assess consumer preferences in choosing an Islamic hospital, albeit limited to the Riau region. They found that understanding and attitude have a significant influence on patient preferences.

Additionally, aspects of patient satisfaction and service quality are widely discussed as potential areas for improvement in Islamic hospitals. Mahdalena, S. et al. (2020) found that the application of sharia-based service concepts has a significant effect on patient satisfaction at RSUD Dr. Zainoel Abidin Banda Aceh. Similar findings were reported by Prayoga et al. (2021), who evaluated the dimensions of Islamic nursing, including *Rabbaniyyah*, *Akhlaqiyyah*, *Waqi'iyah*, and *Insaniyyah*, at PKU Muhammadiyah Hospital, Yogyakarta. Feri Sumadi et al. (2021) also revealed that service quality, price, and facilities jointly affect patient satisfaction in Islamic hospitals. This is reinforced by Wardaningsih and Oktariza (2021), who demonstrate that providing exemplary service in line with Islamic values can significantly increase patient satisfaction.

Nonetheless, studies on Islamic hospitals have been conducted from various aspects; most research remains limited to case studies of specific hospitals, focusing more on operational and service aspects. Ikhwan (2024) stated that direct research linking Islamic hospitals with the development of the halal industry in Indonesia is still relatively limited. Based on these facts, this study offers novelty by examining the development of the halal industry in the context of Islamic hospitals using a quantitative approach and a broader scope, namely, comprehensively analyzing the effect of knowledge and perceptions on

public intentions in using Islamic hospitals, as well as identifying how preference plays a role as a mediating variable. This research is expected to provide a more comprehensive empirical contribution to strengthening the halal ecosystem in the Islamic hospital service sector.

METHODS

This study employed a quantitative approach using both primary and secondary data. Primary data were obtained from questionnaires distributed to people living in provinces with Islamic hospitals, including Jakarta, Banten, Central Java, West Java, East Java, Aceh, NTB, and Sumatra. The synthesis of research variables, knowledge, perception, intention, and preference, was adopted from previous studies (Alfarizi & Arifian, 2023; Ardian et al., 2023; Novriwanda & Herman, 2024; Windasari et al., 2024). Respondents were required to be aware of Islamic hospitals, regardless of whether they had used their services or not. A 5-point Likert scale was used to measure responses, ranging from 1 to 5.

The sampling technique used was simple random sampling. Based on the minimum sample requirements suggested by Hair et al. (2019), a minimum of 59 samples was needed. The final dataset consisted of 116 respondents, with the largest proportion coming from Banten (37%), West Java (31%), and Jakarta (24%). Most respondents were female (62%) and aged between 20 and 30 years.

Data were analyzed using Structural Equation Modeling with the Partial Least Squares (SEM-PLS) method through Smart-PLS software. SEM is a statistical technique that integrates factor analysis and regression to examine relationships among latent and observed variables simultaneously (Hair et al., 2019). The SEM-PLS method was chosen because it is variance-based, prediction-oriented, and suitable for complex models with latent variables and moderate sample sizes (Chin, 1998). SEM consists of two components: the measurement model, which links latent variables with their observed indicators, and the structural model, which specifies the relationships among latent variables. The general model of an SEM can be expressed in three basic equations:

$$\eta = B\eta + \Gamma\xi + \zeta \quad (1)$$

$$Y = \Delta_y \eta + \varepsilon \quad (2)$$

$$X = \Delta_x \xi + \delta \quad (3)$$

The first equation represents the structural model, which establishes the relationship among the latent variables. The components of η are endogenous latent variables; ξ are exogenous latent ones, and both are a system of linear equations with B and Γ ; ζ is a residual vector. Equations 2 and 3 represent measurement models which define the latent variables in terms of the observed variables. That is, Equation 2 links the endogenous indicators, Y , to endogenous latent variables, η , and Equation 3 links the exogenous indicators, X , to the exogenous latent variables ξ . In addition, ε both /and δ are the residuals (Pakpahan et al., 2017).

Figure 1. Research Framework

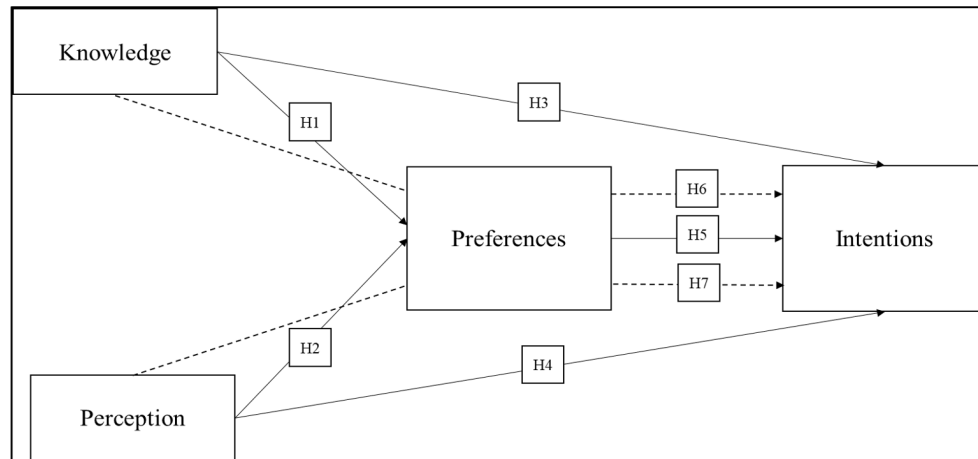


Figure 1 presents the research framework, which illustrates the relationships among knowledge, perception, preference, and intention in Islamic hospitals, with preference as a mediating variable. Based on this framework, several hypotheses are formulated for empirical testing.

RESULTS AND DISCUSSION

This research was conducted on 116 respondents. Table 1 explains the results of descriptive statistical tests of each variable. Based on the results in Table 1, it can be seen that the average respondent's answer to all variables is mostly “agree”.

In PLS-SEM, the structural model illustrates the relationships (paths) between constructs, while the measurement model (also referred to as the outer model) depicts the relationships between constructs and their indicator variables. Measurement models can be distinguished for exogenous latent variables, which explain other constructs, and endogenous latent variables, which are explained by other constructs. (Hair et al., 2021). To assess the outer model using data analysis techniques with SmartPLS, several criteria are evaluated, namely convergent validity, discriminant validity, and reliability.

Tabel 1. Descriptive Statistics

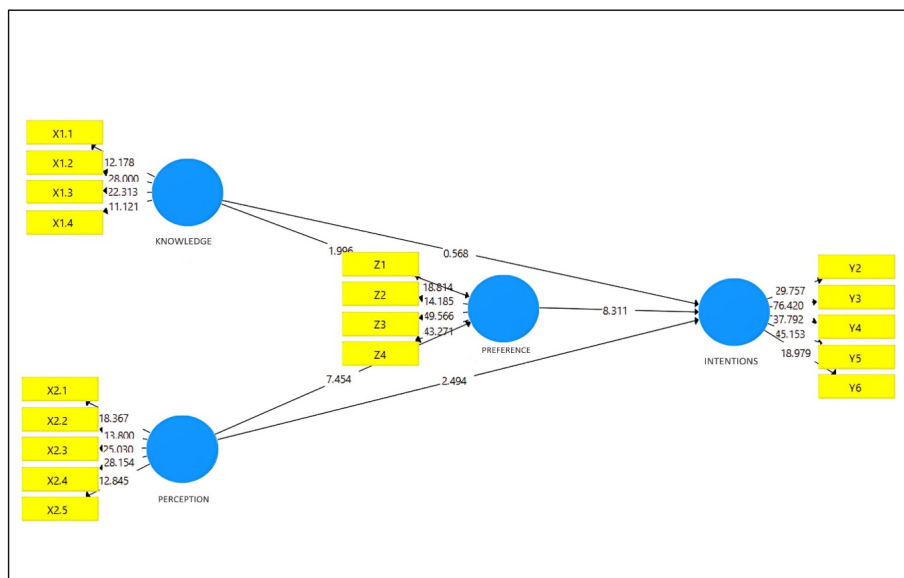
Variabel	N	Min	Max	Mean	Standard Deviation
Knowledge	116	5	25	18,77	3,65
Perception	116	5	25	20,33	3,72
Preferences	116	4	20	15,66	3,08
Intentions	116	12	30	24,74	3,99
Valid N	116				

Source: Primary data processed.

Based on the model in Figure 2, it can be seen that all indicators have a loading factor of more than 0.70, indicating that all constructs have met the requirements for convergent validity. Therefore, these indicators are deemed valid and suitable for analysis.

There are three methods for assessing discriminant validity in a study using Smart PLS. One of them looks at the Heterotrait-Monotrait Ratio (HTMT), where the validity of the discriminant construct is fulfilled, and has an HTMT value below 0.90. The results of the Heterotrait-Monotrait Ratio test are shown in Table 2. The results of data processing in Table 2 indicate that the HTMT of each variable is less than 0.90, meaning the construct meets the discriminant validity requirements and is classified as good.

Figure 2. Output Outer Model



Tabel 2. Heterotrait-Monotrait Ratio (HTMT)

	Knowledge	Perception	Intentions	Preferences
Knowledge				
Perception	0,746			
Intentions	0,530	0,739		
Preferences	0,637	0,772	0,858	

Source: Smart-PLS, data processed.

Reliability is an important requirement for each construct to be analyzed, with a Cronbach's alpha value above 0.6 and composite reliability above 0.7 indicating high reliability (Ghozali & Latan, 2015). The results of the reliability test are presented in Table 3. Table 3 shows that the Cronbach's alpha and composite reliability values have exceeded or met the minimum value requirements. Thus, all constructs/variables have good reliability.

Tabel 3. Composite Reliability dan Cronbach's Alpha

	Cronbach's Alpha	Rho_a	Composite Reliability	Average Variance Extracted (AVE)
Knowledge	0,826	0,831	0,885	0,659
Perception	0,889	0,892	0,919	0,694
Intentions	0,93	0,936	0,947	0,781
Preferences	0,868	0,89	0,91	0,717

Source: Smart-PLS, data processed.

Table 4 shows that R-squared explains the substantive influence between the independent variable and the dependent variable. The interpretation of the R-squared value that will be generated is as follows: 0.75 (strong), 0.50 (moderate), and 0.25 (weak) (Ghozali & Latan, 2015). The adjusted R-squared value indicates that the knowledge and perception variables simultaneously explain preferences by 48.6% (moderate category), while the remaining 51.4% is influenced by other variables not hypothesized. For the intentions variable, the adjusted R-Square value of 64.4% indicates that knowledge, perceptions, and preferences simultaneously explain intentions with a moderate to strong category. In comparison, other variables outside the model influence the remaining 35.6%.

Tabel 4. R-Square Value

	R Square	R Square Adjusted
Intentions	0,654	0,644
Preferences	0,495	0,486

Source: Smart-PLS, data processed.

Q-Square is used to evaluate the quality of model predictions and parameter estimates. This value is considered to have good predictive relevance if it is greater than 0, with an interpretation of 0.02 as weak, 0.15 as moderate, and 0.35 as strong (Ghozali & Latan, 2015), while a value close to zero indicates increasingly optimal model performance. Table 5 above shows that the Q-Square value for the preference variable is 0.340 and for the intentions variable is 0.490, indicating that both have predictive relevance that falls into the moderate to strong and strong categories, respectively.

Tabel 5. Q-Square Value

	SSO	SSE	Q ² (=1-SSE/SSO)
Knowledge	464,000	464,000	
Perception	580,000	580,000	
Intentions	580,000	295,539	0,490
Preferences	464,000	306,465	0,340

Source: SmartPLS, data processed.

Hypothesis testing using the bootstrapping method is employed to determine whether a construct affects other constructs, as indicated by the t-statistic value and the parameter coefficient of the effect (Ghozali & Latan, 2015). The criteria in this study are based on the probability value (p-value) with a significance level of 5%. If the p-value <0.05 and the T-statistic > 1.9808, then the hypothesis is accepted.

The results of hypothesis testing show that knowledge affects preferences, as shown by the t-statistic, which is 1.996, greater than the t-table (1.996 > 1.989), and with a p-value of 0.048 <0.05. Table 6 shows that knowledge has a positive and significant influence on people's preferences in using Islamic hospitals. This finding suggests that the greater the community's knowledge about Islamic hospitals (for example, services, Sharia principles, and benefits), the higher their preference for Islamic hospitals. The knowledge factor makes a significant contribution to shaping people's intentions and choices. This finding aligns with the research of Windasari et al. (2024) and Rahman et al. (2021), which shows that consumer knowledge about halal services and Sharia-friendly hospitals increases patient preference and loyalty. Research by Rashid et al. (2024) also supports the notion that health workers' knowledge of Sharia programs influences their attitudes and service practices. This result indicates that, from both the user's and service provider's perspectives, knowledge is a key factor in shaping the preferences and service quality of Islamic hospitals. This finding aligns with the theory of consumer behavior, which suggests that the deeper a consumer's knowledge, the more it will influence decision-making in accordance with personal needs and preferences.

Tabel 6. Tabel Path Coefficient & Test of Intervening Effect

Hypothesis	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values	Decisions
Knowledge → Preferences	0,179	0,191	0,09	1,996	0,048	Accepted
Perception → Preference	0,575	0,562	0,077	7,454	0,000	Accepted
Knowledge → Intentions	-0,053	-0,038	0,093	0,568	0,571	Rejected
Perception → Intentions	0,272	0,258	0,109	2,494	0,014	Accepted
Preferences → Intentions	0,629	0,64	0,076	8,311	0,000	Accepted
Knowledge → Preferences → Intentions	0,113	0,12	0,054	2,07	0,041	Accepted
Perception → Preferences → Intentions	0,362	0,361	0,074	4,865	0,000	Accepted

Source: SmartPLS, data processed.

This study demonstrates that community perceptions also have a positive influence on preferences. These results align with those of Rahman et al. (2021), who found that positive perceptions of Sharia services contribute to patient loyalty and satisfaction. Wardaningsih and Oktariza (2021) also confirmed that positive perceptions of nurse

behavior in accordance with Islamic values increase patient trust. In the Indonesian context, a KNEKS study by Windasari et al. (2021) and Firdaus and Nafik (2018) reveals that the perception of sharia aspects in health services is a significant determinant in shaping people's preferences. This result suggests that positive perceptions of Islamic hospitals, including confidence in service quality and adherence to Sharia principles, positively influence people's preferences. This result underscores the importance of good perceptions in attracting people to choose sharia-based services.

The results of hypothesis testing show that knowledge does not affect intentions. The findings of this study align with those of Rochmiati et al. (2021), which suggest that knowledge and religiosity do not have a significant impact on patient interest or decisions regarding the choice of Islamic hospitals. The results show that knowledge does not have a significant influence on public intention to use Islamic hospitals directly. This suggests that although people are aware of Islamic hospitals, it does not directly influence their intention to use them. Other factors, such as perception and preference, are more significant mediators in forming intention. This study suggests that although people are aware of Islamic hospitals, their use does not necessarily follow from this awareness. Other factors, such as perception and preference, appear to be more significant mediators in forming intentions.

Furthermore, the public's perception of Islamic hospitals has been proven to have a significant influence on their intentions for using them. This finding aligns with Rahman et al. (2021), which demonstrates that positive perceptions of Sharia services lead to increased patient loyalty and satisfaction. Wardaningsih & Oktariza (2021) also found that perceptions of Islamic nursing behavior have an impact on patient satisfaction and interest. In addition, Ardian et al. (2023) asserted that the application of sharia values in health services contributes to increasing public interest in sharia services. This finding suggests that positive perceptions of Islamic hospitals, including trust in sharia-compliant services, medical quality, and adherence to Islamic ethics, can encourage people to be interested in utilizing these services.

The people's preferences for Islamic hospitals significantly influence their intentions to use them. This finding aligns with Rahman et al. (2021), who state that preferences formed from positive perceptions of Sharia compliance and service quality encourage loyalty and intention to reuse Islamic hospital services. In addition, Firdaus and Nafik (2018) also found that the sharia values on which preferences are based contribute significantly to patients' intention to choose these services. Thus, preference is proven to be a strong determinant of behavioral intention. These results suggest that preferences formed from positive knowledge and perceptions play a significant role in increasing people's interest. In other words, when people prefer Islamic hospitals, their interest in using these services also increases.

The results of testing the intervening effect show that knowledge affects intentions through preference. The results of this study align with those of Wilda et al. (2024), which show that knowledge increases the decision to use Islamic hospitals through aspects of attitude and preference. In addition, these results are reinforced by previous findings,

which confirm that intention or interest can be formed through the mediation path of knowledge and attitude (Eid et al., 2024; Mafabi et al., 2017). Preference acts as a mediator between knowledge and interest, implying that knowledge does not directly influence interest; instead, knowledge can influence preference, which then increases people's interest in the subject. Preference serves as an important link that converts knowledge into a genuine interest in using Islamic hospitals.

In addition, the results of testing other intervening effects show that perception affects intentions through preference, which is indicated by the calculated t value of 4.865, greater than the t table ($4.865 < 1.989$), and with a p -value of $0.000 < 0.05$. This study aligns with Rahman et al. (2021), which demonstrates that perceptions of Islamic service quality influence intention through satisfaction as a mediating variable. Rasyidah et al. (2024) also demonstrate that people's perceptions of Sharia services shape their preferences, which in turn trigger interest in Islamic hospitals. Similar results indicate that perceptions of Sharia service standards influence loyalty through attitudes and preferences (Ngatindriatun et al., 2024). Preference is also proven to mediate the relationship between perception and intentions. The positive perceptions that people have towards Islamic hospitals influence their preferences, which then drive interest in using the service. This result confirms that good perceptions need to be managed to strengthen people's preferences, thereby increasing their interest. The results show that both knowledge and perceptions play a significant role in shaping people's preferences towards Islamic hospitals. The preference has a significant impact on people's intentions, both directly and as a mediator in the relationship between knowledge and perception of intentions.

CONCLUSION

This research aims to analyze the influence of knowledge and perception on intentions, as well as the role of preference as a mediating variable in shaping people's intentions for using sharia hospitals, contributing to the development of the halal industrial ecosystem in Indonesia. The results of this study indicate that knowledge and perception have a significant impact on people's preferences for Sharia hospitals. A good understanding of services and Sharia principles increases people's preferences, while positive perceptions, especially regarding service quality and conformity with Sharia principles, also strengthen these preferences. However, knowledge does not directly influence intentions; instead, it influences them through preferences. This study confirms that preference has become a mediator variable that encourages people's intentions to use Sharia hospitals. Overall, these factors interact with one another to shape public intentions regarding sharia hospital services.

Theoretically, this research contributes to the literature on halal industry and health services by providing empirical evidence on the role of consumer knowledge, perception, and preference in shaping behavioral intention. Practically, the results underscore the importance of public education programs, reputation management, and targeted marketing strategies in enhancing the attractiveness of shariah hospitals. Shariah hospitals' management should strengthen positive perceptions through testimonials, certification disclosure, and

involvement of religious authorities, while designing marketing campaigns that emphasize the unique value of sharia-based services.

This study is limited to four primary constructs: knowledge, perception, preference, and intention. Future research could expand the sample size, include more diverse demographic profiles, conduct longitudinal studies, and extend the model by incorporating additional variables such as trust, satisfaction, religiosity, or perceived value, which may provide a deeper explanation of public behaviors toward Islamic hospitals.

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Countries	2010	2020
ASEAN Countries		
Indonesia	5,814 (71)	5,54 (71)
Malaysia	6,608 (36)	6,62 (36)
Thailand	6,436 (42)	5,96 (50)
Filipina	6,403(44)	5,71 (63)
Singapura	7,719 (11)	8,00 (6)
Vietnam	6,080 (61)	5,64 (68)

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