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Environmental Sustainable Development Target In Indonesia: A VECM Analysis

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ABSTRACT

Environmentally sustainable development is of utmost importance today. Amidst the global challenges of climate change and environmental degradation, Indonesia is facing an urgent situation to balance economic growth with environmental sustainability. This study examines the factors determining sustainable development targets in Indonesia using vector error correction models (VECM). This study uses economic and environmental data from 1992 to 2022 to analyze the relationship between energy consumption, urbanization, environmental policy stringency, and the environmental quality index. The tests used in this study include statistical tests, lag criterion tests, cointegration tests, VAR stability tests, and Granger causality tests. The study results indicate a long-term influence of the variables of energy consumption, urbanization, and environmental policy stringency on environmental quality. In the short term, urbanization has a significant positive effect on environmental quality in Indonesia. These findings emphasize the importance of strong environmental policy integration to mitigate environmental degradation and achieve sustainable development in Indonesia. Strategic policy recommendations for policymakers are to reduce the use of fossil fuels, switch to renewable energy, and implement a sustainable urbanization model by considering strategic urban spatial aspects.

Keywords: *Environmental Quality Index, Energy Consumption, Urbanization, environmental policy Strigency, VECM*

INTRODUCTION

Environmentally sustainable development is a major concern in balancing economic development, environmental restoration, and social welfare (Eisenmenger et al., 2020). In Indonesia, as a country rich in natural diversity, efforts to realize sustainable development are becoming increasingly urgent along with rapid economic growth. It is undeniable that the development of national welfare is closely correlated with the environment. This agenda is in line with the politics of environmentally sustainable development, which is based on the Brutland report published by the World Commission on Environment and Development (WCED) entitled Our Common Future in 1987. The report contains the world's major challenges in the future, which are based on the facts of rampant deforestation, increasing greenhouse effects, and decreasing food production (WCED, 1987). The importance of environmental protection as the main basis for realizing sustainable development is highlighted by the Global Environmental Performance Monitoring Agency, which warns that nature is under great pressure, causing climate change and damage to biodiversity (Lange, 2021). Therefore, environmental considerations must be internalized in every development decision-making process. To further understand the urgency of environmental sustainability in Indonesia, it can also be traced through the mandate of the 1945 Constitution of the Republic of Indonesia, which emphasizes the principle of environmentally aware sustainability (Keraf, 2010). Environmentally conscious development is an effort to

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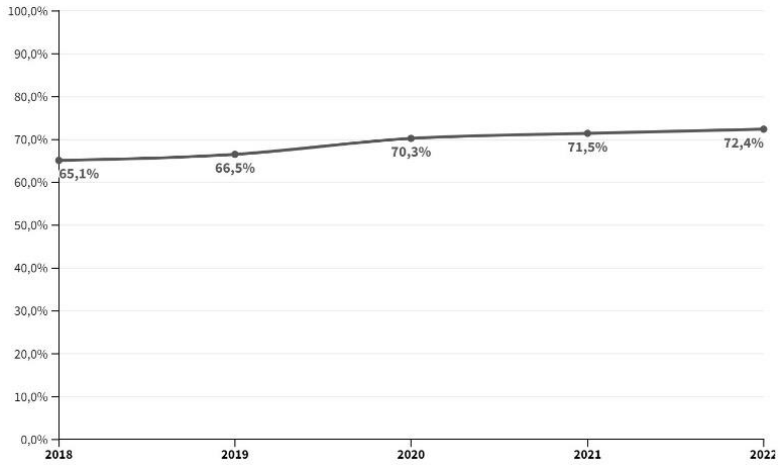
utilize and manage natural resources consciously and wisely. The concept is implemented by optimizing and coordinating various resources, both natural and human (Wahyuningsih & Husnulwati, 2021).

Various studies reveal the importance of sustainable development by paying attention to environmental aspects, such as Hao et al., (2021), show that economic development plays a central role in achieving national welfare. However, the reality of 21st-century economic development is more exploitative and causes environmental degradation and the depletion of natural capital. The crucial issue at this time is sustainable environmental development, which has become the center of many countries' policies (Sun et al., 2020). Economic growth alone is insufficient to support sustainability for future generations. Apart from the reality of modern human life today, the spirit of materialism, hedonism, and consumerism has driven economic development that is not based on the principles of justice and equity, thus simultaneously increasing the scarcity of resources and environmental problems (Ulucak, 2020). Anthropologically, environmental performance depends on human awareness of how to behave responsibly towards the environment. Therefore, the failure or success of sustainable environmental development is determined by the quality of humans and their awareness (Piwowar-Sulej, 2021).

The issue of sustainable environmental development is also inseparable from the phenomenon of the depletion of fossil fuels globally. This link provides an impetus to mitigate the impacts of climate change (Maji et al., 2019). This is inseparable from the fact that the fact that the energy consumption of every country in the hemisphere continues to increase. Ecologists assess that the consumption of non-renewable energy hurts long-term environmental sustainability. This link is very contrary to the principle of environmental sustainability (Jamel & Derbali, 2016). The results of research conducted by Armeanu et al. (2017), revealed that excessive use of energy in Africa for a long time has caused several serious problems. These problems are inseparable from the environment and have an impact on sustainable economic growth. As a result of continued dependence on the fossil fuel energy sector to meet demand, it will only cause environmental degradation (Abdouli & Hammami, 2018).

Meanwhile, along with the increasing migration of people to cities in search of better jobs, facilities, and lifestyles, urban areas around the world are growing at an unprecedented rate (Bera et al., 2023). This process is generally recognized as a multidimensional evolution, where the allocation of spatial elements has resulted in changes in economic growth models and lifestyles. It has also reshaped regional development and land use, which in turn have affected and transformed the social, economic, and natural environment (Chen et al., 2022). While this movement has paved the way for socio-economic benefits, it has also posed major challenges to environmental sustainability (Tonne et al., 2021). Urbanization has become a matter of great concern for both developed and developing countries. Urban areas, as hubs providing employment opportunities, modern facilities, and better social services, are the main factors causing drastic population concentrations (Gu, 2019). However, amidst these seismic changes, the environment often bears the brunt of the responsibility. However, urbanization is not the only enemy of sustainability. Inclusive urban planning and technology integration can transform urban sustainability efforts to stay relevant and up-to-date.



Source: GoodStats and the Ministry of Environment and Forestry

Figure 1
Indonesia's Environmental Quality Index (IKLH) Value 2018-2022

The value of Indonesia's Environmental Quality Index has continued to increase over the past five years. This shows that environmental performance has increased significantly. However, apart from other facts, the regional environmental quality index still shows gaps. This is due to differences in natural resource management and environmental policies implemented in each region. As a result, certain areas experience more severe environmental degradation than other areas (Rohman & Suryanto, 2023). Therefore, the concept of environmental sustainability according to Islam provides moral teachings and its correlation with human responsibility towards nature in an integral way (Sayem, 2023). Environmental fiqh, as a comprehensive consensus, emphasizes that the environment must achieve maqashid sharia. As the core of maqashid sharia is to maintain human welfare integrally, The benefits produced are universal and ensure sustainability as the main agenda in the future (Jajang, Nur Rianto, 2021).

Environmental ethics in Islam provide sophisticated and fair principles. The human species is seen as morally superior to non-natural elements and has the right to manage the environment as a means. The view of conservation ethics also places humans as being able to prioritize the needs of nature and emphasizes justice and the interests of many people. Human monodualism is seen as the unity of a caliph and a servant. Therefore, the caliph is determined by his ability and creativity to act toward the prosperity of natural resources (Arie, 2015). To build a country that adheres to environmental ethics, theoretical aspects are not enough to bind and provide a deterrent effect for human actions. Long before, Porter, (1999), introduced the power of environmental regulation as a factor that drives human awareness to overcome environmental degradation. Appropriate and effective environmental policies must stimulate environmentally friendly innovation (Cook, 2020). When countries around the world are frantically seeking solutions to the environmental crisis, an awareness of environmental ethics is needed that can be extrapolated to form a shared awareness. Strict environmental policies, as the main key, need to be considered as an instrument that accommodates economic and industrial practices that have an impact on the environment.

All of the problems mentioned above contribute to the current environmental quality. The state must design and implement environmental regulations that can mitigate the risk of environmental damage. According to Ahmed et al. (2022), one of the main aspects that should be considered is strict environmental policies. As is clear, no country is immune to environmental damage. To achieve sustainable development targets that are still a challenge for every country today, various efforts have been made by the government, international institutions, and other stakeholders. In the last decade, new policies have been implemented in response to the dynamics of climate change. Environmental policy stringency was created as a measure to assess the stringency of a country's specific environmental policies, developed by the OECD. This policy is defined as the extent to which environmental policies can have an explicit or implicit impact on behavior that pollutes or endangers the environment. As investigated by Martínez-Zarzoso et al. (2019), who studied the importance of EPS, stricter environmental policies result in more patents and environmentally friendly economic practices. According to Yirong (2022), EPS can mitigate the risk of environmental degradation by supporting environmentally friendly technologies and preventing inefficient technologies.

The empirical study experience above is interesting enough to be explored further through the strength of environmental policies developed by the OECD. Based on inconsistent research results, such as Yirong (2022), tightening environmental policies can reduce environmental degradation. This study recommends that countries with high pollution levels maintain strict environmental regulatory policies. While the empirical study is quite surprising, Su et al. (2023), found that the impact of tightening environmental policies was asymmetrical across quartiles. Therefore, this finding emphasizes the need to re-evaluate environmental regulations to determine how effective these policies and innovations are at reducing environmental risks and can be applied at different levels of countries.

Consideration of the facts mentioned above and the gaps in the existing literature, has motivated the author to develop a research framework for promoting sustainable environmental development in Indonesia. Furthermore, it is important to understand that the role of environmental policy cannot stand alone in realizing sustainability. Various factors must go hand in hand, such as socio-economic conditions and the level of public awareness. In addition, in the Islamic context, a holistic approach also needs to be considered. Islam teaches consensus, such as the caliphate and responsibility on earth. Therefore, the author tries to add an analysis of the Islamic approach to sustainable development in this study to provide additional academic insight in formulating environmental policies. As a form of novelty in this study, the author tries to add and analyze the impact of environmental policy strictures developed by the Organization for Economic Co-operation and Development (OECD). Thus, the combination of Islamic approach analysis with the role of environmental policy rigor is expected to provide research contributions after the novelty of making environmental protection policies, which are the main targets of sustainable development in Indonesia.

LITERATURE REVIEW

Overview of the Environmental Quality Index

The environmental quality index is a metric used to understand the performance of environmental quality in Indonesia. This indicator represents the performance of national environmental management, which can be used as information material to support the policy-making process related to environmental protection and management

(Setiawan & Primandhana, 2022). In 2020, officially, the environmental quality indicators used to calculate the IKLH consist of 4 indicators: 1) Water Quality Index (IKA), measured based on TSS, PH, DO, BOD, COD, Total Phosphate, NO3, and Fecal Coli: 2) Air Quality Index (IKU), measured based on SO2 and NO2: 3) Land Quality Index (IKL) measured based on the area of forest and shrub cover in forest areas and protected areas; and 4) Sea Water Quality Index (IKAL) measured based on TSS, DO, Oil and Fat, Total Ammonia, and Ortho-Phosphate parameters. The environmental management indicators in Indonesia (IKLH) are a combination of the concepts of the Environmental Quality Index (EQI) and the Environmental Performance Index (EPI) (Sakina, 2022). IKLH measurements start from 0-100; the higher the value, the better the environmental quality over a certain period. Referring to the regulations of the Minister of Environment and Forestry Number 27 and Forestry No. 27, it shows that the classification of environmental quality starts from (0–24), meaning very poor, (25–49) poor, (50–69) sufficient, (70–89) good, and (90–100) very good (Purnamadewi et al., 2019).

The Relationship between Energy Consumption and Environmental Quality

According to Vosooghzadeh (2020), the theory of energy consumption is sometimes also referred to as the theory of energy costs, which states that the cost of using energy resources in a business or service operation can be compensated through overall economic activity. Stern 2004), stated that energy consumption is a means to drive the industrialization of the economy as a means of accumulating development capital, either complementary or substitutional, to be able to produce output in the economy.

The discussion of energy consumption and environmental quality has also attracted the attention of researchers, starting with a review of the world's resource wealth pioneered by (Wackernagel & Rees, 1998). Realizing the limited natural resources, sustainable development has been glorified since the Kyoto Convention in 1997, as the starting point in the history of sustainable environments and emphasizes that every country needs to address problems related to the effects of greenhouse gases and global warming. This policy is in line with the steps of the World Energy Council (2019), which ranks countries based on energy synthesis policies to address environmental sustainability. Therefore, WEC lists three main policy areas that focus on productivity, efficiency of energy generation, transmission, and distribution of air quality.

The strong relationship between energy consumption and environmental quality is expressed in the environmental Kuznets curve hypothesis proposed by (Grossman & Krueger, 1991). This shows that initially, when a country's income and energy consumption increase, it will cause environmental quality to decline. According to Stern, (2014), the EKC hypothesis begins when income inequality increases, and then decreases along with economic development. In addition, emissions of various pollutants, such as carbon dioxide, sulfur, and nitrogen oxides, are closely related to energy use. Thus, EKC becomes a model of the relationship between energy use and environmental quality. This theory continues to undergo a broad transformation: if the global population controls a large area of land, this means that the environment or ecosystem can produce sufficient natural resources to support human life. As a result, environmental quality will be

threatened, and with the reduction in available natural resources, society will be in a dangerous state (Agbede et al., 2021).

The Relationship between Urbanization Consumption and Environmental Quality

The relationship between urbanization and environmental quality can be traced in the IPAT decomposition introduced by Holdren and Ehrlich (1974), where the environmental impact caused by human activities (I) is considered a product of population size (P), per capita prosperity (A), and technology (T) per unit of prosperity. The model has long-recognized limitations in empirical research. So the IPAT problem is not very accurate in its stochastic version. Then, STIRPAT Dietz dan Rosa (1997), emerged, which explained the strength of factors in understanding the relationship between human activities (population, prosperity, and application of technology). As a more complex example, population growth in certain areas often causes pressure on social services. Increasing community needs will simultaneously increase pollution and waste in the environment (Yuda & Idris, 2022).

In addition to the IPAT theory, there is also a theory put forward by Girardet (2014), about urban metabolism. In this context, the exponential growth of cities will increase the consumption of natural resources and produce a lot of waste. The distinction between population growth and changes in the scale of economic activity in urban areas increases the consumption of energy, water, and raw materials. As a result, it raises pressure on natural resources, leading to excessive exploitation. The decadence of the urbanization phenomenon that hurts the environment requires mitigation in the form of appropriate public policies to accommodate the relocation of activities from rural to urban areas (Holl & Mariotti, 2018).

Environmental Policy Stringency

The phenomenon of environmental degradation in recent years has encouraged the government to adopt more effective policies. To achieve environmentally sustainable development, countries implement environmental policies to internalize the social impacts of pollution and reduce the use of environmentally harmful technologies (Yirong, 2022). The stringency of environmental policy refers to the regulations implemented by governments or organizations to address environmental problems.

The Organization of Economic Co-operation and Development (OECD), provides statistical units relevant to environmental policy (K. Ahmed, 2020). Therefore, environmental policy rigor has become a widely used tool in analyzing environmental policies that focus on climate change and environmental mitigation policies. Measuring the stringency of environmental policies allows for an empirical evaluation of the impact of environmental policies on economic and social pollution. Methodologically, the EPS measurement model ranges from 0 (no policy). The lowest score of zero is given to observations that do not have a policy. While the remaining scores are given using the distribution of observations that have a policy, The highest score is 6 (the most stringent), which is given to observations with values above the 90th percentile for countries that implement the most stringent environmental policies (Kruse *et al*., 2022).

Countries or regions with very high levels of environmental policy stringency tend to prioritize sustainability and environmental protection, while countries with low levels

of stringency prioritize economic development or weak environmental governance systems (Wang *et al.*, 2020). Ecologist Jaffe et al. (1995), support the view that well-enforced environmental regulations will provide benefits to both the environment and companies. So that the policy will not harm competitiveness but will benefit the country through increased innovation activities and increased productivity.

RESEARCH METHODS

In this study, the analysis used is time series data regression with a period of 1992–2022, through the Vector Error Correction Models (VECM) approach. This approach is a very important tool in analyzing short-term and long-term relationships in environmental quality and can assess the consistency of empirical models with environmental theory (Jian et al., 2019). In this study, the VECM model is used to analyze the effect of energy consumption, urbanization, and environmental policy stringency on the environmental quality index in Indonesia. The VECM model analyzes time series data in the Vector Autoregressive (VAR) model, which is stationary in the first difference and meets the cointegration test (Khurshid et al., 2024). Therefore, the form of the VAR model, which has non-stationary variables, is as follows:

$Yt = \mu + \alpha 1\ yt\text{-}1 + \alpha 2\ yt\text{-}2 \ldots\ldots\ldots + \alpha_p yt\text{-}_p + \varepsilon t$ … … … (1)

From equation 1, the following VECM equation can be formed

$\Delta\ Yt = \alpha e\ t\text{-}1 + \beta 1 y\Delta\ t\text{-}1 + \beta 2 y\Delta\ t\text{-}1 + \ldots\ldots\ldots + \beta_p y\Delta\ t\text{-}_p + 1 + \varepsilon t$ (2)

The model equation in this study is:

$IKLH = \beta 0 + \beta 1 EC\ t + \beta 2 URB\ t + \beta 3 EPS + ut$ (3)

Description:

IKLH = Environmental Quality Index

EC = energy consumption

URB = urbanization

EPS = Environmental Policy Stringency

In this study, the following is a description of the variables used:

Table 1
Operational Definition of Variables

Variable	Notation	Data Proxy	Source
Environmental Quality Index	IKLH	0-100	Ministry of Environment
Energy Consumption	EC	Fossil Fuel (% of total)	World Bank
Urbanization	URB	Urban Population Growth (annual %)	World Bank
Environmental Policy Stringency	EPS	0-6	OECD

Source: Created by Author

RESULTS AND DISCUSSION

Stationary Test

Before conducting a comprehensive model test, the first stage is a stationary test based on the Augmented Dickey-Fulley test (ADF test). Table 2 shows the results of the roots test both at the level and first difference levels.

Table 2
Stationary Test Results

Variable	Level		1 Difference	
	Statistic	Prob	Statistic	Prob
Environmental Quality Index	-0.35451	0.0265	-6.960006	0.0000
Energy Consumption	-0.70773	0.8289	-7.063881	0.0000
Urbanization	-3.50509	0.0154	-4.884534	0.0005
Environmental Policy Stringency	1.31151	0.9981	-4.781266	0.0006

Source: Eviews 12 Processed

After the stationary test is carried out, it is continued with the optimal lag test using the lag order selection criteria. The results can be seen in Table 3. Table 3 shows the number of stars for each criterion. In determining the optimal lag, it is necessary to see the relationship between each variable in the system. In determining the right optimal lag, it is very important to consider the number of lags, because if it is too small, the model cannot dynamically know the relationship between the variables. If it is too long, it will cause the model to overfit and be inefficient.

Lag Criteria Selection Test

Table 3
Optimal Lag

LAG	LOGL	LR	FPE	AIC	SC	HQ
0	-222.1915	NA	69.96619	15.59941	15.78800	15.65848
1	-108.5393	188.1139*	0.084347	8.864780	9.807742*	9.160104*
2	-90.92615	24.29400	0.080999*	8.753528*	10.45086	9.285111

Source: Eviews 12 Processed

Stability Test

The next stage is a stability test. This aims to determine whether the VECM model can be forecasted using IRF and VD. The results of the VECM stability test can be seen in Table 4, with the provision that the value of each modulus is less than 1, which can be considered a stable model.

Table 4
Stability Test Results

Root	Modulus
0.271252	0.983004
0.271252	0.983004
0.969467	0.969467

0.961842	0.963574
0.961842	0.963574
0.434176	0.509740
0.434176	0.509740
0.00319	0.003190

Source: Eviews 12 Processed

Cointegration Test

A cointegration test is needed to determine whether there is a stable long-term relationship between two or more non-stationary variables in the time series model. The cointegration test is done using Johansen's cointegration test. Therefore, to determine the research model that meets the VECM requirements, the test results can be seen in Table 5 with the provision of a probability value of <0.05. So it can be concluded that there is cointegration between variables and that they are stationary at the first difference level.

Table 5
Cointegration Test Results

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob*
None *	0.888328	131.4654	47.85613	0.0000
At most 1	0.826069	74.46840	29.79707	0.0018
At most 2	0.665560	28.99192	15.49471	0.0374
At most 3	0.019580	0.514137	3.841465	0.0072

Source: Eviews 12 Processed

Granger Causality Test

The causality test in the VECM model aims to determine the direction of the causal relationship between variables in a long-term relationship. Table 6 shows the results of the causality test with the provision that if the probability value is <0.05, then there is a causal relationship, but if the probability value is >0.05, then it can be concluded that there is no causal relationship in the variable.

Table 6
Causality Test Results

Null Hypotesis	OBS	F-Statistic	Prob
URB does not Granger Cause EC	30	12.5395	0.0015***
EC does not Granger Cause URB		4.82435	0.0368
EPS does not Granger Cause EC	30	3.63030	0.0674
EC does not Granger Cause EPS		2.24374	0.1458
IKLH does not Granger Cause EC	30	1.41541	0.2445
EC does not Granger Cause IKLH		2.70000	0.1119
EPS does not Granger Cause URB	30	0.00463	0.9462
URB does not Granger Cause EPS		2.27341	0.1432

IKLH does not Granger Cause URB	30	1.28426	0.2671
URB does not Granger Cause IKLH		2.06982	0.1617
IKLH does not Granger Cause EPS	30	0.21661	0.6454
EPS does not Granger Cause IKLH		3.24523	0.0828

Source: Eviews 12 Processed

The results of the Granger causality test, as shown in Table 6, show that there is a two-way relationship between energy consumption and urbanization, or that both variables influence each other. This is evidenced by the p-value of <0.05. These results are in line with the study (Bakirtas & Akpolat, 2018).

Discussion and Regression of the VECM Model

Table 7 shows the results of the VECM test for both the long and short term. In this study, the level of significance of a variable relative to another variable is assessed at the 5% level. The results of the influence of energy consumption, urbanization, and environmental policy stringency (EPS) on the environmental quality index can be seen by comparing the t-statistic value with the t-table value of 2.045. If the T-statistic value > the T-table value, the variable is considered to have an influence. The results of the long-term and short-term analyses can be seen in Table 7.

Table 7
Long-Term and Short-Term Test Results

Variable	Coefficient	Std. Error	t-stat	Information
Long Run Results				
EC	-0.104318	(0.02602)	[-4.00862]	Significant
URB	1124.514	(290.701)	[3.86829]	Significant
EPS	43.14794	-15.2428	[2.83070]	Significant
Short Run Results				
CointEq1	-0.28231	(-0.14411)	[-1.95903	
D (EC (-1))	0.008078	(0.01741)	[0.46411]	Not Significant
D (EC (-2))	[0.46411]	(0.29995)	[1.55805]	Not Significant
D (URB (-1))	407.7058	-148.471	[2.74602]	Significant
D (URB (-2))	-0.162271	-0.17632	[-0.92032]	Not Significant
D (EPS (-1))	1.476338	-10.8917	[-0.13555]	Not Significant
D (EPS (-2))	0.172165	-0.19262	[-0.89380]	Not Significant
C	0.054186	(1.16281)	[0.04660]	

Source: Eviews 12 Processed

Based on the research results shown in Table 7, in the long term, it shows that energy consumption, urbanization, and environmental policy stringency affect environmental quality in Indonesia. While urbanization and EPS have a positive impact on environmental quality, energy consumption has a negative impact. This finding shows that a 1% increase in fossil fuel consumption will cause a long-term decrease in energy consumption of -0.104. These results are in line with research conducted by Khan *et al*. (2021), which validates the complex relationship between energy consumption and its

effect on environmental quality. Various studies offer persuasive evidence of the effect of energy consumption on the environment: Adams et al. (2020) and (Nasreen et al., 2017). In theory, it can also be analyzed through the EKC popularized by Simon Kuznets that a country's income and energy consumption will increase due to economic activity but ultimately also have an impact on environmental quality (Stern., 2014). Likewise, the Islamic view is in line with this phenomenon that most of the energy used today is non-renewable energy. This will certainly cause quite worrying problems, especially environmental damage due to excessive mining and exploitation of natural resources. Therefore, the right policy is to encourage the use of renewable energy, which is also supported by Ta'abuddy, or in the form of actions to preserve nature as part of obedience to the creator.

The next finding provides sufficient concrete evidence that urbanization has a significant positive impact on the quality of the environment in Indonesia. Thus, increasing urbanization will increase the environmental quality index by 1124.5. This finding is consistent with the research of Wei dan Zhang (2017), during the urbanization process in China, the agglomeration of elements and knowledge helps improve environmental quality. Ren et al. (2022), the investigation also found the same results: increasing urbanization will cause an increase in (AOD) aerosol optics or air quality. Therefore, developing cities can adopt more environmentally friendly technologies and efficient waste management. Meanwhile, research by J. Wang dan Wang (2024), also affirms that urbanization can improve environmental quality through increasing strict environmental regulations. Strict environmental policies are an effective solution to developing a modern urbanization model. Thus, this finding also successfully confirms the theory of the energy rebound effect popularized by Jevon in 1886, that urbanization will have a positive impact on environmental quality if it supports energy efficiency practices and strives for energy transition.

The results of the study also show that EPS has a positive and significant impact on environmental quality in Indonesia. This fact shows that a 1% increase in EPS will cause a change of 43.14%. These results are also in line with the research of K. Wang et al. (2020), who found that increasing strict environmental policies will have an impact on improving environmental quality. Several studies also reveal the same fact: Assamoi and Wang (2023), found that EPS has a significant impact on environmental quality because of the way the country adopts strict environmental policies as a mitigation of the risk of environmental degradation. Thus, this finding also successfully confirms the Porter Hypothesis theory that the function of environmental regulatory power will shape a pattern of public awareness of caring about environmental quality (Cook, 2020). While Islam also provides the same affirmation, the state must take part in formulating legally binding policies. The state has the authority to implement environmental policies comprehensively to be able to create sustainable environmental development (Suntana, 2010).

In this study, we also tried to reveal the short-term relationship between energy consumption and the environmental quality index. Our findings confirm that there is no significant influence between them. This can be seen from the T-statistic value < T-table

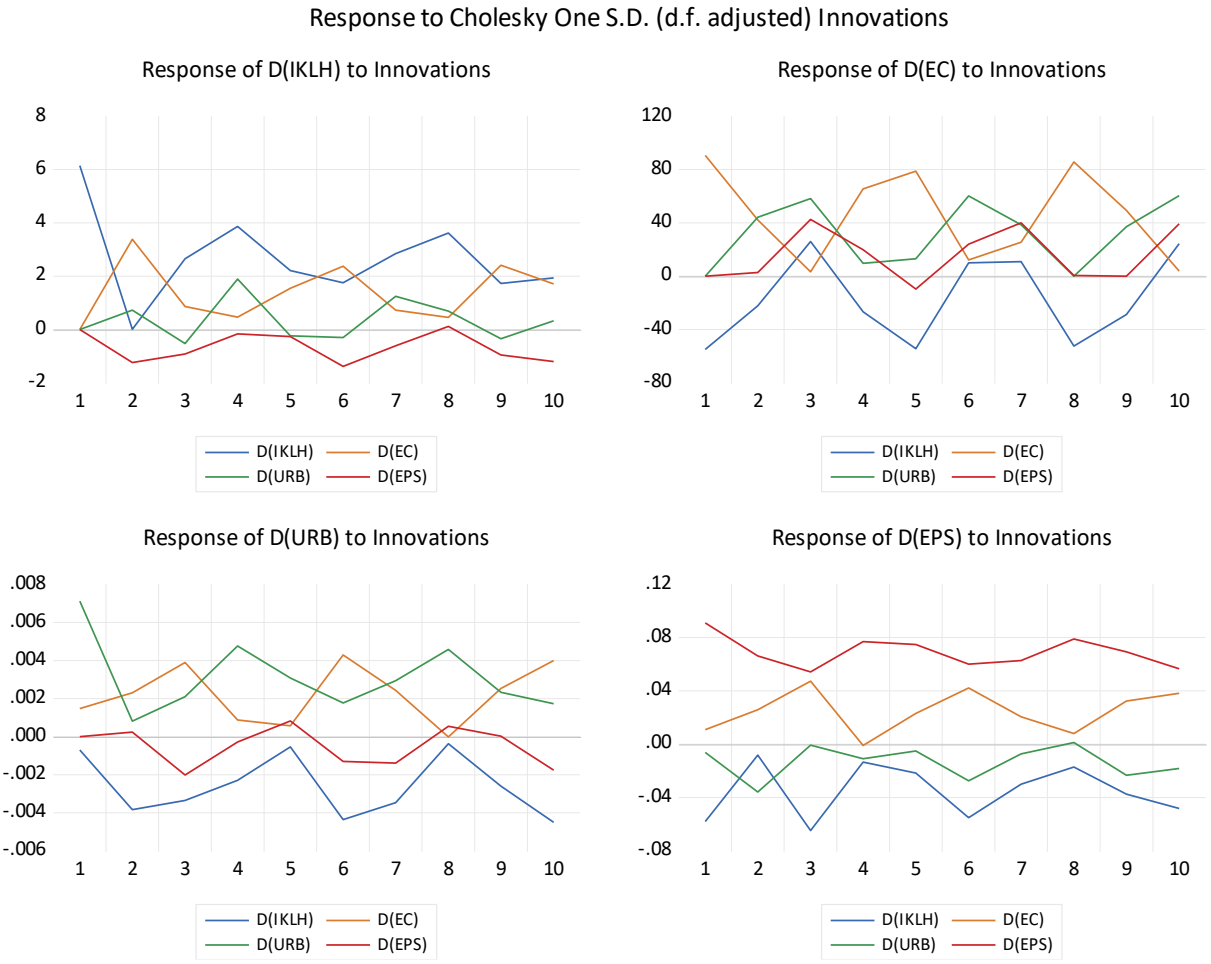
value. The results of this study are in line with empirical research (Salahuddin & Gow, 2019). Most of the environmental impacts due to energy consumption, especially those from fossil fuels, tend to be cumulative. Greenhouse gases released into the atmosphere, such as carbon emissions, take time to show a significant impact (Kweku et al., 2018). Therefore, research Gong et al. (2014), revealed the same results: changes in environmental quality in the short term are not always influenced by energy consumption.

The finding is quite surprising: urbanization has a significant positive effect on environmental quality in Indonesia, with a coefficient value of 407.758, which shows that with a 1% increase in urbanization, environmental quality will increase in the short term by 407.7. This finding shows that well-planned urbanization, allowing for more efficient resource management and increasing green infrastructure, cumulatively contributes to urban air quality. This finding is also in line with the investigation of Zhong et al. (2020), which found that one of the things that causes urbanization to have a positive impact on environmental quality is the urbanization model implemented by the government. According to Zhao and Chai (2015), evaluating the level of sustainable development through urbanization must include aspects such as city scale and infrastructure, economic growth, community welfare, environmental improvement, and urban-rural integration.

Regarding the strength of environmental policy, this study did not find a significant effect in the short term. This is confirmed by the T-statistic value <T-Table Value. Therefore, this study is in line with Porter (1999), that strict environmental policies will always receive critical debate. Some who support economic development will relax environmental regulations to invite investors. While factions that agree with sustainability will support strict environmental policies newly introduced environmental policies take time to be fully implemented and have an effective impact. Therefore, environmental policy strictness has a long-term goal of improving environmental quality (K. Wang et al., 2020). Factors such as policy implementation, environmental inertia, and the variability of external factors all contribute to why the short-term effects of stricter environmental policies are not always reflected in the environmental quality index (Pearce, 2012). Therefore, Islam supports environmental maintenance through regulations set by the state. Policymakers have provided constructive solutions, namely establishing environmental monitoring institutions, both regional and regional, the overall purpose of which is to formulate policies and evaluate developments in environmental quality (Fazriyanti, 2018).

IRF and IFD

Impulse response analysis aims to observe the effect of shocks from one variable to another. Changes in the value of a variable will have an impact on other variables as well as the variable itself. Thus, impulse response will provide a visual depiction of the direction of the relationship between the magnitude of the influence between variables and the estimated period required to achieve equilibrium in the value of a variable.



Source: Eviews 12 Processed

Figure 2
Impulse Response

The results of the processing in the form of four IRF graphs, as shown in Figure 2, provide a visual illustration of how the response or shock of the Environmental Quality Index and three other variables fluctuate from the beginning of the period to the last period. However, the second period experienced a decline and increased again in the fourth period, and the tenth period began to show balance.

Then, the response of energy consumption to the shocks that occurred, both to the other three variables and to the Environmental Quality Index, experienced the same situation. In such conditions, an increase in energy consumption occurred in the eighth period, while the response of the Environmental Quality Index was negative. This shows that the high consumption of fossil energy will hurt the quality of the environment

Furthermore, the average response of the urbanization rate to shocks that occurred to the quality of the environment in Indonesia also experienced the same condition. This can be seen in the early to late period. The value of the Environmental Quality Index for urbanization tends to be negative until the 10th period. This condition shows that in the long term, the level of urbanization will affect the quality of the environment in Indonesia.

Meanwhile, the response of the environmental policy stringency variable to the quality of the environment from the first period to the end of the period received a negative response until the 10th period. However, a balance began to emerge in the tenth period. This shows that stricter regulatory enforcement will have an impact on environmental quality in the long term.

Table 8
Variance Decomposition IKLH

Response of D(IKLH): Period	D(IKLH)	D(EC)	D(URB)	D(EPS)
1	6.145832	0.000000	0.000000	0.000000
2	0.006987	3.381415	0.725717	-1.243038
3	2.651628	0.862911	-0.526196	-0.918643
4	3.868375	0.462917	1.888116	-0.166861
5	2.204441	1.540625	-0.237806	-0.268804
6	1.754094	2.374018	-0.299491	-1.387085
7	2.844007	0.723472	1.247004	-0.616244
8	3.618834	0.455293	0.685240	0.113954
9	1.727280	2.404982	-0.352645	-0.955597
10	1.932585	1.711645	0.320821	-1.202570

Source: Eviews 12 Processed

Explanation of Table 8. The variance decomposition (IKLH) section shows the contribution that occurs in the IKLH variable, wherein the first period 1 IKLH contributed 6.14%, while the energy consumption, urbanization, and EPS variables have not contributed. Furthermore, if observed in the short term, for example, in the 3rd period, the shock that occurred was 3.86%, which showed the largest shock during the 10 periods. However, if observed again, in the 10th period it began to decline by 1.93%, while other variables also began to experience a fluctuating decline.

Table 9
Variance Decomposition Energy Consumption

Response of D(EC): Period	D(IKLH)	D(EC)	D(URB)	D(EPS)
1	-54.91342	90.56448	0.000000	0.000000
2	-22.21650	42.26924	44.28333	2.685749
3	25.95536	3.219267	58.19342	42.55467
4	-26.69167	65.54574	9.621232	19.76712
5	-54.46778	78.86117	13.15997	-9.732448
6	9.930088	12.18845	60.29928	24.02404
7	10.86344	25.48381	38.60583	39.98965
8	-52.40453	85.74873	-0.025476	0.447682
9	-28.77081	49.28835	37.04522	0.071764
10	24.43983	3.870353	60.39441	39.37596

Source: Eviews 12 Processed

The next discussion is to observe the Forecast Error Variance Decomposition (FEVD), as shown in Table 9, which shows the impact of energy consumption. When viewed from the short term, for example, the 3rd period, it resulted in a 25.95% shock to economic growth. However, in the long-term period, it experienced a decline, especially in the 10th period, which was 3.87%, as well as economic growth which experienced a decline of 24.43.

Table 10
Variance Decomposition Urbanization

Response of D(URB): Period	D(IKLH)	D(EC)	D(URB)	D(EPS)
1	-0.000705	0.001471	0.007114	0.000000
2	-0.003837	0.002302	0.000814	0.000232
3	-0.003355	0.003895	0.002096	-0.002021
4	-0.002305	0.000876	0.004754	-0.000281
5	-0.000538	0.000564	0.003074	0.000817
6	-0.004366	0.004286	0.001769	-0.001300
7	-0.003471	0.002425	0.002939	-0.001398
8	-0.000374	-1.43E-05	0.004578	0.000546
9	-0.002604	0.002533	0.002331	1.60E-05
10	-0.004501	0.003994	0.001731	-0.001764

Source: Eviews 12 Processed

Further analysis can be observed in Table 10 which displays the variance decomposition value of urbanization. The shock began to occur in the 3rd period (0.0020) and began to decline in the 10th period, although it was fluctuating.

Table 11
Variance Decomposition Environmental Policy Stringency

Response of D(EPS): Period	D(IKLH)	D(EC)	D(URB)	D(EPS)
1	-0.058065	0.010986	-0.006129	0.091015
2	-0.008239	0.025811	-0.035875	0.066197
3	-0.064770	0.047285	-0.000685	0.054282
4	-0.013452	-0.001019	-0.010956	0.076880
5	-0.021752	0.023064	-0.005064	0.074815
6	-0.055211	0.042112	-0.027498	0.060055
7	-0.030013	0.020547	-0.007213	0.062788
8	-0.017178	0.007931	0.001229	0.078922
9	-0.037467	0.032423	-0.023351	0.069247

10	-0.048245	0.038199	-0.018196	0.056665

Source: Eviews 12 Processed

Next, table 11 shows the value of variance decomposition. Environmental Policy Stringency, from the early period to the last period, experienced a significant decline. As in the 3rd period, it experienced a shock of 0.054% while the IKLH shock was -0.064. But in the long-term period, the shock to EPS was 0.056, while the shock to environmental quality was fluctuating to EPS (-0.048).

CONCLUSION

This study has evaluated and analyzed the factors that determine sustainable environmental development in Indonesia by examining the impact of energy consumption, urbanization, and environmental policy strength using the VECM approach. The results of the analysis take into account four environmental quality index variables: energy consumption, urbanization, and environmental policy stringency from 1992–2022. The VECM estimation results show that in the long term, the variables of energy consumption, urbanization, and environmental policy stringency have a significant effect on environmental quality in Indonesia. Thus, this study emphasizes that the government should pay attention to these three aspects to realize sustainable development, such as the policy of transitioning from fossil energy to renewable energy, urbanization that prioritizes the balance between ecology and economy, and maintaining strict environmental policies. Meanwhile, an important reminder of the impact of the VECM test in the short term is the use of fossil energy and environmental policies that have not had a significant impact. It is important to evaluate these to allocate more proportions of financing so that the two components can run integrally and sustainably both in the short and long term. Therefore, the urbanization variable that remains consistent with its impact on the environment is very important to maintain to realize sustainable development.

This study provides valuable input for policymakers in Indonesia regarding the right strategy for preparing a sustainable environmental development plan in both the medium and long term. Such as the proactive environmental strength policy developed by the Organization for Economic Co-operation (OECD). This study has limited time and uses variables that are still considered lacking. Therefore, the suggestion for future research is to try to test variables that can affect the quality of the environment in Indonesia to obtain more comprehensive results on the dynamics of sustainable environmental development. This goal will produce a more credible research study that is not multi-interpretable.

REFERENCES

Abdouli, M., & Hammami, S. (2018). The dynamic links between environmental quality, foreign direct investment, and economic growth in the Middle Eastern and North African countries (MENA region). *Journal of the Knowledge Economy*, *9*(3), 833–853.

Adams, S., Boateng, E., & Acheampong, A. O. (2020). Transport energy consumption and environmental quality: does urbanization matter? *Science of the Total Environment*,

744, 140617.

Agbede, E. A., Bani, Y., Azman-Saini, W. N. W., & Naseem, N. A. M. (2021). The impact of energy consumption on environmental quality: empirical evidence from the MINT countries. *Environmental Science and Pollution Research*, *28*(38), 54117–54136. https://doi.org/10.1007/s11356-021-14407-2

Ahmed, K. (2020). Environmental policy stringency, related technological change and emissions inventory in 20 OECD countries. *Journal of Environmental Management*, *274*, 111209.

Ahmed, Z., Ahmad, M., Rjoub, H., Kalugina, O. A., & Hussain, N. (2022). Economic growth, renewable energy consumption, and ecological footprint: Exploring the role of environmental regulations and democracy in sustainable development. *Sustainable Development*, *30*(4), 595–605.

Arie, M. A. (2015). *Filsafat Ekonomi Islam* (I). Lembaga Studi Filsafat Islam.

Armeanu, D. Ş., Vintilă, G., & Gherghina, Ş. C. (2017). Does renewable energy drive sustainable economic growth? multivariate panel data evidence for EU-28 countries. *Energies*, *10*(3), 381.

Assamoi, G. R., & Wang, S. (2023). Asymmetric effects of economic policy uncertainty and environmental policy stringency on environmental quality: evidence from China and the United States. *Environmental Science and Pollution Research*, *30*(11), 29996–30016.

Bakirtas, T., & Akpolat, A. G. (2018). The relationship between energy consumption, urbanization, and economic growth in new emerging-market countries. *Energy*, *147*, 110–121.

Bera, B., Chinta, S., Mahajan, D. A., Sailaja, A., & Mahajan, R. (2023). *Urbanization and Its Impact on Environmental Sustainability : A Comprehensive Review Urbanization and Its Impact on Environmental Sustainability : A Comprehensive Review*. *August*.

Chen, M., Chen, L., Cheng, J., & Yu, J. (2022). Identifying interlinkages between urbanization and Sustainable Development Goals. *Geography and Sustainability*, *3*(4), 339–346.

Cook, B. J. (2020). The Environmental Protection Agency: policy and administration in a turbulent setting. In *Handbook of US Environmental Policy* (pp. 39–52). Edward Elgar Publishing.

Dietz, T., & Rosa, E. A. (1997). Effects of population and affluence on CO2 emissions. *Proceedings of the National Academy of Sciences*, *94*(1), 175–179.

Eisenmenger, N., Pichler, M., Krenmayr, N., Noll, D., Plank, B., Schalmann, E., Wandl, M.-T., & Gingrich, S. (2020). The Sustainable Development Goals prioritize economic growth over sustainable resource use: a critical reflection on the SDGs from a socio-ecological perspective. *Sustainability Science*, *15*(4), 1101–1110.

Fazriyanti, N. (2018). Islam dan Lingkungan Hidup. *Jurnal Lembaga Pengembangan Tilawah Qur'an Provinsi Kalimantan Tengah*, 1–284.

Girardet, H. (2014). *Creating regenerative cities*. Routledge.

Gong, Z., Zhao, Y., & Ge, X. (2014). Efficiency assessment of the energy consumption and economic indicators in Beijing under the influence of short-term climatic factors: based on data envelopment analysis methodology. *Natural Hazards*, *71*, 1145–1157.

Grossman, G. M., & Krueger, A. B. (1991). *Environmental impacts of a North American free trade agreement*. National Bureau of economic research Cambridge, Mass., USA.

Gu, C. (2019). Urbanization: positive and negative effects. *Science Bulletin*, *64*(5), 281–283.

Hao, L.-N., Umar, M., Khan, Z., & Ali, W. (2021). Green growth and low carbon emission in

G7 countries: how critical the network of environmental taxes, renewable energy and human capital is? *Science of the Total Environment*, *752*, 141853.

Holdren, J. P., & Ehrlich, P. R. (1974). Human Population and the Global Environment: Population growth, rising per capita material consumption, and disruptive technologies have made civilization a global ecological force. *American Scientist*, *62*(3), 282–292.

Holl, A., & Mariotti, I. (2018). The geography of logistics firm location: the role of accessibility. *Networks and Spatial Economics*, *18*(2), 337–361.

Jaffe, A. B., Peterson, S. R., Portney, P. R., & Stavins, R. N. (1995). Environmental regulation and the competitiveness of US manufacturing: what does the evidence tell us? *Journal of Economic Literature*, *33*(1), 132–163.

Jajang, Nur Rianto, T. W. (2021). *Ekonomi Pembangunan Islam*. Bank Indonesia.

Jamel, L., & Derbali, A. (2016). Do energy consumption and economic growth lead to environmental degradation? Evidence from Asian economies. *Cogent Economics & Finance*, *4*(1), 1170653.

Jian, J., Fan, X., He, P., Xiong, H., & Shen, H. (2019). The effects of energy consumption, economic growth and financial development on CO2 emissions in China: A VECM approach. *Sustainability*, *11*(18), 4850.

Keraf, A. S. (2010). *Etika lingkungan hidup*. Penerbit Buku Kompas.

Khan, I., Hou, F., & Le, H. P. (2021). The impact of natural resources, energy consumption, and population growth on environmental quality: Fresh evidence from the United States of America. *Science of the Total Environment*, *754*, 142222.

Khurshid, N., Fiaz, A., Ali, K., & Rashid, M. (2024). Unleashing the effect of energy efficiency, knowledge spillover, and globalization on environmental sustainability: an VECM analysis for policy empirics. *Environment, Development and Sustainability*, *26*(3), 6027–6049.

Kruse, B. T., Saffar, R., & Branch, P. S. (2022). *Economics Department Measuring Environmental Policy Stringency In Oecd Countries : An Update Of The Oecd Composite Eps Indicator Economics Department Working Papers No . 1703 member countries . The opinions expressed and arguments employed are those of th*. *March*.

Kweku, D. W., Bismark, O., Maxwell, A., Desmond, K. A., Danso, K. B., Oti-Mensah, E. A., Quachie, A. T., & Adormaa, B. B. (2018). Greenhouse effect: greenhouse gases and their impact on global warming. *Journal of Scientific Research and Reports*, *17*(6), 1–9.

Lange, B. H. (2021). A Message from the Executive Director. *SMPTE Motion Imaging Journal*, *130*(2), 6. https://doi.org/10.5594/JMI.2021.3057266

Maji, I. K., Sulaiman, C., & Abdul-Rahim, A. S. (2019). Renewable energy consumption and economic growth nexus: A fresh evidence from West Africa. *Energy Reports*, *5*, 384–392.

Martínez-Zarzoso, I., Bengochea-Morancho, A., & Morales-Lage, R. (2019). Does environmental policy stringency foster innovation and productivity in OECD countries? *Energy Policy*, *134*, 110982.

Nasreen, S., Anwar, S., & Ozturk, I. (2017). Financial stability, energy consumption and environmental quality: Evidence from South Asian economies. *Renewable and Sustainable Energy Reviews*, *67*, 1105–1122.

Patra Yuda, M. A., & Idris, I. (2022). Analisis Kepadatan Penduduk, Pertumbuhan Ekonomi dan Anggaran Lingkungan terhadap Kualitas Lingkungan Hidup di Indonesia. *Jurnal Kajian Ekonomi Dan Pembangunan*, *4*(2), 53. https://doi.org/10.24036/jkep.v4i2.13362

Pearce, D. (2012). Environmental policy as a tool for sustainability. In *Scarcity and Growth Revisited* (pp. 198–224). Routledge.

Piwowar-Sulej, K. (2021). Human resources development as an element of sustainable HRM–with the focus on production engineers. *Journal of Cleaner Production*, *278*, 124008.

Porter, M. E. (1999). Michael Porter on competition. *The Antitrust Bulletin*, *44*(4), 841–880.

Purnamadewi, Y. L., Orchidea, M. D., & Mulatsih, S. (2019). Fiscal policy and environmental quality in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *399*(1), 12051.

Ren, X., Huang, S., Wang, J., & Xu, X. (2022). The impact of urbanization on air quality in Africa from time and spatial perspectives. *Environmental Science and Pollution Research*, *29*(49), 74699–74714.

Rohman, F. A., & Suryanto, S. (2023). Hubungan indeks kualitas lingkungan hidup dan ketimpangan pendapatan di Kabupaten Kebumen. *Region : Jurnal Pembangunan Wilayah Dan Perencanaan Partisipatif*, *18*(1), 123. https://doi.org/10.20961/region.v18i1.49206

Salahuddin, M., & Gow, J. (2019). Effects of energy consumption and economic growth on environmental quality: evidence from Qatar. *Environmental Science and Pollution Research*, *26*, 18124–18142.

Sayem, M. A. (2023). Islam and Environmental Ethics: A Qur'anic Approach. In *Asian Spiritualities and Social Transformation* (pp. 263–276). Springer.

Setiawan, M. R., & Primandhana, W. P. (2022). Analisis pengaruh beberapa sektor PDRB terhadap indeks kualitas lingkungan hidup di Indonesia. *Kinerja*, *19*(1), 53–62. https://doi.org/10.30872/jkin.v19i1.10830

Stern, D. I. (2004). Economic growth and energy. *Encyclopedia of Energy*, *2*(00147), 35–51.

Stern, D. I. (2014). *The environmental Kuznets curve: A primer*.

Su, M., Yang, Z., Abbas, S., Bilan, Y., & Majewska, A. (2023). Toward enhancing environmental quality in OECD countries: Role of municipal waste, renewable energy, environmental innovation, and environmental policy. *Renewable Energy*, *211*, 975–984.

Sun, H., Pofoura, A. K., Mensah, I. A., Li, L., & Mohsin, M. (2020). The role of environmental entrepreneurship for sustainable development: evidence from 35 countries in Sub-Saharan Africa. *Science of the Total Environment*, *741*, 140132.

Suntana, I. (2010). *Politik Ekonomi Islam* (1st ed.). CV PUSTAKA SETIA.

Tonne, C., Adair, L., Adlakha, D., Anguelovski, I., Belesova, K., Berger, M., Brelsford, C., Dadvand, P., Dimitrova, A., & Giles-Corti, B. (2021). Defining pathways to healthy sustainable urban development. *Environment International*, *146*, 106236.

Ulucak, R. (2020). How do environmental technologies affect green growth? Evidence from BRICS economies. *Science of the Total Environment*, *712*, 136504.

Vosooghzadeh, B. (2020). Introducing Energy Consumption Theory and Its Positive Impact on the Economy. *Research Gate*, *May*. https://doi.org/10.13140/RG.2.2.30016.35846

Wackernagel, M., & Rees, W. (1998). *Our ecological footprint: reducing human impact on the earth* (Vol. 9). New society publishers.

Wahyuningsih, S., & Husnulwati, S. (2021). Pembangunan Berwawasan Lingkungan dalam Kaitan Nilai–Nilai Pancasila Kearah Tujuan Pembangunan Nasional. *Jurnal Education and Development*, *9*(3), 415–421.

Wang, J., & Wang, R. (2024). The Impact of Urbanization on Environmental Quality in Ecologically Fragile Areas: Evidence from Hengduan Mountain, Southwest China. *Land*, *13*(4), 503.

Wang, K., Yan, M., Wang, Y., & Chang, C.-P. (2020). The impact of environmental policy stringency on air quality. *Atmospheric Environment*, *231*, 117522.

WCED, S. W. S. (1987). World commission on environment and development. *Our Common Future*, *17*(1), 1–91.

Wei, H., & Zhang, Y. (2017). Analysis of impact of urbanization on environmental quality in China. *China & World Economy*, *25*(2), 85–106.

World Energy Council. (2019). *World Energy Council Annual Report 2019 World Energy Council (a Company Limited By Guarantee) Annual Report and Accounts*. *December*.

Yirong, Q. (2022). Does environmental policy stringency reduce CO2 emissions? Evidence from high-polluted economies. *Journal of Cleaner Production*, *341*, 130648.

Zhao, J., & Chai, L. (2015). A novel approach for urbanization level evaluation based on information entropy principle: A case of Beijing. *Physica A: Statistical Mechanics and Its Applications*, *430*, 114–125.

Zhong, L., Li, X., Law, R., & Sun, S. (2020). Developing sustainable urbanization index: Case of China. *Sustainability*, *12*(11), 4585.