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REALIZING THE SDGS THROUGH THE DEVELOPMENT OF ISLAMIC FINANCE: ITS IMPACT ON ENVIRONMENTAL QUALITY, ECONOMIC GROWTH, AND POPULATION IN ALL PROVINCES OF INDONESIA

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ABSTRACT

Indonesia faces significant challenges in achieving sustainable development, amidst increasing air pollution, social inequality, and the need to improve public welfare. In efforts to optimize Islamic Financial Development (IFD) as an instrument to support the Sustainable Development Goals (SDGs), this study aims to explore its impact on Environmental Quality (EQ), Economic Growth (GDP), and Population (POP) across all provinces in Indonesia. Using the Panel Vector Error Correction Model (PVECM), the study finds that IFD has a negative effect on air quality (EQ), although this impact is not significant in both the short and long term. On the other hand, economic growth (GDP) shows a significant negative impact on environmental quality, with an increase in GDP contributing to a reduction in air pollution. Meanwhile, population (POP) has a significant negative impact on environmental quality, meaning that although an increase in population may worsen air quality, proper environmental policies can mitigate its negative effects. The findings of this study suggest that the integration of the Islamic finance sector with effective environmental policies is crucial for accelerating the achievement of SDGs in Indonesia, with attention to the specific characteristics of different regions.

Keywords: *Islamic Financial Development, Environmental Quality, Economic Growth, Population, SDGs*

INTRODUCTION

Sustainable Development Goals (SDGs) are a global agenda adopted by the United Nations to encourage development that integrates economic, social, and environmental aspects. The SDGs have 17 main goals, including poverty alleviation, improved health and education, reduction of inequality, and environmental conservation (Rive & Rübbelke, 2010; Trimulato et al., 2021). This agenda aims to ensure the sustainability of human life on earth by maintaining a balance between economic progress, social welfare, and environmental sustainability (Hansson et al., 2019). As one of the financial instruments based on sharia principles, Islamic finance has great potential in supporting the achievement of the SDGs. In contrast to the conventional financial system that often focuses on profitability, Islamic finance prioritizes the principles of justice, sustainability, and social responsibility (Fitriansyah & Huda, 2023). With principles such as the prohibition of usury, gharar, and investment in sectors that are detrimental to society, Islamic finance can be an effective tool for sustainable development (Pokhrel, 2024).

The concept of the Sustainable Development Goals (SDGs) was ratified and introduced at the United Nations (UN) general assembly on September 25, 2015 in the United States. The SDGs include seventeen (17) goals and focus on global development. For developed countries, the SDGs are used to reduce inequality, consumption, and excessive production (Candra Ningluthfi & Arif Nurohman, 2024). Meanwhile, for developing countries, the SDGs are an effort to reduce poverty levels and improve the quality of health, education, protection of marine and forest ecosystems, sanitation, and

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the availability of drinking water. Before the SDGs were formulated, countries in the world had agreed on the importance of financing as the key to the successful implementation of sustainable development around the world, both in developing and developed countries (Subarsono, 2017). This commitment is contained in *the Addis Ababa Action Agenda* (AAAA) published in July 2015 at the Third International Conference on Financing for Development held by the United Nations. This agenda was attended by 174 countries and private institutions such as development banks, UN organizations, economic commissions, and non-governmental organizations (Tok et al., 2022).

Environment-based economic growth or now known as green economic growth has become a concern for many countries in the world. The commitment to environmentally based economic development is contained in the 2015 Paris Agreement, which is an agreement to protect and conserve natural resources and reduce the negative impacts of climate change. The realization of this green economy requires large funding, especially for renewable energy projects (Suhandi, 2023). This funding issue then encourages stakeholders to create financial instruments that focus on funding projects that are in line with Environmental, Social, and Governance (ESG) principles and the achievement of the Sustainable Development Goals (SDGs) (Suhandi, 2023). Islamic finance, through instruments such as green sukuk and productive waqf, has the potential to fund projects that focus on environmental conservation, sustainable natural resource management, and carbon emission reduction (Muhmad et al., 2021).

In Indonesia, green sukuk has been used to fund projects that support climate resilience, renewable energy, and waste management (Raja et al., 2021). The impact is better environmental quality and reduced disaster risk due to climate change. In addition to supporting environmental quality, Islamic finance also has the potential to encourage economic growth in various provinces in Indonesia (Muhmad et al., 2021). With the principle of risk sharing and prohibition against speculation, investment in Islamic finance tends to be more stable and sustainable. This has a positive impact on local economic stability, opens jobs, and encourages investment in productive sectors (Risanti et al., 2020). Development driven by Islamic finance can have an effect on the quality of life of the population. Investment in the education, health, and other social infrastructure sectors through waqf funds, for example, can improve people's quality of life and support healthier and more prosperous population growth (Aminudin & Hadiningrum, 2019). Islamic finance can also help overcome economic inequality that exists in several regions, especially in disadvantaged provinces in Indonesia (Pratama et al., 2022).

One of the prominent Islamic financial instruments in supporting the SDGs is green sukuk. This sukuk aims to fund projects that support environmental sustainability, such as renewable energy and waste management (Santoso, 2020). In Indonesia, green sukuk has contributed to several major projects that have a direct impact on reducing carbon emissions and improving environmental quality (Barrera-Heredia et al., 2024). Green sukuk is a breakthrough financial instrument proposed in accordance with Islamic law as a response to the increasingly certain development of the green economy (Santoso, 2020). The proceeds from the sale of green sukuk will later be allocated to finance projects that fall into the predetermined green sector category. Based on guidance from the Indonesian government, several projects that are categorized as green include: *energy efficiency and renewable energy, green building green tourism, disaster risk education, sustainable transport, waste to energy and waste management, sustainable management of natural resources and sustainable agriculture.* In addition to showing the government's

commitment, this green sukuk is an instrument that provides Indonesia's support for the expansion of *the green bond* and *green* sukuk market both domestically and internationally, especially in the Southeast Asian region (Patel et al., 2017). Therefore, Indonesia is proud of the efforts that have been made towards a low-carbon development transition. The potential of the green sukuk domestic market can be reviewed from the development of Retail Sukuk and Savings Sukuk investors, showing positive developments (Patel et al., 2017).

In the context of its use, the proceeds from the issuance of green sukuk are exclusively used to finance or refinance expenses directly related to "*Eligible Green Projects*." The Green Project criteria refer to the Green Bond Principles, which are projects that support the transition to low-emission economic growth and resilience to climate change (Perry et al., 2021). The results of this publication will be used to fund projects in five sectors, namely climate change resilience for disaster-prone areas, sustainable transportation, energy and waste management, sustainable agriculture, and renewable energy spread across various ministries or institutions (Yulianto & Guratan Djermor, 2018). In this case, the government uses the green framework as a benchmark in allocating green sukuk financing for green projects that support the transition to low emissions, economic resilience growth, and climate. The nine sectors covered by the green framework are renewable energy, sustainable transportation, sustainable natural resource management, green tourism, sustainable agriculture, waste and energy management, energy efficiency, and resilience to the impacts of climate change (Perry et al., 2021).

In Indonesia, the government through the Ministry of Finance has issued three series of green bond instruments with a green sukuk structure. Green sukuk is a green bond instrument issued in accordance with Islamic Sharia principles (IIN, 2023). The first green sukuk was a global sukuk issued in 2018 worth USD 1.25 billion. In November 2019, retail green sukuk was again issued through the ST-006 series. Specifically, this sukuk is only targeted for sales to domestic retail investors in the territory of the Unitary State of the Republic of Indonesia (Yulianto & Guratan Djermor, 2018). This issuance managed to absorb funds of IDR 1.4 trillion and was dominated by investors from millennials. One of the main goals of the SDGs is poverty alleviation. Islamic finance can play a role in this through a microfinance system that focuses on the underprivileged. By providing fair and interest-free financing, Islamic finance is able to increase people's access to business capital and encourage microeconomic growth (Vira Prajna Cantika et al., 2022).

Poverty is a macroeconomic problem that is a concern for all countries, both developed and developing countries (Economics et al., n.d.). Poverty is a complex problem that must be overcome immediately. Indonesia is one of the countries that focuses on overcoming poverty by combining economic growth and development (Ekonomi et al., n.d.). Judging from the data from the Central Statistics Agency, the number of the percentage of poor people in Indonesia increased in the September 2020 period. The percentage of poor people in Indonesia is 10.19%, an increase of 0.41% when compared to data in March 2020 and an increase of 0.97 percentage points compared to September 2019 (Candra & Arif, 2024). The number of poor people as of September 2020 is 27.55 million people, where this figure has increased by 1.13 million people compared to March 2020 data. The increase in the number of poor people in Indonesia is influenced by the COVID-19 pandemic that shocked the world (Goma, 2021).

The 2023 World Air Quality Report published by IQAir shows that air quality in different cities around the world varies significantly (Hansson et al., 2019). Lahore,

Pakistan, topped the rankings with a very high Air Quality Index (AQI) of 609, making it the city with the worst air quality in the world. It was followed by Delhi, India, with AQI 412, and Baghdad, Iraq, with AQI 160. Other cities such as Dhaka, Kolkata, and Sarajevo also recorded AQI figures indicating unhealthy air conditions (Hansson et al., 2019) Overall, many cities in South Asia and the Middle East face serious challenges related to air pollution.

Green sukuk is one of the important financial instruments in supporting sustainable projects to improve environmental quality (Al-Silefanee et al., 2022). In Indonesia, the government has issued several series of green sukuk to fund projects that meet the criteria of "Green Projects." These projects include renewable energy, waste management, and sustainable transportation (Beisheim & Simon, 2018). With this green sukuk, it is hoped that it can encourage more environmentally friendly economic development and help countries achieve the Sustainable Development Goals (SDGs), especially in terms of poverty alleviation and improving people's quality of life.

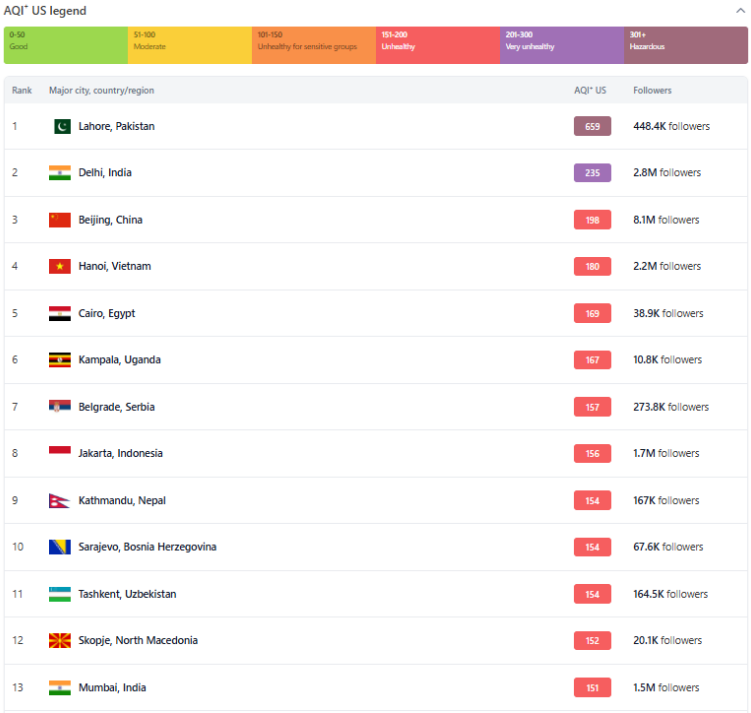

Figure 1. Air Quality in the World
Source: International Air Quality, 2024

Global air quality is an important issue that affects public health, the environment, and climate change. IQAir's 2023 World Air Quality Report provides a comprehensive overview of the air quality status in cities around the world. In this report, the Air Quality Index (AQI) is used to measure air pollution levels, with higher numbers indicating poorer air quality (Beisheim & Simon, 2018). Based on data from IQAir, some of the cities with the worst air quality include Lahore, Pakistan, with an AQI of 609, followed by Delhi, India (AQI 412), and Baghdad, Iraq (AQI 160). These cities present serious challenges when it comes to air pollution that can negatively impact the health of their residents (Beisheim & Simon, 2018). On the other hand, cities like Vancouver, Canada, and some cities in Europe are showing better air quality with a much lower AQI. Efforts to improve air quality involve various strategies, including reducing emissions from transportation and industry, increasing the use of renewable energy, and public policies that support

environmental sustainability (Humaida et al., 2020). By understanding this data, governments and communities can take the necessary steps to address air pollution problems and improve quality of life.

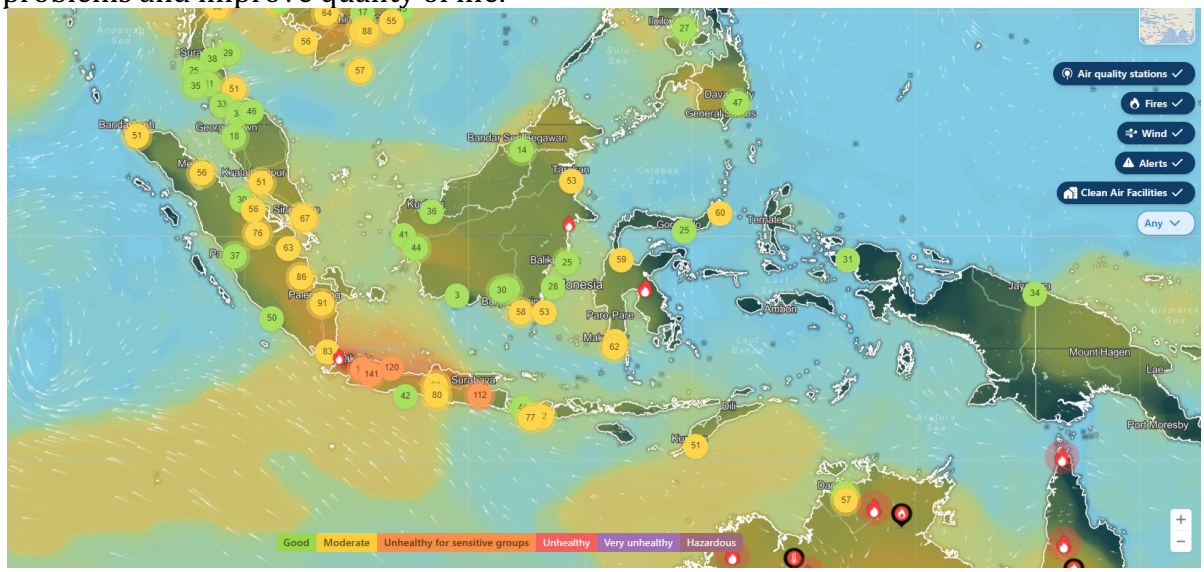

Figure 2. Air Quality in Indonesia
Source: International Air Quality, 2024

The phenomenon of air quality in Indonesia has become an increasingly urgent problem, with a number of major cities such as Jakarta, Bandung, and Surabaya recording very high levels of air pollution. Data shows that Jakarta is ranked 9th in the world in terms of poor air quality, with AQI (Air Quality Index) often in the unhealthy to dangerous category (AQI >150) (Maulidiyah & Auwalin, 2021). These cities, driven by rapid population growth and intensive economic activity, experienced a significant increase in air pollution, especially as a result of motor vehicles, fossil burning, as well as rapidly growing industries. This adds to Indonesia's challenges in achieving the Sustainable Development Goals (SDGs), especially in terms of maintaining environmental quality. Although various environmentally friendly policies have begun to be implemented, rapid economic growth and rapid urbanization in various provinces such as West Java and DKI Jakarta have actually worsened air quality, making this problem even more complex (Barrera-Heredia et al., 2024). Therefore, this study aims to explore how the development of Islamic finance, with instruments such as zakat, waqf, and green sukuk, can play a role in supporting environmental quality management in Indonesia, in order to achieve a more sustainable SDGs.

Various efforts have been designed and realized by the government to reduce poverty in Indonesia, in the SDGs it is also stated *that no poverty* or no poverty is the top priority to eliminate poverty in any form throughout the world, including Indonesia. (Al-Silefanee et al., 2022)One of them is to form a Sharia Financial Institution. Where Islamic Financial Institutions are a banking system whose implementation is based on Islamic law (sharia). In this case, Islamic financial institutions are needed to operationalize functions related to money (Patel et al., 2017). Community Sharia Financial Institutions can help regulate the economic system in the field of industry and trade which is based on the concept of morality and divinity and relies on the teachings of halal, good, honest, trustworthy, mutual love and brotherhood. The success of Islamic finance in supporting the SDGs also requires synergy between the government and the private sector (Candra Ningluthfi & Arif Nurohman, 2024). This cooperation can be in the form of joint financing

for infrastructure projects or collaboration in the development of Islamic financial products that support the environment. Non-governmental institutions, such as zakat and waqf institutions, also have an important role in managing sharia funds to support the SDGs. With transparent and accountable management systems, these institutions can have a significant impact on community welfare and environmental sustainability (Allen et al., 2018).

The main problem faced in this study is the high level of air pollution in Indonesia, which is getting worse along with population growth, urbanization, and the expansion of economic sectors. This phenomenon demands serious attention, because poor environmental quality risks hindering the achievement of the Sustainable Development Goals (SDGs), especially related to a healthy and sustainable environment. The urgency of this research is even more real, considering that despite various environmental policies that have been implemented, the impact of air pollution is still very significant, especially in big cities such as Jakarta and Surabaya. The novelty of this research lies in the innovative approach in connecting the development of Islamic finance with efforts to improve environmental quality, which is expected to be an alternative solution in facing existing environmental challenges. The purpose of this study is to analyze the contribution of Islamic finance to environmental quality, population, and economic growth, with a focus on sustainable resource management, to create a healthier and more harmonious future for the people of Indonesia.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Sharia Finance Development and Environmental Quality

Islamic Financial *Development* plays a crucial role in shaping a financial system that focuses not only on economic benefits, but also on environmental sustainability. Based on sharia principles that avoid practices such as riba and excessive speculation, IFD encourages more ethical and responsible investment, including financing environmentally friendly sectors such as renewable energy (Maulidiyah & Auwalin, 2021; Muhmad et al., 2021). This is in line with the theory of sustainable development which states that ethical-based finance can support environmentally friendly projects, reducing negative impacts on air quality and pollution (Alam et al., 2015). Research by Tretter et al., (2018) and Iskandar et al., (2020) reinforces this, by showing that countries with developing Islamic finance sectors have lower carbon emissions, compared to countries that rely on conventional financial systems, proving that IFDs can be a catalyst for green and sustainability initiatives (Iskandar et al., 2020).

Furthermore, as the Islamic finance sector develops, there is a greater opportunity to support environmentally friendly financing that can reduce air pollution and improve environmental quality (Abduh et al., 2022). With the principle of al-mashlahah (public benefit) in the Islamic financial system, IFD encourages transparency and reduces speculation that damages the environment (Raja et al., 2021). Islamic finance creates a more responsible investment ecosystem, which directly supports sustainable development. Therefore, the negative direction found in this study suggests that IFD has the potential to lower air pollution levels and improve environmental quality. Based on these findings and taking into account previous theories and research, the researcher formulated the following hypotheses:

H1: The development of Sharia Finance has a significant negative impact on the quality of the environment in the short and long term.

Economic Growth and Environmental Quality

Economic growth often goes hand in hand with increased air pollution, which is one of the biggest challenges for the environment. In many cases, as a country experiences a surge in GDP, industrial sectors that rely on fossil fuels, high energy use, and transportation activities increase rapidly, resulting in more pollution emissions (Grossman & Krueger, 1995). As predicted by the *Environmental Kuznets Curve* (EKC) theory, in the early phase of economic growth, air quality actually deteriorates due to massive exploitation of natural resources and unsustainable economic activities (Omri et al., 2015). This is clearly reflected in many developing countries, including Indonesia, where economic growth is not always accompanied by adequate awareness of the importance of maintaining air quality (Cole & Elliott, 2003; Shafik & Bandyopadhyay, 1992). Thus, despite the increase in GDP, air pollution has also experienced a significant increase, which indicates the negative impact of economic growth on the environment.

As a real example, Jakarta, which is recorded as one of the cities with the highest levels of air pollution in the world, illustrates the direct impact of this relationship. Jakarta, which ranks eighth highest in global air pollution, experienced a decline in air quality despite its economic growth continuing to expand (Iskandar et al., 2020). The city's economic growth, driven by increased industry and motor vehicles, has turned out to exacerbate air pollution that damages the quality of the environment and the health of its residents (Al-Silefanee et al., 2022). This shows that although economic activities are growing rapidly, without proper regulation and high environmental awareness, an increase in GDP can actually contribute to an increase in air pollution (Surya et al., 2021). This phenomenon highlights the importance of paying attention to environmental impacts in long-term economic planning. Therefore, the researcher formulates the following hypothesis:

H2: Economic Growth has a significant positive impact on Environmental Quality in the short and long term.

Population and Environmental Quality

In the midst of rapid urbanization and population growth, major provinces in Indonesia such as West Java, DKI Jakarta, and Banten face major challenges in maintaining environmental quality. West Java, with more than 50 million people, DKI Jakarta with more than 10 million people, and Banten, which recorded more than 12 million people, are areas with very rapid population growth (Central Statistics Agency, 2024). This increase in population triggered a surge in energy consumption, the use of motor vehicles, and an intense industrial expansion, which directly impacted air quality (Weber & Sciubba, 2019). The Malthusian theory explains that population growth is directly related to greater exploitation of resources, which ultimately increases air pollution (T. R. Malthus & Winch, 1992). In DKI Jakarta, for example, the density of motorized vehicles that increases along with the increase in population further worsens the air quality which has been recorded as one of the worst in the world (Dimnwobi et al., 2021).

Various environmentally friendly policies are implemented, the very fast population growth in these areas still has a significant impact on environmental quality (Khan et al., 2021). In West Java and Banten, the rapid urbanization has resulted in an increase in demand for energy, residential space, and other natural resources. Despite efforts to integrate green technologies and reduce pollution, the rapid rate of population growth continues to put a strain on existing infrastructure and environmental management. Previous research has also noted that in developing countries such as

Indonesia, population increases often worsen environmental quality due to the inability to manage effectively (Neumayer, 2006). Therefore, this study formulates the hypothesis:

H3: Populations significantly positively impact Environmental Quality in the short and long term.

RESEARCH METHODS

This study is quantitative and uses panel data covering 34 provinces in Indonesia from 2013-2023 with a total data sample of 374 samples. The data analyzed consisted of several main variables, namely Environmental Quality (EQ), Sharia Financial Development (IFD), Economic Growth (GDP), and Population (POP). Environmental Quality is measured by an air quality index in percentage (%) and obtained from the Central Statistics Agency (BPS). Sharia Finance Development (IFD) is proxied through sharia financing in billions of IDR, sourced from the Financial Services Authority (OJK). The Economic Growth (GDP) variable is represented by Gross Domestic Product at constant prices, and this data is also taken from BPS to provide an overview of economic activity in each province. Meanwhile, the Population variable (POP) is measured in thousands of people, also sourced from BPS, reflecting population size as an important factor in socio-economic analysis.

Table 1. Variables and Measurements

Variable	Measurement	Source
Environmental Quality (EQ)	Air quality index (%)	BPS
Islamic Finance Development (IFD)	Sharia Financing (Miliar IDR)	OJK
Economic Growth (GDP)	PDB (Constant price)	BPS
Population (POP)	In thousands of lives	BPS

Source: Secondary data processed by the author

This study adopts the *Panel Vector Error Correction Model* (PVECM) as an ideal approach to analyze non-stationary time sequence data, with the ability to uncover long-term relationships and short-term dynamics between variables.

$$EQ = \alpha_0 + \alpha_1 IFD_{\,t-1} + \alpha_2 GDP_{t-i} + \alpha_3 POP_{t-i} + \varepsilon t \quad (1)$$

$$\Delta EQ = \beta_0 + \sum_{i=t}^{m} \beta_{1i}\, \Delta IFD_{\,t-1} + \sum_{i=1}^{m} \beta_{2i}\, \Delta GDP_{t-i} + \sum_{i=1}^{m} \beta_{3i}\, \Delta POP_{t-i} + \lambda 1 ECT_{t-i} + \varepsilon t \quad (2)$$

In this model, the first equation describes the long-term relationship through the constant α0 and the α1-α2 coefficient describing the relationship between independent variables, while εt indicates the error term*. The second equation leads to short-term dynamics with* the *coefficients* β1-β2 and *the Error Correction Term* (ECT) λ1, which indicates the speed of adjustment towards balance after a disturbance. To ensure that the data meets the stationery assumptions, an *Augmented Dickey Fuller* (ADF) test was carried out to check for the presence of a root unit. If unstationarity is found, differentencing is carried out until the data becomes stationary (Engle & Granger, 1987; Widarjono, 2018). Selection of optimal lag length using *the Akaike Information Criterion* (AIC) and *Schwarz Bayesian Criterion* (SBC) helps ensure the accuracy of the model (Akaike, 1974; Schwarz, 1978). while the stability test of the model ensures the reliability of the results in the long term through the analysis of the nominal root modulus value (Widarjono, 2018). A model is considered stable if it has a modulus value less than 1, which signifies a solid and reliable relationship.

Furthermore, the cointegration test using *the Johansen Cointegration Test* was carried out to prove the existence of a long-term relationship between the variables in the model, with the accepted cointegration if the *trace statistic value* was greater than

the critical value at the significance level of 5% (Johansen, 1991; Widarjono, 2018). Furthermore, to assess the causality relationship between variables, Granger's causality test was carried out (Engle & Granger, 1987; Widarjono, 2018). *The Impulse Response Function* (IRF) serves to describe how shocks in one variable can affect other variables, while *Variance Decomposition* Analysis measures the relative contribution of independent variables to variations in environmental quality prediction (Widarjono, 2018). Finally, the *Variance Decomposition Test* estimates the percentage of variance contribution of each variable to changes in other variables in the PVECM system, providing a comprehensive overview of the dynamics and influences between variables in the model (Widarjono, 2018).

RESEARCH RESULTS

Descriptive Statistics

The descriptive statistics in Table 2 reveal inequality in four main indicators, namely Environmental Quality (EQ), Sharia Financial Development (IFD), Gross Domestic Product (GDP), and Population (POP) in various regions of Indonesia. Environmental quality (EQ), measured through the air quality index, had an average of 86.72, with the highest score of 96.94 recorded in DKI Jakarta and the lowest 41.51 in Papua. This disparity indicates that regions such as Papua may face more serious environmental challenges compared to Jakarta, which has better access to environmental management infrastructure and technology.

Table 2. Descriptive Statistics

	EQ	IFD	GDP	POP
Mean	86.71532	261.5870	11.73124	7777.462
Median	89.09500	135.0540	11.68946	4055.900
Maximum	96.94000	1450.000	14.53358	49860.30
Minimum	41.51000	0.000000	5.164786	641.9000
Std. Dev.	8.130913	304.9458	1.376949	10950.14
Observations	374	374	374	374

Sumber: Data sekunder yang dikerjakan oleh penulis menggunakan EViews 12, 2024

In the Sharia Financial Development (IFD) variable, the average was recorded at IDR 261.59 billion. The highest value of IDR 1,450 billion is found in West Java, which indicates the high level of Islamic financial activity in the region, while regions such as Papua recorded the lowest value, which is 0. This indicates that there is a gap in access to and use of Islamic financial services in Indonesia, which may be influenced by differences in economy, population, and financial needs. In terms of GDP, DKI Jakarta recorded the highest figure of 14.53 billion IDR, while Papua recorded the lowest figure of 5.16 billion IDR, reflecting significant differences in economic activity between regions. In terms of population, DKI Jakarta has the highest number of 49,860.3 thousand people, while Papua has the lowest population of 641.9 thousand people. These inequalities highlight the importance of more inclusive policy planning to ensure equitable distribution of welfare across Indonesia, especially in underdeveloped areas such as Papua.

Stationary Test: ADF Test

Table 3. ADF Test

Variables	Augmented Dickey Fuller (ADF)	
	LEVEL	1st difference
EQ	0.0000*	0.0000*
IFD	0.6796	0.0070*
GDP	0.1318	0.0000*
POP	0.9961	0.0011*

Prob value, 5% significance level
Source: Secondary data worked by the author using EViews 12, 2024

Based on Table 3, the results of the stationarity test using Augmented Dickey-Fuller (ADF) showed a variation in characteristics at the level level among the variables in this study. Only the Environmental Quality (EQ) variable is stationary at the level level with a p-value of 0.0000, which is significantly below the 5% significance level. Meanwhile, the variables of Sharia Financial Development (IFD), Gross Domestic Product (GDP), and Population (POP) are not stationary at the level level because they have p-values greater than 0.05, respectively of 0.6796, 0.1318, and 0.9961. This shows that the three variables require further differentiation to meet the stationery assumption.

After the first differentiation, all variables, including IFD, GDP, and POP, became stationary with a p-value below 0.05. This suggests that the first differentiation process successfully addresses the problem of astationality at the level, allowing all variables to meet the stationarity assumptions necessary for further econometric analysis. These results indicate that the variables in this study, especially IFD, GDP, and POP, need to be analyzed in the form of first differentiation so that the results of the model analysis are valid and reliable.

Optimal Lag Test Results

Based on Table 4, the optimal lag test shows that lag 2 is the best choice for this model. This can be seen from the Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn (HQ) scores, all of which reached the lowest scores in lag 2 compared to other lags. An FPE value of 1.76×1010 in lag 2 indicates the lowest prediction error rate, while an AIC value of 34.94090, SC of 35.41814, and HQ of 35.13250 also supports this lag selection. With lag 2 as the optimal choice, the model can predict data more accurately and efficiently, so it is expected to be able to describe variable dynamics more reliably in advanced analysis.

Table 4. Optimal Lag Test Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4849.148	NA	3.70e+10	35.68491	35.73794	35.70620
1	-4756.738	181.4227	2.11e+10	35.12307	35.38820*	35.22951
2	-4715.963	78.85200*	1.76e+10*	34.94090*	35.41814	35.13250*

Source: Secondary data worked by the author using EViews 12, 2024

Stability Test

Based on Table 5, the results of the Stability Test show that all characteristic roots of the VAR model have modulus values below 1, as seen in the modulus values of 0.659520, 0.646648, and 0.547765. This indicates that the VAR model is in a stable state, which means it is reliable for long-term analysis without the risk of instability. Model stability is essential in time series data analysis because it ensures that variables in the model will not experience excessive fluctuations that could result in inaccurate prediction results.

Table 5. Stability Test Results

Root	Modulus
0.659520	0.659520
-0.086960 - 0.640774i	0.646648
-0.086960 + 0.640774i	0.646648
-0.632700	0.632700
-0.287612 - 0.466182i	0.547765
-0.287612 + 0.466182i	0.547765

0.176680 - 0.445880i	0.479609
0.176680 + 0.445880i	0.479609
-0.464593	0.464593
-0.046872 - 0.411630i	0.414290
-0.046872 + 0.411630i	0.414290
-0.377514	0.377514

Source: Secondary data worked by the author using EViews 12, 2024

Granger Causality Test

Based on Table 6, the results of the Granger Causality Test show that there is a significant relationship between the main variables. There is a two-way relationship between Gross Domestic Product (GDP) and Environmental Quality (EQ), which can be seen from the significant p-value value in both directions, namely GDP affects EQ (p-value 0.0226) and vice versa, EQ affects GDP (p-value 0.0033). This shows that there is a mutual linkage, where economic growth and environmental quality affect each other. In addition, there is a one-way relationship between GDP and Islamic Finance Development (IFD), where GDP affects IFD (p-value 0.0362), but not the other way around, indicating that economic growth plays an important role in driving Islamic finance development. On the other hand, Population (POP) was also shown to affect GDP (p-value 0.0001) without any adverse effects, suggesting that population growth contributes to economic growth, while economic growth has no direct impact on changes in population numbers.

These results show that economic and social variables interact with each other in different ways, reflecting the complexity of development dynamics that need to be considered in national policies. The reciprocal relationship between GDP and environmental quality (EQ) underscores the importance of a development approach that not only pursues economic growth but also considers environmental impacts. Meanwhile, the one-way relationship from GDP to IFD highlights the economic potential that can boost the Islamic finance sector, indicating that strong economic development can be the foundation for more inclusive financial sector growth. The one-way relationship between population and GDP also implies the importance of population management to support sustainable economic growth.

Table 6. Causality Test Results

Null Hypothesis:	**Obs**	**F-Statistics**	**Prob.**
IFD does not Granger Cause EQ	374	0.24689	0.7814
EQ does not Granger Cause IFD		0.08112	0.9221
GDP does not Granger Cause EQ	374	3.83676	0.0226*
EQ does not Granger Cause GDP		5.83845	0.0033*
POP does not Granger Cause EQ	374	2.91538	0.0557
EQ does not Granger Cause POP		0.07330	0.9293
GDP does not Granger Cause IFD	374	3.35543	0.0362*
IFD does not Granger Cause GDP		1.35344	0.2599
POP does not Granger Cause IFD	374	1.33202	0.2655
IFD does not Granger Cause POP		0.34621	0.7076
POP does not Granger Cause GDP	374	9.51233	0.0001*
GDP does not Granger Cause POP		0.52910	0.5897

Source: Secondary data worked by the author using EViews 12, 2024

Johansson co-integration test

Tabel 7. Trace Statistics

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistics**	**0.05 Critical Value**	**Prob.****
None *	0.573888	264.0089	47.85613	0.0000
At most 1 *	0.322329	107.0472	29.79707	0.0000
At most 2 *	0.120110	35.45409	15.49471	0.0000
At most 3 *	0.062676	11.90968	3.841465	0.0006

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Source: Secondary data worked by the author using EViews 12, 2024

Tabel 8. Maximum Eigenvalue

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistics**	**0.05 Critical Value**	**Prob.****
None *	0.573888	156.9617	27.58434	0.0000
At most 1 *	0.322329	71.59309	21.13162	0.0000
At most 2 *	0.120110	23.54442	14.26460	0.0013
At most 3 *	0.062676	11.90968	3.841465	0.0006

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values
Source: Secondary data worked by the author using EViews 12, 2024

Based on the results of the Johansen cointegration test shown in Table 7 and Table 8, there are four significant cointegration relationships between the variables in the model, both in the Trace and Maximum Eigenvalue tests. In the Trace test, significant cointegration statistics were found on None, At most 1, At most 2, and At most 3 with p-values of 0.0000 to 0.0006, indicating that there was a cointegration at the 5% level. Similarly, in the Maximum Eigenvalue test, significant results appeared at the same four levels of cointegration, with p-values also supporting significance at the 5% level. These findings indicate that there is a stable long-term relationship between the variables tested, where they move together towards equilibrium in the long term.

Estimation Panel Vector Error Correction Model (PVECM)

Table 9 Short-Term and Long-Term PVECM Results

Variable	Coefficient Value	T-Statistics	Information
Short-Term Results			
CointEq1	-0.982397	[-9.93356]	
D(IFD(-1)) → EQ	-0.002116	[-1.90858]	Insignificant
D(GDP(-1)) → EQ	-1.468786	[-5.72708]	Significant
D(POP(-1)) → EQ	-0.002476	[-2.48809]	Significant
Long-Term Results			
EQ	1.000000	1.000000	
IFD → EQ	-0.002944	[-1.82371]	Insignificant
GDP → EQ	-5.024478	[-10.2811]	Significant
POP → EQ	-0.003766	[-3.86687]	Significant
Note: T-table (α= 0,05) = 1.966396			

Source: Secondary data worked by the author using EViews 12, 2024

Based on the results of PVECM estimates in Table 9, the Gross Domestic Product (GDP) and Population (POP) variables show a significant influence with a negative direction on Environmental Quality (EQ) both in the short and long term. In the short term, GDP has a coefficient of -1.468786 with a t-statistic of -5.72708, while POP has a

coefficient of -0.002476 with a t-statistic of -2.48809. This negative direction indicates that an increase in GDP and population numbers is correlated with a decrease in air pollution, which means that there is a positive effect on air quality. This could imply that along with economic growth and an increase in population, more environmentally friendly policies or patterns of economic and social activity begin to be implemented, thus promoting better air quality.

In the longer term, a similar pattern is seen, with GDP and POP continuing to show a significant negative influence on environmental quality, with coefficients of -5.024478 for GDP and -0.003766 for POP, respectively. These results signify that economic growth and population growth in this context could contribute to improved environmental quality or a reduction in air pollution in the long term, perhaps as a result of increasingly implemented environmentally friendly policies or practices. On the other hand, the Sharia Financial Development (IFD) variable shows a negative but insignificant coefficient, both in the short and long term, indicating that the sector's contribution to environmental quality is still limited. This insignificance, especially in low-IFD regions such as Papua, East Nusa Tenggara, and Maluku, suggests that limited access to Islamic financial services reduces the sector's opportunities to support green initiatives and sustainable development.

Impulse Responde Function (IRF) and Forecast Error Variance Decomposition (FEVD)

Based on the results of the Impulse Response Function (IRF) presented in Figure 3, the response of each variable to innovation shows interesting and different characteristics. The D(EQ) variable, which reflects the quality of the environment, responds negatively at first to innovation before achieving stability in the long term, reflecting adaptation to external changes. The D variable (IFD) showed a significant initial response but tended to stabilize after several periods, indicating an initial sensitivity to external shocks that was then offset by balancing factors. Gross Domestic Product (D(GDP)) showed a sharp spike in positive response at the beginning, which was followed by fluctuations that began to stabilize over time, showing how economic sectors can be affected by changes, but are likely to find balance. Finally, D(POP) or population gives a strong positive response at first, but also fluctuates towards stability, describing the potential for population growth that is influenced by external factors but can adjust gradually. The results of the IRF as a whole illustrate the complex adaptation dynamics of various variables, emphasizing the importance of a policy approach that pays attention to the short-term and long-term responses of various economic and social factors.

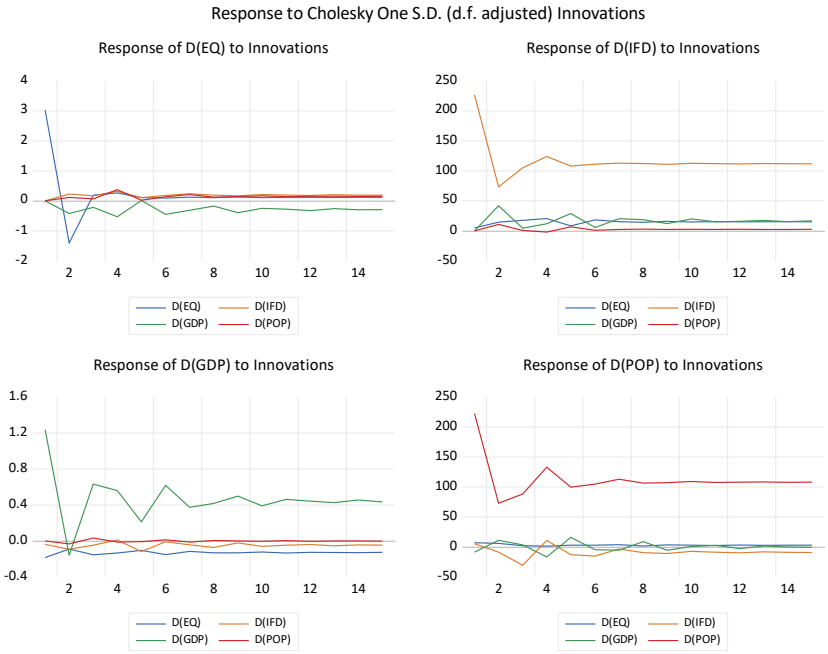

Figure 3. Impulse Responde Function (IRF)

Source: Proses EViews 12

Based on Table 10, the results of the ZIS Variance Decomposition analysis show that the variability of Environmental Quality (EQ) in the early period is almost entirely influenced by itself, which is 100% in the first period. However, as time went on, the contribution of other variables began to gradually increase in influencing EQ. In the 5th period, for example, EQ's contribution to itself decreased to 93.04%, while the contribution of other variables such as GDP and IFD increased to 4.17% and 1.59%, respectively. This trend continued until the 15th period, where the influence of EQ on itself decreased to 82.36%, while the contribution of other variables such as GDP increased significantly to 10.61%. These results show that although Environmental Quality is initially influenced by internal factors, in the long run, external variables such as economic growth (GDP) and Islamic finance (IFD) begin to have a greater influence on environmental quality. These findings reflect the importance of paying attention to economic factors in an effort to maintain sustainable environmental quality.

Tabel 10. Variance Decomposition ZIS

Variance Decomposition of D(EQ): Period	S.E.	D(EQ)	D(IFD)	D(GDP)	D(POP)
1	3.035241	100.0000	0.000000	0.000000	0.000000
2	3.378994	97.87114	0.451777	1.564260	0.112823
3	3.395972	97.21592	0.690892	1.945656	0.147529
4	3.482251	93.04337	1.492599	4.171814	1.292217
5	3.485859	92.95107	1.590398	4.164330	1.294206
6	3.522927	91.07703	1.811274	5.699339	1.412357
7	3.553298	89.65369	2.227151	6.375304	1.743858
8	3.566320	89.09583	2.492528	6.557032	1.854607
9	3.597247	87.70445	2.671520	7.642258	1.981774
10	3.617644	86.81338	2.991170	8.020318	2.175130
11	3.638092	85.94651	3.247135	8.500270	2.306090
12	3.662164	84.93177	3.448604	9.172406	2.447220
13	3.682193	84.10984	3.722924	9.568796	2.598440
14	3.704272	83.21553	3.946623	10.10897	2.728877
15	3.725651	82.36449	4.163378	10.60607	2.866059

Source: Secondary data worked by the author using EViews 12, 2024

Discussion

The Impact of Sharia Financial Development on Environmental Quality

The results of the analysis that show that Sharia Financial Development (IFD) has a negative but insignificant effect on Environmental Quality (EQ) illustrate the challenges that exist in utilizing this sector for environmental sustainability in Indonesia. Although IFDs have the potential to support green projects such as green sukuk and renewable energy financing, these results indicate that the Islamic finance sector in some Indonesian provinces is still not developed enough to have a significant impact on air quality (Heger et al., 2018). According to the theory of sustainable development, although the Islamic finance sector can play a key role in financing projects that support environmental goals, constraints such as low penetration rates of Islamic finance and limited access to environmentally friendly financial infrastructure can limit their positive impact (Alam et al., 2015). This can be explained by the low level of IFD implementation in regions such as Papua, East Nusa Tenggara, and North Kalimantan, which have limited access to the Islamic financial system and infrastructure that supports environmental initiatives.

Previous research by Mustofa, (2021) revealed that in provinces with lower levels of IFD development, as is the case in these provinces, more effective environmental policies and environmentally friendly infrastructure have not been fully optimized. These limitations inhibit IFD's potential to drive air pollution reduction and environmental quality improvement (Maulidiyah & Auwalin, 2021). In other words, while the Islamic finance sector is expected to play an important role in sustainable financing, major challenges such as regional inequality and a lack of supportive policies need to be addressed in order for a positive impact on environmental quality to be achieved across Indonesia.

Impact of Economic Growth on Environmental Quality

The results of the analysis show that economic growth, which is reflected in Gross Domestic Product (GDP), has a significant negative influence on environmental quality (EQ), which means that an increase in GDP contributes to a decrease in air pollution. This can be explained by the implementation of increasingly stringent environmental policies, as well as the increasing public and industrial awareness of the importance of environmental sustainability (Charfeddine et al., 2018). According to the *Environmental Kuznets Curve* (EKC) theory, in the early stages of economic growth, environmental quality tends to deteriorate due to intensive economic activities and exploitation of natural resources. However, as per capita income increases, there is a shift towards greener policies and the use of technologies that reduce environmental impact (Grossman & Krueger, 1995). For example, some regions with the highest GDP such as DKI Jakarta and West Java, despite facing challenges related to high air pollution, have begun to implement green technologies and emission reduction policies, such as the use of electric vehicles and the development of renewable energy (Grossman & Krueger, 1995; Shafik, 1994). This reduction in pollution can also be linked to better energy efficiency and infrastructure improvements that support better air quality management, which goes hand in hand with economic development (Febriana et al., 2019).

However, despite the decline in air pollution in some regions with high GDP, regions with low GDP, such as Papua and East Nusa Tenggara, show limitations in the application of green technology and air pollution control (Santi & Sasana, 2021). This shows that although economic growth has a positive impact on air quality in some

provinces, the gap between regions with high and low economic capacity still affects the results. In regions with lower GDP, the implementation of green technologies and pollution control regulations has not been fully effective, potentially worsening air quality if there is no adequate intervention from the government and related sectors (Usman et al., 2022). Therefore, while economic growth can have a positive impact on air quality, it is important for the government to continue to strengthen environmental policies that support pollution reduction throughout Indonesia.

Population Impact on Environmental Quality

The results of the analysis show that population growth has a negative effect on environmental quality, which means that the higher the population, the greater the potential to lower air pollution. This is because with the increasing population, governments often introduce stricter environmental policies, as well as environmentally friendly technologies that can reduce the negative impact of urbanization and industrialization growth. According to the Malthusian theory, which states that population growth will increase pressure on natural resources and cause environmental degradation (T. Malthus, 1798), governments can implement policies to reduce overexploitation of natural resources by adopting environmentally friendly technologies. For example, in areas with high population levels such as DKI Jakarta and West Java, although the population continues to grow, there has been a significant increase in efforts to reduce air pollution through initiatives such as green transportation, the construction of green spaces, and restrictions on highly polluting motor vehicles. As evidence, in some areas with denser populations and high incomes such as Jakarta and West Java, there are efforts to reduce pollution with green technology and pro-environmental policies (Alam et al., 2015; Iskandar et al., 2020).

However, Jakarta, despite being one of the most populous cities in the world, is recorded in the highest global air pollution ranking. This is due to a variety of factors, including motor vehicle density, industrial emissions, and rapid urbanization, which contribute to poor air quality. In line with the *Environmental Kuznets Curve* (EKC) theory, which states that environmental quality tends to deteriorate in the early phases of economic growth and urbanization, but can improve when per capita income increases and stricter environmental policies are implemented (Grossman & Krueger, 1995). Even so, environmentally friendly policies and technologies implemented in Jakarta have the potential to reduce air pollution. For example, with the increase in environmentally friendly public transportation, the use of electric vehicles, and waste management and urban greening projects, Jakarta is trying to reduce these negative impacts. Although Jakarta still faces major challenges, these efforts provide hope that with the right policies, air pollution can be controlled and environmental quality can be improved. Therefore, even though Jakarta has high pollution, the existence of stricter regulations and the adoption of environmentally friendly technologies suggests that the potential to reduce pollution still exists, especially when balanced with public participation and sustainable innovation (Borck & Schrauth, 2021; Shafik, 1994).

CONCLUSION

In an effort to realize sustainable development in Indonesia, Islamic finance development (IFD) has emerged as one of the potential solutions to support environmental sustainability. However, although IFD has the potential to reduce air pollution through instruments such as green sukuk and renewable energy financing, the

results of the analysis in this study show that its impact on environmental quality is still limited and insignificant. This is mainly due to the low level of IFD implementation in some provinces, such as Papua, East Nusa Tenggara, and North Kalimantan, which have limited access to the Islamic financial system and infrastructure that supports environmental initiatives. In contrast, regions with high GDP such as DKI Jakarta and West Java, despite facing air pollution challenges, have begun to implement environmentally friendly policies and technologies that have the potential to reduce negative impacts on air quality.

Based on the results of this study, it is recommended for further research to expand the scope of the analysis by including relevant additional variables, such as education, tourism sector, and poverty level. Higher education has the potential to increase public awareness of environmental conservation, while the tourism sector with its impact on natural resources can be an important factor in influencing air quality. In addition, a study of the relationship between poverty and environmental degradation will provide a clearer picture of the impact of economic inequality on air quality. Thus, this study paves the way for more effective policy models in air quality management and pollution reduction, taking into account various variables that play a role in sustainable development in Indonesia.

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