

## Determinants Of Environmental Quality In Yogyakarta: Panel-Data Approach

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### ABSTRACT

*Environmental degradation is an important issue that currently challenges the continuity of sustainable economic development in a big city like Yogyakarta. This study analyzes what factors affect environmental quality. By using annual panel data from 2017-2023 in Yogyakarta City and proposing Panel Data Regression Analysis as the analysis method. The results show that GDP and Education have a positive effect on Environmental Quality, Population has no significant effect on Environmental Quality, and Tourists have a negative effect on Environmental Quality. An increase in per capita income and getting a proper education will improve the quality of the environment. However, the increase in population has no effect because public awareness still needs to be improved in environmental conservation efforts. Tourists increase consumption, so environmental pollution is getting higher. The implications of this research are useful for the government to develop policies that focus on raising awareness and stricter environmental regulations in Yogyakarta.*

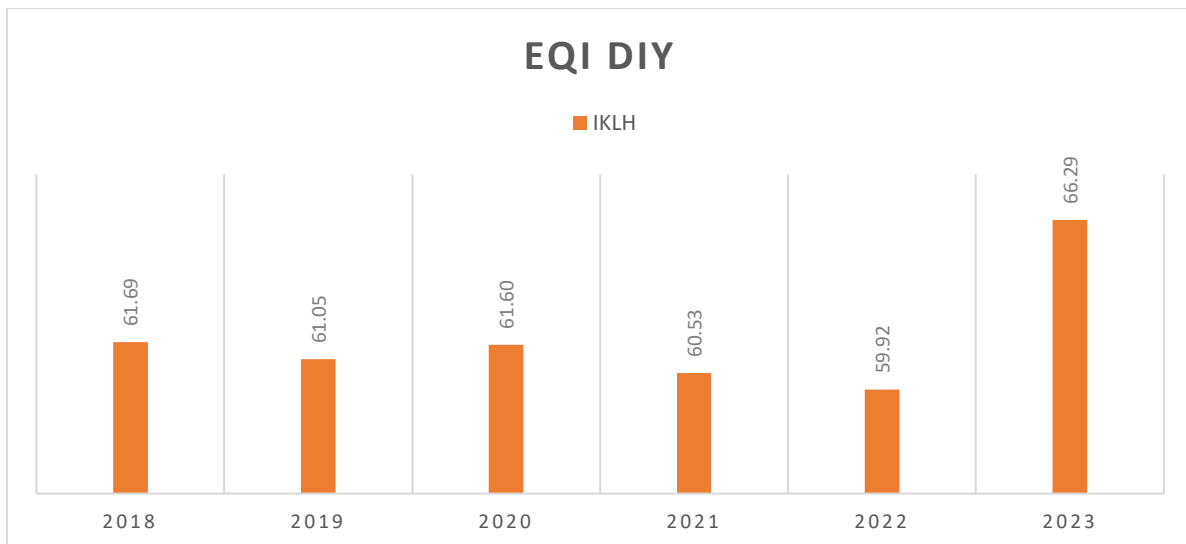
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### INTRODUCTION

The life of humans is always related to the existence of an environment that provides natural resources (Faizah *et al.*, 2021). Natural resources develop in accordance with human actions, causing interdependent interactions so that they can develop optimally. In fact, the development of economic activity will have a negative impact in the form of pollution and environmental damage (Yani *et al.*, 2023). One of the main challenges in economic development is balancing economic progress and environmental sustainability. This is a classic dilemma where focusing on one aspect has the potential to sacrifice the other (Ghifary *et al.*, 2022). Economics and environmental sustainability are like two sides of an inseparable coin. The environment, as the place where humans live, is the main foundation of economic activity and growth. The environment provides essential natural resources for humans to produce goods and services while at the same time accommodating these products (Ginting *et al.*, 2023).

The Environmental Quality Index (EQI) is an environmental management performance indicator compiled by the Ministry of Environment (Kondolele *et al.*, 2023). The parameters, methods, and categories of the Environmental Quality Index (EQI) in Indonesia are regulated by the Minister of Environment Regulation Number 27 of 2021. In 2023, Indonesia's EQI reached 72.54 out of a 100-point scale, showing a slight increase compared to 2022. The details of Indonesia's EQI value in 2023 based on its components and quality categories are as follows: Water quality index: 54.59 (medium quality), Air quality index: 88.67 (good quality), Land cover quality index: 61.79 (medium quality), Seawater quality index: 78.84 (good quality).

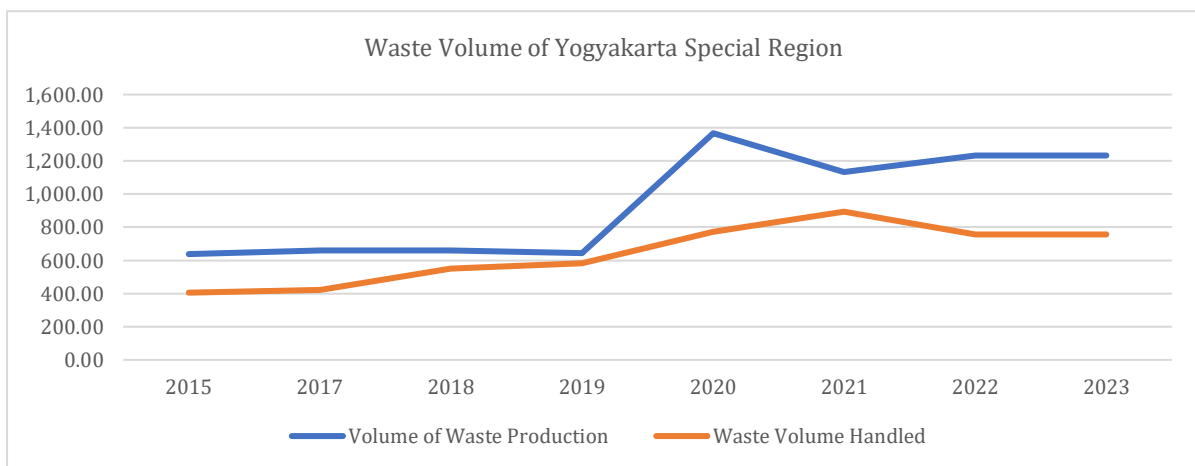
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Source: [bappeda.jogjaprovo.go.id](http://bappeda.jogjaprovo.go.id), 2024

Figure 1  
Yogyakarta Environmental Quality Index 2018-2023

While the Environmental Quality Index in Yogyakarta fluctuates, with an average EQI value of 61.88 from 2019 - 2023 of moderate quality, the lowest value was in 2022, at 59.92 (moderate). The highest year for the last five years occurred in 2023, with a medium quality of 66.29. However, a good-quality EQI does not represent the volume of waste that is currently increasing and has not been fully addressed.



Source: [bappeda.jogjaprovo.go.id](http://bappeda.jogjaprovo.go.id), 2024

Figure 2  
Volume of Waste Production and Handling in Yogyakarta Special Region

Based on Figure 1.2. explains that the volume of waste in the Special Region of Yogyakarta is increasing year by year. The most significant increase occurred in 2020 at 1,366.79 tons/day, handling 773 tons/day. This shows that the Ministry of Environment has yet to be able to handle this problem. EQI is also a performance indicator of environmental management that adopts these various needs, including waste

management. Good waste management will help prevent environmental damage, such as pollution and environmental damage that exceeds the standard criteria. Good waste management will also help support public health and the environment and facilitate development with advanced environmentally friendly technology (Armadi, 2021).

Factors that affect environmental quality come from economic growth, according to Ginting *et al.* (2023), including population growth and density. The amount of residential land has an impact on environmental quality because it increases the demand for the provision of human needs facilities such as roads and clean water, and it generates increased waste. Then the next factor is the level of education. Along with increasing the level of education, opportunities to create innovations in tackling environmental problems are also increasingly wide open. This is because qualified education can increase understanding and encourage community behaviour to preserve the environment (Haris *et al.*, 2023). High income can help the government reduce environmental pollution, such as by protecting forests, improving waste management, and reducing air pollution (Luhung & Yuniasih, 2023).

The relationship between economic growth and environmental quality can be adopted from the Environmental Kuznets Curve (EKC) theory developed by Simon Kuznets in 1955 (Leonardo *et al.*, 2023). EKC theory is the first theory that describes the relationship between economic growth rate and environmental degradation. When a country's income is still low, the country will prioritize investments that can drive income growth, so that pollution levels will fall as growth continues (Putri, 2020). This theory seeks to improve environmental quality in poor countries that are mostly under gradual development and whose people's living standards are increasing (Abid *et al.*, 2023).

Research by Ramadhantie *et al.* (2020) and Pambudi (2020), provide evidence that the Human Development Index (HDI) has a significant effect on the Environmental Quality Index (EQI) Then research by Hidayati and Zakianis (2022) and Yani *et al.* (Furthermore, according to Ilham (2021), economic development, population density, and the number of vehicles have an impact on environmental degradation in Indonesia. Corroborated by research by Abid *et al.* (2023) and Yunita *et al.* (2023), gross domestic product (GDP) per capita shows a positive effect on CO<sub>2</sub> emissions. Furthermore, the research of Nurhamidah and Suwandana (2023), shows that increasing economic growth in Indonesia can have a negative impact on environmental quality. This is evidenced by the negative and significant influence of economic growth indicators, namely GDP and FDI, on environmental quality.

However, several studies are not in accordance with the theory, such as research from Finanda and Gunarto (2021), Putra and Adry (2022), and Yani *et al.* (2023), proving that the effect of economic growth shows a negative and significant effect on environmental quality in Indonesia. Followed by research by Yunita *et al.* (2023), that income inequality has no significant positive effect on CO<sub>2</sub> emissions in the short term and no significant adverse effect in the long term. Total population has no significant negative effect on CO<sub>2</sub> emissions in the short term and a significant positive effect in the long term. The inconsistency of research related to the relationship between economic growth and environmental quality needs to be reviewed from a different perspective.

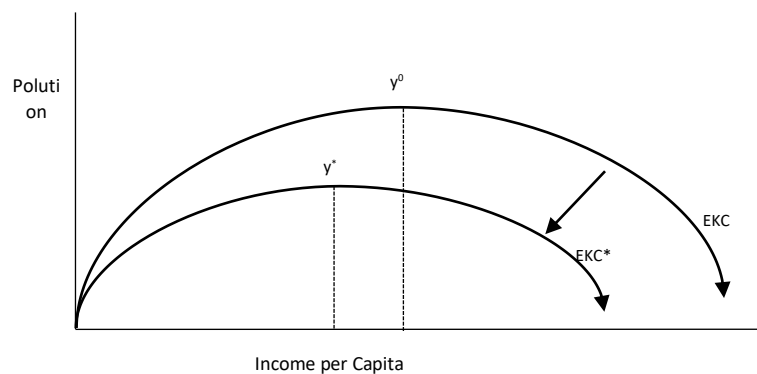
The contribution of this research is that, first, few studies examine what factors affect environmental quality by adding the variable number of tourists in the Yogyakarta area. Second, to strengthen previous research related to the relationship between economic development and the environment. In previous studies, there are still many inconsistent results, such as in the research of Nurhamidah and Suwandana

(2023), showing that an increase in economic growth can reduce the environment. Meanwhile, the research of Yani *et al.* (2023), proves that the effect of economic growth shows a negative and significant effect on environmental quality. Third, the results of this study will help in effective and efficient environmental management based on what factors can influence it. Then, it can be used as a reference by regulators when making government policies.

## LITERATURE REVIEW

### Environmental Kuznet Curve (EKC)

The environmental Kuznets curve (EKC) hypothesis states that there is an 'inverted U' shaped relationship between various indicators of environmental pollution or resource depletion and per capita income levels. That is, environmental degradation will initially increase, but eventually decrease as per capita income increases (Barbier, 1997; Cole *et al.*, 1997). Grossman and Krueger (1991) also revealed a relationship between environmental degradation and per capita income levels. High economic growth increases environmental improvement because there is a link between economic growth and environmental degradation (Noor & Saputra, 2020; Santi & Sasana, 2021). As a process of industrial activity, the continuous production of goods for an industry will cause environmental degradation in the form of waste in the form of soil, water, and air pollution. Along with continued economic growth, it will bring awareness to the public about the importance of maintaining better environmental quality (Cristy & Sakti, 2022).



Source: Todaro and Smith (2015)

Figure 3

Hypothetical Income-Pollution Relationship: Environmental Kuznets Curve (EKC)

The relationship between economic growth and environmental quality can be analyzed using the EKC (Environmental Kuznets Curve) model. In Figure 1, the relationship between per capita income and environmental degradation follows an inverted U-shaped curve. Initially, as income increases, pollution and other environmental degradation also increase. However, at a certain income level, this trend reverses. In countries with higher per capita income, environmental degradation tends to decrease (Todaro & Smith, 2015).

The model divides the relationship into three stages: Stage 1. Early Growth and Increased Environmental Damage, in the early stages of economic growth, there is a transition from agrarian to industrial sectors. This triggers an increase in environmental damage. Stage 2. Decrease in Environmental Damage. As the economy

progresses, the economic structure shifts from heavy energy-based industries to technology-based industries and services. Stage 3. Stabilization of Environmental Quality. At this stage, the rate of environmental degradation slows down and reaches a stable level. This shows that economic growth is only sometimes directly proportional to environmental degradation (Dasgupta *et al.*, 2002).

The EKC model shows that the relationship between economic growth and environmental quality is complex and non-linear. Appropriate policy implementation, such as the development of environmentally friendly technologies, increasing public awareness, and strengthening regulations, can help achieve sustainable economic growth by minimizing negative environmental impacts (Nikensari *et al.*, 2019).

### **Environmental Quality Index**

Law of the Republic of Indonesia Number 32 of 2009 concerning Environmental Protection and Management defines the environment as a unity of space that includes all objects, forces, conditions, and living things, including humans and their behavior. This unity influences each other and determines the survival and welfare of humans and other living things. To measure the quality of the environment in Indonesia, the Environmental Quality Index (EQI) is used (Laura & Suhartini, 2021).

Experts and international organizations concerned with future sustainability are aggressively researching the relationship between environmental quality and sustainable economic growth. Environmental quality is measured using the Environmental Quality Index (EQI), which combines several indicators such as air quality, water quality, and forest cover quality (Wafiq & Suryanto, 2021).

### **Economic Growth**

Economic growth can be interpreted as an increase in economic activity as indicated by the rise in the production of goods and services produced by the community. This increase can occur in both positive and negative directions (Hasibuan *et al.*, 2023). Along with economic progress, people began to realize the importance of preserving the environment. As incomes increase, the consumption of natural resources and the production of waste increase. This results in air pollution and environmental damage. Sadly, the demand to repair environmental damage often needs to catch up to the rate of damage (Putri, 2020). However, as a region's GDP increases, governments and companies have more resources to invest in environmental infrastructure such as wastewater treatment, waste management, and natural habitat protection. Such investments can improve environmental quality. Based on research by Cristy and Sakti (2022); Puspitasari and Yuliawan (2023), economic growth and industrial growth on environmental quality, there is a positive relationship. So that the hypothesis is compiled:

**H1: GDP has a positive effect on the Environmental Quality Index (EQI)**

### **Education**

Education plays an important role in driving change towards sustainable development. Initially, people were fixated on over-consumption. As education improved, so did environmental awareness. Knowledge of clean technology and green consumption is key in this transition (Lavany, 2022). Based on research by Arbulú *et al.* (2015), found that education has a significant effect on reducing waste generation. The level of education underlies public awareness to protect the environment in Chen

(2010), the higher the level of education, the more aware and concerned about the quality of the surrounding environment.

## **H2: Education has a positive effect on the Environmental Quality Index (EQI)**

### **Population**

High population density can trigger various negative impacts on people's quality of life. In densely populated areas, efforts to improve quality of life become more complex. This has the potential to affect social, economic, welfare, security, and the availability of vital resources such as land, clean water, and food. One of the most severe consequences is environmental damage (Christiani *et al.*, 2014). According to Todaro & Smith (2006), population growth can lead to the inability of land to meet food needs through agricultural products, resulting in a decrease in soil carrying capacity and environmental damage. In addition Santi and Sasana (2021), research shows that population has a positive and significant effect on the level of Carbon Footprint, which can worsen environmental quality.

## **H3: Population has a negative effect on the Environmental Quality Index (EQI)**

### **Tourism**

Tourism offers various economic benefits but also presents controversial issues in the context of global sustainable development and climate change impacts. The increasing environmental problems caused by tourism and its development are a significant concern. The tourism industry is suspected of causing changes to natural resources. The surge in the number of tourists in a tourist destination can strain the capacity of the local environment. This results in a drastic increase in domestic and industrial waste, which leads to water, air and soil pollution (Nejati *et al.*, 2014). Research from Ali *et al.* (2020), also said that there is environmental pollution due to the arrival of more and more tourists. The quality of the environment decreases with the increase in the number of tourists.

## **H4: Tourism have a negative effect on the Environmental Quality Index (EQI)**

## **RESEARCH METHODS**

The purpose of this study is to test what variables can affect environmental quality, namely testing the independent variables of GDP, education, population, tourists and the Environmental Quality Index (EQI) as the dependent variable. Quantitative information in the form of numbers processed using the Eviews version 10 program is the research data used in this study. The main subjects of this research are districts in Yogyakarta Province for the period 2017-2023. Using secondary data on the BPS Yogyakarta website (<https://yogyakarta.bps.go.id/>) and Jogja Dataku (<https://bappeda.jogjaprovo.go.id/>). The type of data in this study is panel data with panel data multiple regression analysis as the analysis method.

The Panel Data Multiple Linear Regression Model can be expressed in the form of the equation below:

$$EQI_{it} = \alpha + \beta_1 GDP_{it} + \beta_2 EDUCATION_{it} + \beta_3 POPULATION_{it} + \beta_4 TOURISM_{it} + e$$

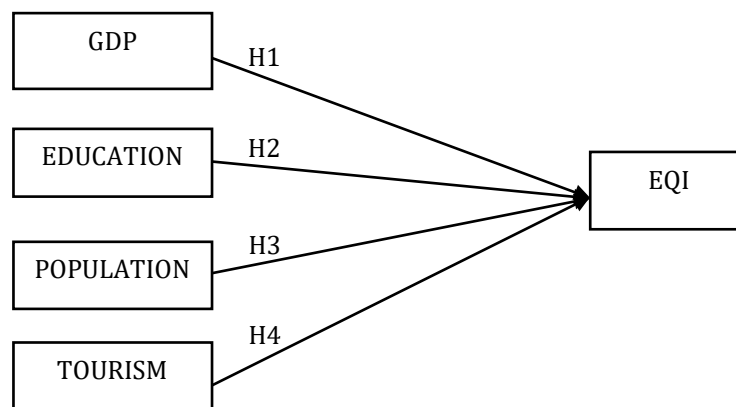
Description:

EQI	: Environmental Quality Index (%)
A	: constant
$\beta_1 - \beta_7$	: regression coefficient

GDP : Income per Capita (Billion Rp)  
 EDUCATION : Level of Education (%)  
 POPULATION : Total Population (Person)  
 TOURISM : Number of Tourists (Person)  
 e : error

The above panel data models are estimated using common effect, fixed effect, and random effect approaches. To evaluate panel data, the appropriate model specification must be tested. The Chow Test and Hausman Test are the intended model specification tests.

Based on the variables explored and the hypotheses made, the model of this study is displayed in Figure 1.4 which shows the relationship between the variables evaluated in this study.



Source: researcher processed data, 2024

Figure 4  
 Framework

**RESULTS AND DISCUSSION**

**Analysis Results**

**Research Data Development**

Table 1  
 Results of Descriptive Statistical Analysis

	<b>EQI</b>	<b>GDP</b>	<b>EDUCATION</b>	<b>POPULATION</b>	<b>TOURISM</b>
Mean	60.76343	18.541.430	91.16857	784006.5	46329992
Median	61.74000	15.039.722	93.03000	758316.0	3055284.
Maximum	71.64000	39.508.677	113.2800	1300361.	6.25E+08
Minimum	34.71000	33.906.00	63.91000	421500.0	-1.89E+08
Std. Dev.	7.410050	10466768	11.47895	327854.0	1.55E+08
Skewness	-1.443136	0.348069	-0.390332	0.210930	2.685050
Kurtosis	5.812496	2.283242	2.787296	1.490673	9.613530
Jarque-Bera	23.68436	1.455925	0.954741	3.581719	105.8411
Probability	0.000007	0.482892	0.620413	0.166817	0.000000

Sum	2126.720	6.49E+08	3190.900	27440229	1.62E+09
Sum Sq. Dev.	1866.900	3.72E+15	4480.054	3.65E+12	8.17E+17
Observations	35	35	35	35	35

Source: Data processed, 2024

Based on table 1. EQI has an average value of 60.76343 from all districts in Yogyakarta Province. The maximum value of 71.64000 was seen from Bantul Regency in 2023, while the minimum value of 34.71000 was found from Sleman Regency in 2020. The standard deviation of EQI in the study period amounted to 7.410050. The independent variable GDP has an average value of 18541430 with a standard deviation of 10466768. Sleman Regency in 2023 has the highest GDP value of 39,508,677 million, and the minimum value of 33,906 occurred in 2020 in Sleman Regency. The education variable has an average value of 91.16857 with a standard deviation of 11.47895. Kulon Progo Regency in 2017 had the highest education level of 113.2800; the minimum value of 63.91 occurred in 2018 in Gunung Kidul Regency. The population variable has an average value of 784006.5 with a standard deviation of 327854.0. Sleman Regency in 2023 has the highest population level of 1,300,361 people; the minimum value of 421,500 occurred in 2017 in Kulon Progo Regency. The tourist variable has an average value of 46329992 with a standard deviation of 1.55E+08. Bantul Regency in 2017 had the highest value of 624,503,080 people; the minimum value of 735,858 people occurred in 2022 in Bantul Regency.

### Classic Assumption Test

#### Normality test

Table 2  
Jarque-Bera Test. Normality Test Results

	Stat.	Prob.
Skewness	-1.360542	0.913171
Kurtosis	1.396556	0.081274
<b>Normality</b>	<b>2.157333</b>	<b>0.340049</b>

Source: Data processed, 2024

The results of the normality test table 2. with a sample of data for 5 districts in Yogyakarta in 2017-2023 through the Skewness-Kurtosis Test shows a probability value of 0.340049. This value is more than 0.05, which means the data is normally distributed.

### Multi Collinearity Test

Table 3  
Multicollinearity Test Results

	GDP	EDUCATION	POPULATION	TOURISM
GDP	1	0.3812	0.1505	0.0093
EDUCATION	0.3812	1	-0.2870	0.1486
POPULATION	0.1505	-0.2870	1	0.1977
TOURISM	0.0093	0.1486	0.1977	1

Source: Data processed, 2024



Based on table 3. the results of the multicollinearity test on the sample of Islamic banks above, show that all variable correlation coefficient values  $<0.80$ . So it can be concluded that there is no multicollinearity problem between the independent variables.

### Heteroscedasticity Test

Table 4  
Heteroscedasticity Test Results–Metode Glejser

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.923261	4.226915	0.928162	0.3607
GDP	8.10E-08	6.16E-08	1.313374	0.1990
EDUCATION	-0.022883	0.039835	-0.574441	0.5700
POPULATION	2.13E-06	2.35E-06	0.905999	0.3722
TOURISM	-1.62E-09	3.78E-09	-0.427929	0.6718

Source: Data processed, 2024

Based on the results of the heteroscedasticity test with the Glejser method where the regression results between the absolute value of the residuals and all independent variables are all insignificant, namely the prob value. all independent variables are more than the significance level (0.05). So it can be concluded that the model in this study does not occur heteroscedasticity.

### Autocorrelation Test

Table 5  
Autocorrelation Test Results

	Residual
N	35
Durbin-Watson stat	1.79759
DL	1.28330
DU	1.65282

Source: Data processed, 2024

Based on table 5. Shows the results of the autocorrelation test using Durbin-Watson. After calculating using the DL / DU table, the results are  $DU < DW < 4-DU$ , namely  $1.65282 < 1.79759 < 2.34718$ , meaning that there is no autocorrelation problem in the research model.

### Chow Test

Chow test is a test to determine the Common Effect or Fixed Effect model that is most appropriate to use in estimating panel data.

Hypothesis:

H0: Common Effect Model

H1: Fixed Effect Model

Table 6  
Chow Test

Effects Test	Statistic	d.f.	Prob.
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Cross-section F	12.356515	(4,26)	0.0000
Cross-section Chi-square	37.276970	4	0.0000

Source: Data processed, 2024

Based on table 6, the prob value is obtained. 0.0000, which is smaller than the sig level (0.05). Then H1 is accepted. The suitable model for this study is the fixed effect model.

### Hausman Test

The Hausman test is a statistical test to choose whether the fixed effect or random effect model is most appropriate to use.

Hypothesis:

H0: Random Effect Model

H1: Fixed Effect Model

Table 7  
Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	49.426058	4	0.0000

Source: Data processed, 2024

Based on Table 7, the prob value is obtained. 0.0000, which is smaller than the sig level (0.05). Then H1 is accepted. The suitable model for this research is the fixed effect model.

### Fixed Effect Model

Table 8  
Fixed Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	77.47504	34.48316	2.246750	0.0334**
GDP	3.70E-07	1.10E-07	3.357780	0.0024***
EDUCATION	0.268272	0.121281	2.211981	0.0360**
POPULATION	-5.92E-05	4.35E-05	-1.363159	0.1845
TOURISM	-3.41E-08	7.24E-09	-4.714787	0.0001***

**Note: \*\*\*; \*\*, \* stand for significant at  $\alpha = 1\%$ ,  $5\%$ , and  $10\%$  respectively. Probability is shown in parentheses.**

Source: Data processed, 2024

The results of the t-statistical test in Table 8. show that GDP (X1) has a significant positive effect on EQI. This is evidenced by the probability value of 0.0024 < 0.01 (1% significance level) with a positive coefficient value, which means H1 is accepted. Hypothesis (H2) states that Education (X2) has a significant positive effect on EQI. The results of this study indicate a probability value of 0.0360 < 0.05 (5% significance level), which means H2 is accepted. Furthermore, the results of the t-statistic test found that Population (X3) has no significant effect on EQI. This is evidenced by the probability value of 0.1845 > 0.05 (5% significance level), which means that H3 is rejected. The last hypothesis shows that Tourism (X4) can have a significant negative effect on EQI. This result is indicated by a probability value of 0.0001 < 0.01 (1% significance level), which means H4 is accepted. Based on the results of the multiple regression analysis above, it

is known that H1, H2, and H4 are accepted because the probability value is smaller than 5% and 1%.

Table 9  
Results of the Coefficient of Determination Analysis

<b>R-squared</b>	<b>Adjusted R Square</b>
0.743218	0.664208

Source: Data processed, 2024

Based on the results of the data analysis, the adjusted R<sup>2</sup> coefficient of determination is 0.743218. This shows that the variation in the Environmental Quality Index (EQI) can be explained by GDP, Population, Education, and Tourism by 74.3218%, while the remaining 25.6782% is explained by other variables outside this research model.

## Analysis and Discussion

### The Effect of GDP on the Environmental Quality Index (EQI) in Yogyakarta

Gross Regional Domestic Product (GDP) has a significant positive effect on the Environmental Quality Index (EQI) in Yogyakarta. The increase in the economy in Yogyakarta, which is expressed in the value of GDP, does not bring public awareness about the importance of maintaining environmental quality. Increasing economic growth is indicated by the production of goods and services that occur in an area and the increase in the amount of people's income. This statement is following the EKC theory, which has an impact on the increase in pollution produced (Barbier, 1997; Cole *et al.*, 1997). The enforcement of laws and regulations and the tightening of regulations related to the environment in all economic activities have yet to be adequately enforced, so public awareness of the need to protect the environment still needs to be improved. This result is following research conducted by Ginting *et al.* (2023) and Acheampong & Opoku (2023) which explain that there is an inverse relationship between economic growth and environmental quality, where increasing economic growth triggers high environmental damage due to increasing total greenhouse gas and carbon emissions. And the increase in carbon emissions has an impact on economic growth. Furthermore, research by Hassan *et al.* (2024), also explained the results that economic growth (GDP) has a significant positive relationship with environmental degradation, namely the decline in environmental quality conditions in Brunei Darussalam.

These results contradict Yusuf (2023), that economic growth has a positive impact on environmental quality in Nigeria, this is due to the use of renewable energy that can minimize carbon emissions generated from production.

### The Effect of Education on the Environmental Quality Index (EQI) in Yogyakarta

Education has a significant positive effect on the Environmental Quality Index (EQI) in Yogyakarta. This means that every increase in the percentage of years of education can reduce environmental quality in Yogyakarta. Research by Ozbay dan Duyar (2022), states that higher education levels can not only improve environmental quality, but also have the most significant impact on renewable energy utilization. In addition, research by penelitian Lai dan Chen (2020), also explains that the average length of schooling shows a positive influence on the Environmental Performance Index. These results support the idea that Yogyakarta's level of education is quite good, so it is easy to get renewable innovations to improve environmental quality. This result contradicts Irzy (2023), that education has a significant negative relationship with

environmental quality. This is due to the role of education in modernization, namely the transformation process from traditional to modern life, which in this case is the use of more sophisticated technology. The existence of modernization in people's lives can have a negative impact such as air pollution in the form of CO<sub>2</sub> emissions.

### **The Effect of Population on the Environmental Quality Index (EQI) in Yogyakarta**

The total population does not have a significant effect on the Environmental Quality Index (EQI) in Yogyakarta. This means that the population in Yogyakarta does not affect environmental quality in Yogyakarta. According to research by Nugrahayu *et al.* (2017), explained that the increase in population in Yogyakarta resulted in an increase in land for settlements. Settlements that are dominated by human land use result in an increase in emissions generated from household activities, especially carbon emissions. So the population can only directly affect the quality of the environment with the resulting population activities, furthermore, the majority of residents in Yogyakarta are migrants from other regions (urbanization), making residents in Yogyakarta have no significant impact on environmental quality. Following the research of Dimnwobi *et al.* (2021); Sarwar & Alsaggaf (2019); and Tarazkar *et al.* (2021), that urban population growth (urbanization) does not contribute seriously to environmental degradation.

This result contradicts the research of Ilham (2021) and Hanif dan Gago-de-Santos (2017), that there is a relationship between population size and environmental quality, where controlling population size can help reduce adverse environmental impacts in developing countries. Furthermore, research by Dimnwobi *et al.* (2021), also explained that population has a positive impact on environmental degradation, namely the decline in environmental quality conditions.

### **The Effect of Tourism on the Environmental Quality Index (EQI) in Yogyakarta**

The number of tourists in Yogyakarta has a significant negative effect on the Environmental Quality Index (EQI) in Yogyakarta. This result is in line with EKC theory supported by research by Deb *et al.* (2023), which states that tourist attendance and income have a negative correlation with CO<sub>2</sub> emissions. Various reasons contribute to the decrease in CO<sub>2</sub> emissions. Following the findings by Ali *et al.* (2020), Granger causality results also concluded that tourist arrivals are one of the leading causes of environmental pollution because tourism-related activities, including transportation, accommodation, food and beverages, and shopping behavior, add up to a large amount of CO<sub>2</sub> emissions. Similarly, tourism development can deteriorate soil structure and cause an increase in CO<sub>2</sub> emissions while building new tourism-related facilities. The large volume of CO<sub>2</sub> worsens the quality of the environment that will arise.

Similarly, Adebayo *et al.* (2023), said that increasing visitor arrivals increases the operation of the tourism industry. This suggests that the growth of tourism activities triggers energy consumption and encourages degradation. This finding is not in line with research (Ahmad *et al.*, 2022; Fethi & Senyucel, 2021; Voumik *et al.*, 2024), that tourism activities can reduce environmental degradation, meaning that the more tourists, the better the environmental quality. Therefore, it is important to consider the local context and factors in managing tourism impacts on the environment. The better the management and awareness of the environmental effects, the better the environmental quality that can be maintained.

## CONCLUSION

The results of the analysis show that GDP has a significant negative effect on the EQI in Yogyakarta. This means that economic improvement, as measured by GDP, is different from an increase in environmental awareness or the implementation of adequate environmental regulations. Education has a significant positive effect on the EQI in Yogyakarta. A high level of education in Yogyakarta contributes to increased environmental awareness and implementation of environmentally friendly technologies. The total population does not have a significant influence on KPI in Yogyakarta. Although an increase in population may lead to a rise in carbon emissions through human activities, this finding suggests that the direct impact of population on environmental quality is relatively low. Urbanization and population characteristics may also affect the relationship between population and environmental quality. The presence of tourists in Yogyakarta increases CO<sub>2</sub> emissions and environmental degradation through tourism activities such as transportation, accommodation, and consumption. This is consistent with the finding that the growth of the tourism industry often worsens environmental quality despite studies showing that tourism can help reduce environmental degradation. Suggestions from researchers for future policies include concrete steps needed to manage the tourism industry in Yogyakarta and make it more sustainable. Future researchers can deepen the study related to other factors that can affect the environment, such as household behavior factors, government policies, or other relevant factors.

The implications of this research are useful for the government to develop policies that focus on raising awareness and stricter environmental regulations in Yogyakarta. In addition, the tourism industry needs to be managed sustainably with strategies such as eco-friendly transportation, sustainable infrastructure, and tourist education on environmental sustainability. The limitations of this research are seen from the secondary data published by the Yogyakarta city government, which has limitations in accuracy and completeness. Then, several other factors can affect environmental quality, such as household behavior, government policies, and technology, that are not considered in this study. It is hoped that future research will add other factors that can affect environmental quality, especially in Yogyakarta.

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