ANALYSIS OF DETERMINANTS OF THE ENVIRONMENTAL QUALITY INDEX IN SIX PROVINCES OF JAVA ISLAND

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Abstract

Environmental quality is an important indicator that reflects the sustainability of ecosystems and the welfare of communities in a region. The Environmental Quality Index (EQI) provides a quantitative measure of environmental quality in an area over a given period, derived from the Water Quality Index (WQI), Air Quality Index (AQI), Land Quality Index (LQI), and Marine Water Quality Index (MWQI). To date, Java Island has consistently had the lowest LQI among Indonesian islands. This study was conducted to determine the effect of access to proper drinking water, access to adequate sanitation, population density, land transportation, and the number of large and medium industries on the Environmental Quality Index (EQI) in 6 provinces on the island of Java from 2016 to 2024 using panel data regression analysis with the Fixed Effect Model (FEM) approach and Granger causality testing with 54 observations. The study found that access to safe drinking water, access to proper sanitation, population density, and the number of industries significantly affected the EQI. Land transportation did not have a significant effect on the EQI. Based on the Granger causality test, there was a reciprocal relationship between several independent variables and the EQI.
***Keywords**: EQI, safe drinking water, proper sanitation, population density, and number of industries.*

INTRODUCTION

The environment is a fundamental element in the lives of all living things, especially humans, as it supports their basic survival needs and enhances their standard of living (Wafa, 2024). The increasing pressure of human activities has led to environmental problems and has evolved into a complex global challenge. Pressures from various directions, such as population growth, industrialization, and the exploitation of natural resources, which cause ecological degradation, are important issues that must be addressed appropriately (Badan Pusat Statistik, 2025).

Indications of environmental damage continue to show that the quality of global ecosystems is increasingly threatened, mainly due to the growing pressure from human activities and economic development, which has become a global concern. Phenomena such as declining air quality, land degradation, and water pollution demonstrate that the dynamics of social and economic activities and population growth can directly affect a region’s environmental quality (Ruzieva & Ruziev, 2024).

On a global scale, environmental quality is measured by the Environmental Performance Index (EPI), an international metric that assesses each country’s environmental management effectiveness. The EPI was created by the Centre for Environmental Law and Policy Studies (Yale University), first released in 2006, and updated every two years (Block et al., 2024). The EPI assesses how well a country manages its environment to maintain human health and ecosystems, using an index score from 0 to 100, with higher scores indicating better environmental quality. As an illustration of the effectiveness of environmental management at the national level, the following graph shows the trend in Indonesia's EPI score, which reflects fluctuations in environmental sustainability performance in recent years.

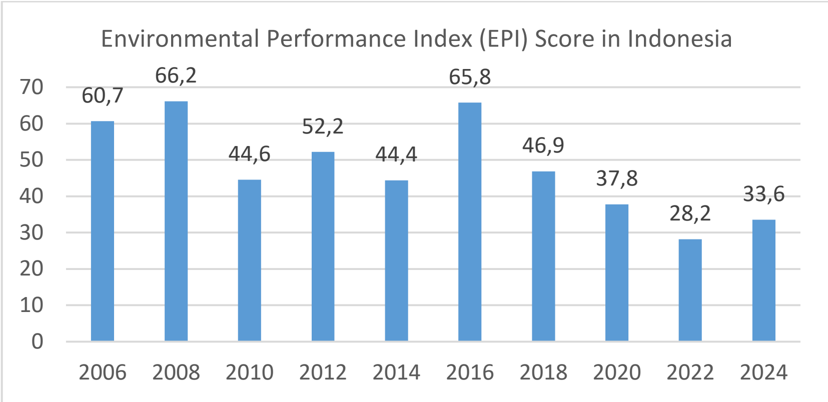


Figure 1. *Environmental Performance Index (EPI)* in Indonesia
Source: EPI, processed data

Figure 1 shows that Indonesia's score on the world stage tends to decline and is categorized as low performance in environmental sustainability efforts. It is known that in 2024, Indonesia received an EPI score of 33.6 on a scale of 0-100. Although this is an increase from the previous year, 2022, with a score of 28.2, Indonesia still ranks 20th among the countries with the lowest indices in the world.

To assess Indonesia's environmental competitiveness in the regional arena, it is important to compare these scores with those of neighboring countries in Southeast Asia. The graph below maps Indonesia's position among ASEAN countries in 2024.

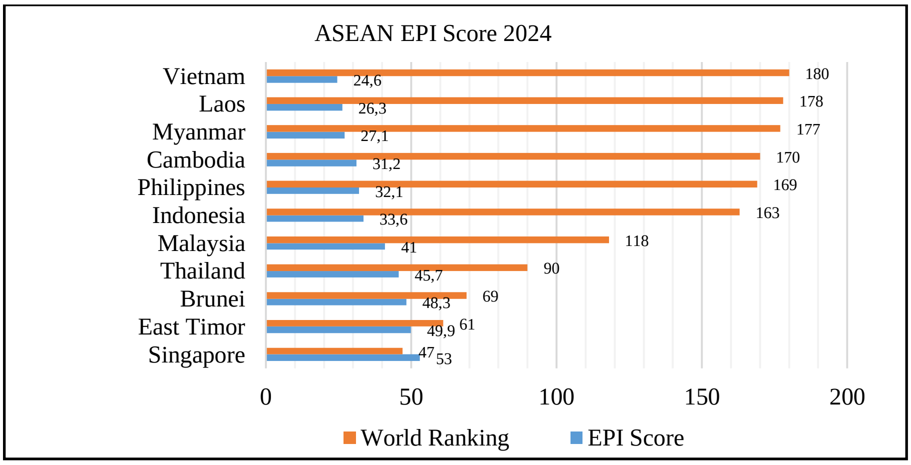


Figure 2. ASEAN EPI Scores in 2024
Source: EPI, data processed

According to the 2024 Environmental Performance Index (EPI) report, Indonesia ranks 163rd out of 180 countries (Figure 2). In addition, Indonesia's EPI score ranks sixth among 11 ASEAN countries. This position indicates a need to improve the effectiveness of environmental policies, supervision, and the use of natural resources to maintain environmental carrying capacity. One of these efforts is to emphasize the urgency of studying the various determinants that affect national environmental quality, namely the Environmental Quality Index (EQI).

The EQI explains quantitative measures that gauge the state of the environment in a region within an observation period. The EQI is derived from a combination of several environmental components, including WQI, AQI, LQI, and MWQI (Yani, Restiatun, & Nuratika, 2023). This index then functions as a supporting instrument in the policy decision-making process and environmental effectiveness assessment, and as the primary reference for determining development priorities, with an index score from 0 to 100, where higher scores reflect better environmental quality (Samosir, Karim, Fauzi, & Berliana, 2024). In the national context, there are clear disparities in environmental quality between regions, as shown by the average EQI development on the following major islands in Indonesia.

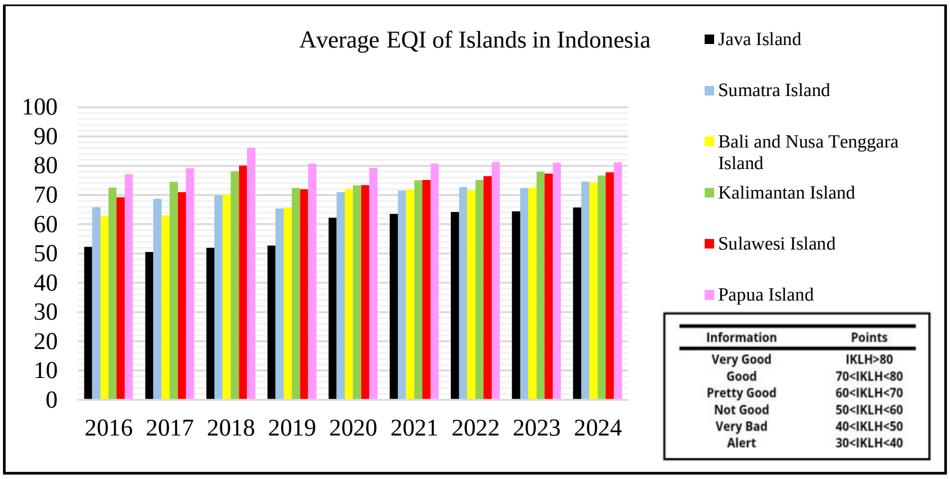
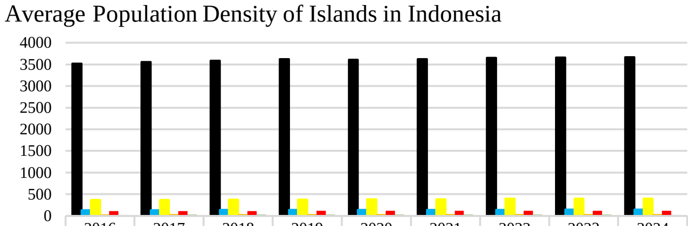


Figure 3. Average EQI of Islands in Indonesia 2016–2024
Source: BPS, processed data

Figure 3 shows the average development of the island EQI in Indonesia from 2016 to 2024. It can be seen that Java has the lowest index of the five islands in Indonesia. Although Java's index value has increased every year, this increase has not been sufficient to close the environmental quality gap with other islands (Pujiati, Nurbaeti, & Damayanti, 2023). Therefore, it is necessary to analyze the determinants of EQI for Indonesian islands from 2016 to 2024.

The Central Statistics Agency's (2024) population census findings state that the majority of Indonesia's population is concentrated on the island of Java. Increasing population density can significantly pressure environmental quality (Kartika & Purwiyanta, 2024). The increase in population density drives demand for land, housing, and other resources, ultimately increasing the challenges to environmental carrying capacity. In the long term, these demographic dynamics may weaken environmental quality (Zahro & Tutik, 2025).

High population density drives demand for land and housing, which, in turn, puts massive pressure on the environment's carrying capacity. To understand the extent of demographic differences across regions in Indonesia, the following graph compares average population density per island for the period 2016-2024.



	2016	2017	2018	2019	2020	2021	2022	2023	2024
Jawa Island	3520	3556	3590	3625	3607	3627	3654	3657	3669
Sumatra Island	130	133	135	137	136	138	142	143	145
Bali and Nusa Tenggara Island	366	370	374	378	381	385	395	397	401
Kalimantan Island	38	39	39	40	39	40	42	42	43
Sulawesi Island	109	111	112	113	115	116	117	118	119
Papua Island	23	24	24	24	26	27	27	27	22

Figure 4. Average Population Density of Islands in Indonesia 2016–2024

Source: BPS, processed data

Figure 4 shows the population density development of each island in Indonesia for the period 2016–2024. It can be seen that Java Island, which covers six provinces, including DKI Jakarta, Banten, West Java, DI Yogyakarta, Central Java, and East Java, is the most densely populated island at the national level. BPS (2025) reports that 6% of Indonesia's population lives on Java Island with an average population density of 3,612 people per km^2.

High population density can degrade environmental quality and increase demand for goods and services. This condition drives the expansion of land requirements for housing and waste volume, both liquid waste that affects water quality and solid waste and gas emissions that put pressure on soil and air quality (Iswari & Kusuma, 2022). Aldilla, Restiatun and Afrizal (2024) found a significant association between population density and EQI.

From these factors, another factor emerges that affects environmental quality: proper sanitation. The volume of liquid waste generated on the island of Java from household activities, industry, and development will affect environmental quality if there are inadequate facilities and infrastructure, such as access to sanitation (Aldilla et al., 2024). Dewi and Fitria (2022) research shows that sanitation has a significant influence on environmental quality.

Environmental problems caused by population density are also closely related to the provision of basic infrastructure, particularly access to sanitation. Improving access to sanitation is crucial to preventing soil and water pollution, and progress on Java is shown in the graph below.

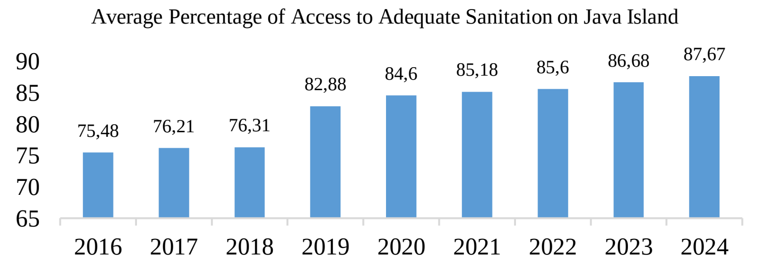


Figure 5. Average Percentage of Access to Adequate Sanitation from 2016 to 2024

Source: BPS, processed data

Figure 5 shows the development of adequate sanitation access on Java Island from 2016 to 2024. It can be seen that there was an increase from 75.48% to 87.67%. However, this increase was accompanied by a 1.2 million-ton-per-day rise in household waste, 60% of which came from Java Island (BPS, 2025). A UNICEF report in 2024 states that access to sanitation managed by UNICEF in collaboration with the government shows limited progress, rising from 10.2% to 10.25%, even though open defecation decreased significantly from 4.2% to 3.2% in 2024. This limited access continues to pose a serious threat to public health and environmental conditions.

Another factor affecting environmental quality is access to safe drinking water. Liquid waste from poor sanitation also degrades the quality of the aquatic environment. Access to safe drinking water is not only a matter of environmental quality but also of socioeconomic development, especially in areas with high population density (Okafor, Ude, Okoh, & Eromonsele, 2024). Data from the Coordinating Ministry for Infrastructure and Regional Development (2025) indicates that around 28 million Indonesians still have difficulty accessing safe drinking water, and that 50% of water sources in Indonesia are potentially polluted. The following graph illustrates the progress of household access to safe drinking water in six provinces on the island of Java during the observation period.

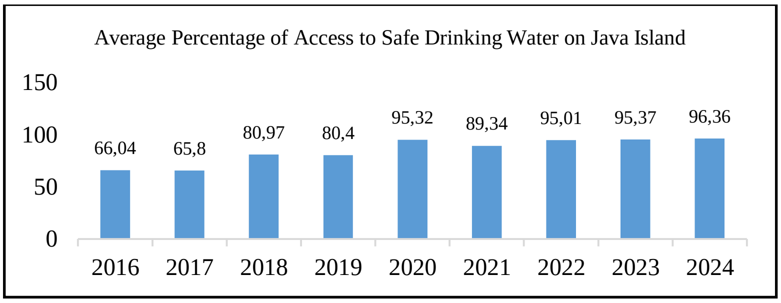


Figure 6. Average Percentage of Access to Safe Drinking Water 2016-2024
Source: BPS, data processed

Figure 6 shows the development of access to safe drinking water on the island of Java from 2016 to 2024. It can be seen that there has been an increase from 66.04% to 96.36%. However, this increase is accompanied by a report from the Ministry of Environment (2025) stating that the national water quality index is recorded at 51.78, which is still below the national target. This puts Java Island in the spotlight because it is the region with the highest population density and economic activity. There is evidence of regional inequality in the availability of clean water. Java Island has the lowest clean water utilization index at 0.27, even though household water demand exceeds 30 billion m^3 per year. Meanwhile, Papua has the highest index at 1.89.

Another factor affecting environmental quality is land transportation. Motor vehicle activities make transportation one of the most significant contributors to various forms of pollution. In addition to vehicle emissions, fuel consumption also contributes to the decline in environmental quality (Arif & Nurwati, 2022). Research by Kondolele, Rahmatia, and Mustari (2023) indicates a significant relationship between land transportation and EQI.

The land transportation sector also plays a dominant role in degrading environmental quality, particularly through vehicle emissions that damage air quality. Given its role as the center of national mobility, the following (Figure 7) is data on the volume of land vehicles operating in Indonesia and their concentration on the island of Java.

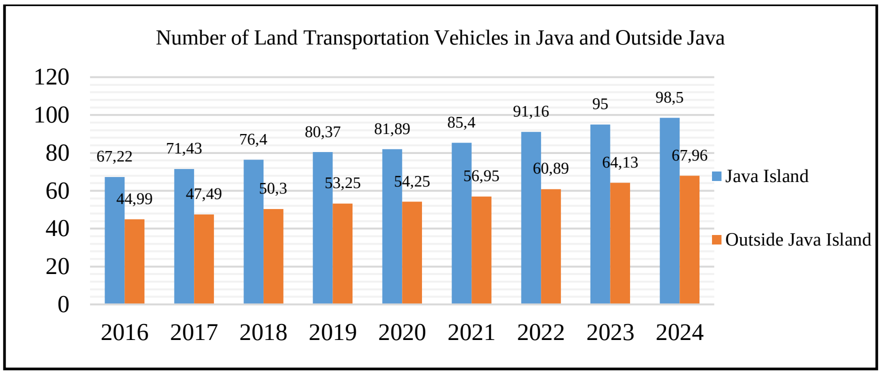


Figure 7. Number of Land Transportation in 2016-2024
Source: BPS, processed data

According to BPS (2025), population mobility on the island of Java in 2024 shows that this region is the center of national transportation. As much as 59.26% of the total vehicles in Indonesia are located on the island of Java. This means that 98,464,194 units out of 166,136,793 transportation units are located on the island of Java. The three provinces with the highest number of motor vehicles in Indonesia in 2024 are located on Java Island: West Java with 27.1 million units, DKI Jakarta with 22.9 million units, and Central Java with 21.5 million units.

Another factor affecting the quality of the environment is the number of large and medium-sized industries, as their operations often cause water, air, and soil pollution through waste treatment, emissions that exacerbate the greenhouse effect, and uncontrolled exploitation of natural resources (Iswari & Kusuma, 2022). According to the BPS (2025), medium-scale industries are manufacturing industries that employ fewer than 99 workers, while large-scale industries employ more than 100 workers. The graph below compares the trend in the number of industrial units on Java Island with those in other regions of Indonesia from 2016 to 2024.

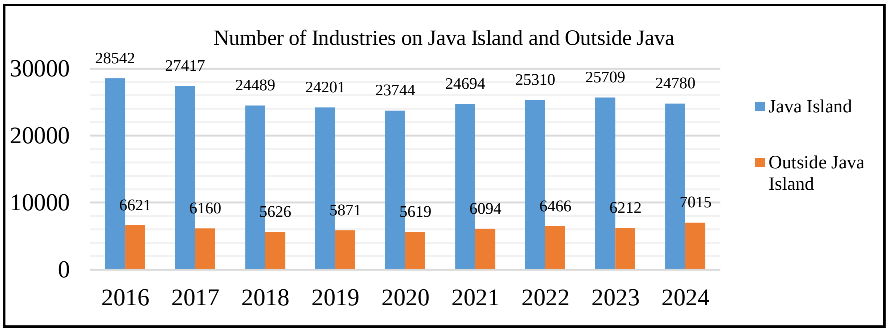


Figure 8. Number of Large and Medium Industries from 2016 to 2024
Source: BPS, processed data

Figure 8 shows the trend in the number of large and medium-sized industries in Java and outside Java from 2016 to 2024. It can be seen that Java is the largest industrial centre in Indonesia every year. In 2016, Java had 28,542 industrial units (82% of the national total), decreasing to 24,542 industrial units (78% of the national total) in 2024. Meanwhile, outside Java, the number of industrial units increased from 6,621 in

2016 to 7,015 in 2024. Despite the decline in the number of large and medium-sized industries on Java Island, this region remains the most significant contributor to industry.

The decline in environmental quality on Java Island, despite various policies, reveals a gap between planning and actual conditions. Population pressure, limited basic services, and high land transportation activity indicate the need for more targeted empirical research. To date, there have been few studies that comprehensively examine the impact of population density, adequate sanitation, adequate drinking water, land transportation, and the number of industries on the EQI on the island of Java. This research is important for filling this gap and providing a scientific basis for more effective environmental policy strategies on the island of Java.

The Environmental Quality Index (EQI) in Java, which consistently ranks lowest nationally despite various improvement programs launched, reflects a wide gap between environmental regulations and the realities of development on the ground. Extreme demographic pressure, limited sanitation and clean water infrastructure, and massive transportation and industrial activities underscore the urgency of empirical studies on the main factors degrading environmental quality in this region. Although ecosystem restoration efforts have been touted, few studies have comprehensively examined the simultaneous effects of access to basic services (sanitation and drinking water), population density, and economic activity (transportation and industry) on EQI in Java. This research is crucial for filling this gap and providing a strong scientific basis for formulating more targeted, effective, and sustainable environmental management strategies.

LITERATURE REVIEW

Environmental Quality Theory

This theory explains that human activities influence environmental conditions, the intensity of resource use, and the carrying capacity of ecosystems (Inbit, Alkolany, Kazem, Hussein, & Brism, 2024). Khan, Lei, Muhammad, Khan and Lei (2023) found that increasing pressure on water, air, and land components directly impacts declines in environmental quality. This theory provides the conceptual basis for measuring EQI, which shows the condition of components over time.

Population Pressure Theory

This theory states that high population growth increases ecological pressure through resource consumption, land requirements, and waste production (Beeson, 2022). Koninck and Pham (2025) found that densely populated areas, such as Java, tend to face greater environmental pressure.

Public Health and Sanitation Theory

This theory posits that improvements in sanitation and water quality are often linked to public health (Hamid, Susilawaty, & Saleh, 2025). Adequate sanitation infrastructure prevents soil and water pollution, while adequate drinking water reduces the risk of contamination and hazardous waste. Okafor et al. (2024) found that improvements in sanitation and access to adequate drinking water directly enhance environmental quality.

Transportation Emission Theory

This theory emphasizes that land transportation activities produce major pollutants, including CO2, NOx, SO2, particulates, and hydrocarbons, which contribute to air quality deterioration (Khan, 2021). Azemsha, Kapski, and Pegin (2018) found that the higher the number of motor vehicles, the greater the air pollution burden affecting the EQI assessment components.

Industrial Emission Theory

This theory views industry as a metabolic system that uses large amounts of energy and raw materials and produces waste and emissions (Martín-Gómez, Ávila-Gutiérrez, Lama-Ruiz, & Aguayo-González, 2024). Ditia (2024) found that industry is a significant source of liquid waste, exhaust gases, and solid residues that affect soil, water, and air components.

Sustainable Development Theory

This theory emphasizes the importance of balancing economic growth, social welfare, and environmental sustainability (Anas & Natarajamurthy, 2025). The provision of adequate sanitation, clean drinking water, and industrial management are elements of sustainable development that determine a region's environmental quality (Khonkhodjaeva, 2025).

Environmental Kuznet Curve

This theory states that the relationship between economic growth and environmental quality is curvilinear (Setiawan & Anwar, 2022). In the early stages of development, industrialization and urbanization degrade environmental quality by increasing emissions and resource consumption. In contrast, once income reaches a certain threshold, the adoption of environmentally friendly technologies and regulations improves environmental quality (Singh & Yadav, 2021). Mazwan and Tain (2024) found that Java Island, with its high population density and large industrial activities, is in the early phase of the EKC, so that economic growth still puts pressure on the Environmental Quality Index (EQI).

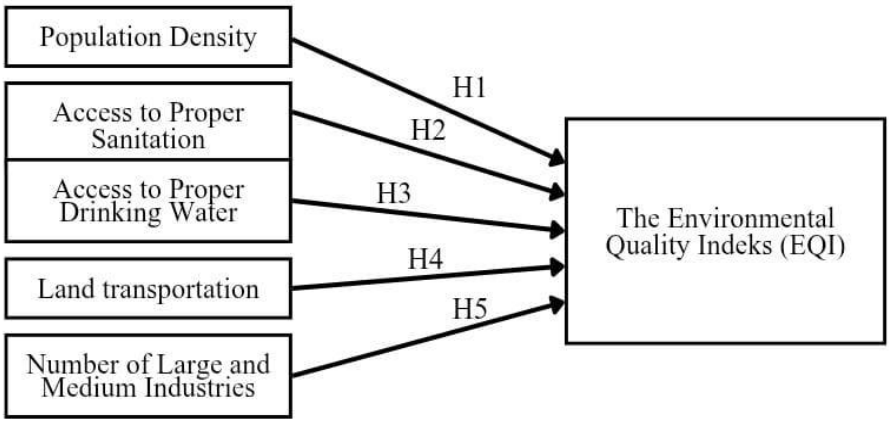


Figure 9. Conceptual Framework

Conceptual Framework

Based on theoretical explanations and empirical evidence from previous studies, the interrelationships among the variables in this study are summarized in the following conceptual framework (Figure 9).

RESEARCH METHOD

This study employs a quantitative approach using secondary data sourced from Statistics Indonesia (BPS). Analysis is conducted using panel data regression, which combines cross-sectional and time series data. The study covers six provinces on the island of Java for the period 2016-2024, with a total of 54 observations. The research variables and indicators are described in Table 1.

Table 1. Research Variable Indicators

Variable	Description	Unit	Source
Environmental Quality Index	An aggregate measure representing the level of environmental quality in a region	Index	BPS
Population Density	The ratio of the population to the area of a specific administrative region	Soul/km^2	BPS
Access to Adequate Sanitation	The proportion of households that have a safe and adequate sanitation system	%	BPS
Access to Adequate Drinking Water	Proportion of households with access to quality drinking water	%	BPS
Land Transportation	Intensity of motor vehicle-based land mobility activities	Unit	BPS
Number of Large and Medium Industries	Number of medium and large-scale industrial business units in a region	Unit	BPS

In panel data regression, it is necessary to select the best model between the Common Effect Model (CEM), Fixed Effect Model (FEM), or Random Effect Model (REM) using the Chow test, Hausman test, and Lagrange multiplier test. The research data must meet the classical assumptions, including tests for multicollinearity and heteroscedasticity autocorelation, and cross section dependence.

Data processing was carried out with the hypothesis in this study that the variables of population density, access to proper sanitation, access to proper drinking water, land transportation, and the number of large and medium industries affect EQI on the island of Java, and that simultaneously, all dependent variables in this study affect the independent variable. For the panel data regression model, the following Equation was formulated as Formula 1.

$$EQI_t = \beta_0 + \beta_1 KP_t + \beta_2 SL_t + \beta_3 AML_t + \beta_4 TD_t + \beta_5 IBS_t + \varepsilon \quad (1)$$

Explanation:

EQI = Environmental Quality Index
KP = Population Density
SL = Adequate Sanitation
AML = Adequate Drinking Water
TD = Land Transportation
IBS = Number of Large and Medium Industries
β_0 = Constant
β_1 β_2 β_3 = Regression Coefficient
ε = Error
I = Cross Section of 6 provinces on the island of Java
t = Time Series 2016-2023

CONCLUSION AND DISCUSSION

In panel data regression analysis, the most appropriate model for this study was determined using the Chow and Hausman tests. A summary of the test results is presented below.

Table 2. Selection of the Best Model

Test	Statistic	Cross-section Probability	Selected Model
Chow Test	52.251587	0.0000	FEM
Hausman Test	70.162189	0.0000	FEM

Source: EViews 10 (data processed, 2025)

Referring to Table 2, FEM is determined to be the most appropriate model. The Chow test between FEM and CEM produces a probability of 0.0000 < 0.05, so FEM is selected. The Hausman test comparing FEM with REM also shows a probability of 0.0000 < 0.05, confirming that FEM remains the best. The next test is the classical assumption test, which includes tests for multicollinearity, heteroscedasticity, autocorrelation, and cross-sectional dependence. The results of the classical assumption test can be displayed as follows.

Table 3. Multicollinearity Test Results

	KP	SL	AML	TD	IBS
KP	1,000000	0,454802	-0.109149	0.256345	-0.321620
SL	0.454802	1,000000	0,242796	-0.188885	-0.683685
AML	-0.109149	0,242796	1,000000	0.094466	0.093002
TD	0.256345	-0.188885	0.094466	1.000000	0.471812
IBS	-0.321620	-0.683685	0.093002	0.471812	1.000000

Source: EViews 10 (data processed, 2025)

Multicollinearity testing (Table 3) was conducted to examine the correlation between independent variables (Naufal et al., 2025). Initial identification using a correlation matrix showed that all independent variables had correlation values below 0.85. Thus, there was no initial indication of multicollinearity in the model.

Heteroscedasticity (Table 4) was detected using the Glejser test to ensure the stability of residual variance in the regression model. The analysis results showed that the p-values for all explanatory variables were greater than 0.05, indicating that the regression model is free of heteroscedasticity.

Table 4. Heteroscedasticity Test Results

Variabel	Prob.	α	Description
KP	0,6405		
SL	0,2652		
AML	0,5001	0,05	Free of Heteroskedastisitas
TD	0,5795		
IBS	0,1226		

Source: EViews 10 (data processed, 2025)

Table 5. Autokorelasi Test Result

Prob.	α	Description
0,9620	0,05	Free of Autokorelasi

Source: EViews 10 (data processed, 2025)

The autocorrelation test (Table 5) assesses whether residuals from regression models exhibit a relationship across different time periods. The Breusch-Godfrey test yielded a p-value of 0.9620 (>0.05), indicating that the regression model does not exhibit autocorrelation.

Table 6. Cross-section Dependence Test Result

Prob.	α	Description
0,7490	0,05	Free of cross-section dependence

Source: EViews 10 (data processed, 2025)

The cross-section dependence test (Table 6) aims to determine whether there is a residual relationship between cross-section units in the panel data model. The initial test results using the Breusch–Pagan LM method, developed by Trevor Breusch and Adrian Pagan, yielded a p-value of 0.0029 (<0.05), indicating cross-section dependence in the model. However, after correction using the Driscoll-Kraay standard errors developed by John Driscoll and Aart Kraay, the probability value was 0.749 (>0.05), suggesting that the regression model no longer exhibits cross-section dependence after robust correction.

Table 7. Results of the Selected Panel Data Regression Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Description
C	-14.54321	8.949265	-1.625073	0.1115	
KP	0.000703	0.000266	2.649465	0.0112	Significant
SL	0.639993	0.135747	4.714605	0.0000	Significant
AM	0.172192	0.037338	4.611696	0.0000	Significant
L	7.31E-08	2.53E-07	0.288815	0.7741	Not
TD	0.000646	0.000316	2.043351	0.0472	significant
IBS					Significant
F-statistic		25.66527	**R-square**		0.856501
Probability (F-statistic)		0.000000	**Adjusted R-square**		0.823129

Source: EViews 10 (data processed, 2025)

The results of panel data regression show that population density (KP), access to proper sanitation (SL), access to proper drinking water (AML), and the number of large and medium industries (IBS) have a significant effect on the Environmental Quality Index (EQI). Conversely, the land transportation variable (TD) has no significant effect.

In detail, the KP variable has a coefficient of 0.000703 and a significance level of 0.0112 (<0.05), indicating a significant effect on the EQI. The SL variable shows a coefficient of 0.639993 and a significance value of 0.0000 (<0.05). The AML variable has a coefficient of 0.172192 with a significance value of 0.0000 (<0.05). Meanwhile, the IBS variable has a coefficient of 0.000646 with a significance level of 0.0472 (<0.05). On the other hand, the TD variable yielded a coefficient of 7.31E-08 and a p-value of 0.7741 (>0.05), indicating it was not significant in explaining variation in EQI.

The simultaneous test in Table 7 shows an F-statistic value of 25.66527, which is greater than F-tabel (2.0066), and a probability value of 0.000000 (<0.05). This confirms that all independent variables together have a significant effect on EQI in the six provinces of Java. The Adjusted R-Square value of 0.856501 indicates that 85.6% of the variation in EQI can be explained by the variables KP, SL, AML, TD, and IBS. Other factors beyond the scope of this study account for the remaining 14.4%.

This study applied the Granger causality test to assess the direction of the cause-and-effect relationship between variables in panel data analysis and to determine whether past fluctuations in a variable can predict changes in other variables at present or in the future. In the panel data regression model with FEM in this study, the Granger test helps reveal the patterns of interaction between variables, including whether the relationship is unidirectional, reciprocal, or there is no causal relationship, as seen from the probability value (p-value) < 0.05, which indicates a significant causal relationship between the variables examined.

The Granger causality test (Table 8) was conducted within the VAR model framework with an optimal lag of 3. The lag selection was based on the AIC, SIC, and HQ information criteria, which yielded minimum values at lag 3. At the same time, all variables met the stationarity assumption, so that the test results were free from spurious regression.

Table 8. Granger Causality Test Result

Hypothesis	Optimal Lag	Prob	Description
KP → EQI	3	0.1169	No causal correlation
EQI → KP	3	0.0136	There is a causal correlation
SL → EQI	3	0.0006	There is a causal correlation
EQI → SL	3	0.0317	There is a causal correlation
AML → EQI	3	0.4140	No causal correlation
EQI → AML	3	0.6352	No causal correlation
TD → EQI	3	0.5221	No causal correlation
EQI → TD	3	0.6888	No causal correlation
IBS → EQI	3	0.1608	No causal correlation
EQI → IBS	3	0.0390	There is a causal correlation

he results of the Granger causality test with an optimal lag of three periods show that EQI has a one-way causal effect on population density (KP) and number of industries (IBS). The variable of access to adequate sanitation (SL) has a reciprocal causal relationship with EQI. In contrast, access to adequate drinking water (AML) and land transportation (TD) do not show a significant causal relationship. These findings confirm that improvements in environmental quality influence several structural determinants, while reciprocal relationships occur specifically in sanitation services.

The Effect of Population Density on EQI in Six Provinces on Java Island

The analysis shows that population density has a positive and significant effect on EQI on the island of Java. Empirically, these findings indicate that higher population density is associated with improved environmental quality, even though high density is conventionally considered to put pressure on the environment.

This phenomenon can be explained by the Population Pressure Theory, which emphasizes that the impact of population pressure on the environment depends heavily on institutional capacity, governance quality, and regional adaptability. Areas with high density tend to have greater public service needs, thereby encouraging local governments to strengthen the provision of environmental infrastructure and more organized management systems (Warlina, Aulia, Hakim, Nuraeni, & Dewi, 2021).

In the context of Indonesia, particularly Java, these findings confirm that population density should be understood as a governance challenge requiring effective planning and public services, rather than as an automatic driver of environmental degradation. These results are consistent with the literature, which shows that the relationship between population density and environmental quality can be context-dependent, depending on institutional capacity and infrastructure investment (Muzayanah, Lean, Hartono, Indraswari, & Partama, 2022).

The Effect of Access to Adequate Sanitation on EQI in Six Provinces on Java Island

The estimation results show that access to adequate sanitation has a significant effect on EQI. The Granger test results show a two-way relationship between adequate sanitation and EQI, indicating that improvements in sanitation can predict an increase in environmental quality. In contrast, better environmental quality encourages the expansion of sanitation services. Empirically, increased sanitation coverage reduces environmental pollution from domestic waste, primarily affecting water and soil quality. This condition shows that improvements in sanitation services directly affect environmental quality (Gama, 2023).

Theoretically, these results are consistent with the Public Health and Sanitation Theory, which holds that sanitation is the primary foundation for a healthy and sustainable environment. These findings reinforce the findings of Iswari and Kusuma (2022), which show that sanitation is an important determinant of environmental quality. In the Indonesian context, these results imply that accelerating sanitation development, especially in densely populated areas, is an effective strategic policy for improving environmental quality sustainably (Djansena, Erika, & Santoso, 2025).

The Effect of Access to Safe Drinking Water on EQI in Six Provinces on the Island of Java

The analysis shows that access to safe drinking water has a positive and significant effect on EQI. Empirically, the availability of safe drinking water helps reduce pressure on water resources, thereby supporting overall improvements in environmental quality (Okafor et al., 2024). These findings indicate that basic services are closely related to environmental conditions (Cheeseman, 2024).

This relationship can be explained through Environmental Quality Theory and Public Health Theory, which emphasize the importance of water quality in maintaining environmental balance. In the Indonesian context, these findings underscore the importance of protecting water sources while improving access to drinking water services to ensure sustainable environmental benefits (Susilo, Prasetyo, & Hasniati, 2025).

The Impact of Land Transportation on EQI in Six Provinces on the Island of Java

The estimation results show that land transportation has no significant impact on EQI. Empirically, these findings indicate that the increase in the number of motor vehicles has not been directly reflected in changes in aggregate environmental quality (Tudor & Sova, 2023). This may be due to the characteristics of the EQI as a composite index that reflects various environmental dimensions (Stevens, Joy, Abrahamse, Milfont, & Petherick, 2023).

From the perspective of Transportation Emission Theory, land transportation activities can increase emissions and degrade environmental quality, particularly air quality. However, the results of this study are in line with Hidayati and Zakianis (2022), which shows a significant impact in areas with high emission intensity. In the Indonesian context, these findings indicate the need for transportation indicators that are more specific to emissions, enabling the environmental impact of the transportation sector to be measured more accurately (Gidarjati & Matsumoto, 2024).

The Effect of the Number of Large and Medium Industries on EQI in Six Provinces on Java Island

The analysis results show that industrial activities have a significant effect on EQI. Empirically, these findings indicate that an increase in formal industrial activities on Java Island does not always negatively affect environmental quality, especially when these industries are adequately supervised and regulated (Nihayah, Mafruhah, Hakim, & Suryanto, 2023).

Theoretically, these findings can be explained through the Environmental Kuznets Curve (EKC) and Sustainable Development Theory, which state that at a certain stage of economic development, environmental quality can be improved through regulation and technological innovation. However, it should be noted that this positive correlation may also be influenced by the composition of indicators in the EQI, as this index covers various aspects of industrial services and management, so that regions with a high number of industries but good governance can obtain a higher EQI score.

In the context of Indonesia, particularly Java, these findings confirm that the quality of industrial governance is a key factor in maintaining a balance between economic growth and environmental quality. Thus, variables that are usually considered environmental pressures can have a positive effect on the EQI when supported by adequate regulations and infrastructure (Vita, Nur, & Sopiana, 2025).

CONCLUSION AND SUGGESTIONS

The study’s results show that interactions among population, basic infrastructure, and economic activity factors influence environmental quality on the island of Java. Population density, access to proper sanitation, access to proper drinking water, and the number of large and medium-sized industries are positively associated with EQI. At the same time, land transportation does not show a significant influence. The Granger causality test confirms that an increase in EQI significantly drives an increase in population density, access to adequate sanitation, and industrial activity, and shows a reciprocal causal relationship between EQI and adequate sanitation. Conversely, access to adequate drinking water and land transportation does not have a significant causal relationship in the observation period.

The policy implications of these findings underscore the importance of integrating environmental quality improvement into the regional development strategy. Strengthening sanitation services needs to be prioritized because it has been proven to have a direct causal relationship with EQI, while improving environmental quality can be used to encourage more managed population and industrial growth. The integration of environmental policy with spatial planning, industrial supervision, and water and transportation resource management is necessary to support sustainable development in Indonesia.

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