

Analysis of Population Density, Economic Growth Rate, and the Number of Motorized Vehicles on Environmental Quality in Indonesia

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Abstract: This study, entitled "A nalysis of Population Density, Economic Growth Rate, and the Number of Motorized Vehicles on Environmental Quality in Indonesia," aims to analyze: 1) the development of environmental quality in Indonesia; 2) the influence of population density, economic growth rate, and the number of motorized vehicles on environmental quality in Indonesia. This study employed a quantitative method, utilizing secondary data from 2019-2023, sourced from the Central Statistics Agency (BPS), the Ministry of Environment and Forestry (KLHK), and other sources. Panel data analysis tools, classical assumption tests, and hypothesis testing were used. Panel data regression results indicate that, partially, population density has a significant negative effect, economic growth rate has a negative and significant effect, while four-wheeled and two-wheeled motorized vehicles have a positive and significant effect on environmental quality in Indonesia. Meanwhile, collectively, population density, economic growth rate, and the number of motorized vehicles significantly influence environmental quality in Indonesia.

Keywords: BPS; Economic Growth Rate; Environmental Quality; KLHK; Population Density.

1. Introduction

Indonesia is a country with abundant natural resources and a very large population, making it the fourth most populous country in the world. Continuous population growth from year to year puts significant pressure on environmental quality. According to data from the Central Statistics Agency (BPS), Indonesia's population is projected to reach 282.47 million people in 2024, up from 278.69 million in 2023. This population growth has shown a consistent upward trend over the past five years, with a growth rate of around 1 percent per year. Population growth has implications for increasing demand for land, energy, transportation, and natural resource consumption.

In addition to population growth, Indonesia is also experiencing accelerated urbanization, particularly in major cities like Jakarta, Surabaya, and Bandung. While urbanization has a positive impact on economic growth, it also increases pressure on the environment, particularly related to emissions from motor vehicles, air pollution, green space conversion, and increased waste volume. This is reinforced by data showing an increase in population density from 140 people per km² in 2019 to 147 people per km² in 2023. This increase demonstrates that population growth is outpacing efforts to equitably distribute regional development.

In the environmental context, the Environmental Carrying Capacity theory states that every environment has a limited carrying capacity. If human activities such as transportation, industry, and energy consumption exceed the environment's capacity, environmental degradation occurs. Therefore, analyzing the relationship between population density, economic growth, and the number of motorized vehicles is crucial for understanding the pressures on environmental quality in Indonesia.

Previous studies have shown varying results regarding the influence of these variables. Some studies found a negative relationship between economic growth and environmental

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quality, while others showed that the impact could be positive if accompanied by adequate environmental policies. This inconsistency highlights the need for further research using more recent data and a more comprehensive analytical approach.

2. Preliminaries or Related Work or Literature Review

This section discusses the theoretical foundations and previous research findings relevant to this study. The discussion includes population theory, economic growth theory, environmental theory, and empirical studies related to the effects of population density, economic growth, and the increasing number of motorized vehicles on environmental quality. The literature on environmental issues is diverse and demonstrates that environmental quality is influenced by various multidimensional factors.

The concept of environmental quality is generally related to indicators such as air quality, water quality, the availability of green open spaces, carbon emissions, and pollution levels. Various studies indicate that uncontrolled increases in human activity are a major factor in the decline of environmental quality. This is exacerbated by inadequate waste management, the extensive use of fossil fuels, and high fuel consumption by motorized vehicles.

Population Density and Environment

Population density is an important indicator reflecting pressure on the environment. Research by Kondolele and Mustari (2025) found that population density has a significant negative impact on environmental quality, particularly on the island of Java. This is due to high human activity, increased transportation needs, and limited green open space in densely populated areas.

Furthermore, Urban Ecology Theory explains that the higher the population in an area, the greater the pressure on the ecosystem, including air pollution, water pollution, and soil degradation. Domestic activities, transportation, and energy consumption increase significantly in areas with high population density, leading to increased emissions of CO₂, PM2.5 particulate matter, and other pollutants that impact public health.

Several studies in developing countries show a similar pattern: population growth is closely linked to environmental degradation if not balanced by sound spatial planning policies. High population density is also associated with an increased risk of environmental disasters such as floods, droughts, and water pollution.

Economic Growth, Motor Vehicles, and the Environment

Indonesia's economic growth from 2019 to 2023 showed significant dynamics. 2020 was a period of economic contraction due to the COVID-19 pandemic, but in subsequent years the economy returned to positive growth. Economic growth drove increased industrial activity, energy consumption, and public mobility, leading to an increase in the number of motorized vehicles.

Research by Padilah & Karimi (2025) states that economic growth has a negative relationship with environmental quality if not balanced by sustainable environmental policies. Economic growth results in increased energy demand, much of which is still supported by fossil fuels. This increases pollutant emissions, particularly from the land transportation sector.

The number of motorized vehicles in Indonesia increased from 133 million units in 2019 to more than 157 million units in 2023. A study by Hariz and Karimi (2024) states that motorized vehicles are a major contributor to CO₂ emissions and air pollution in Indonesia. The greater the number of motorized vehicles, the higher the level of air pollution, especially in metropolitan areas.

3. Proposed Method

The research method used in this study is a quantitative approach using regression to analyze the influence of population density, economic growth, and the number of motorized vehicles on environmental quality. Data were obtained from the Central Statistics Agency (BPS) for the period 2019–2023.

The research steps included secondary data collection, data cleaning, descriptive analysis, trend analysis, and regression analysis. The entire process was conducted systematically to ensure the validity of the research results.

Algorithm/Pseudocode

- a. Start
- b. Input data on population density, economic growth, number of motorized vehicles, and environmental quality
- c. Normalize the data
- d. Perform descriptive analysis
- e. Perform regression:
 - 1) Determine the independent variables X_1, X_2, X_3
 - 2) Determine the dependent variable Y
 - 3) Estimate the model $Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \epsilon$
- f. Test the significance of the model and coefficients
- g. Interpret the results
- h. Finish

Formatting of Mathematical Components

The mathematical linear regression model used in this study is:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \epsilon$$

Where:

Y = Environmental Quality

X_1 = Population Density

X_2 = Economic Growth

X_3 = Number of Motor Vehicles

β_0 = Constant

$\beta_1, \beta_2, \beta_3$ = Regression Coefficients

ϵ = Error

4. Results and Discussion

The research results show that population density has a significant negative impact on environmental quality. This suggests that the higher the population density, the greater the pressure on the environment. Furthermore, the number of motorized vehicles also significantly impacts environmental degradation due to increased vehicle exhaust emissions.

Economic growth has varying effects, depending on the level of industrialization and environmental policies in each region. In some regions, economic growth has a positive impact on environmental quality when accompanied by environmentally friendly technologies, while in others, it has a negative impact due to high fossil fuel consumption.

The regression results indicate that the most dominant variable influencing environmental quality is the number of motorized vehicles. This aligns with the real-world situation in Indonesia, where the land transportation sector is the largest contributor to emissions.

Figures and Tables***Environmental Quality***

Indonesia's Environmental Impact Assessment (IKLH) trend shows positive improvement during the 2019–2023 period, although growth is relatively slow. According to Ministry of Environment and Forestry (KLHK) data, the national IKLH score has consistently exceeded the established target. For example, in 2019, the IKLH stood at 71.45 points, and continued to improve, reaching 72.54 points in 2023 (KLHK, 2024; DataIndonesia, 2024). This improvement indicates that efforts by local governments in 34 provinces to control environmental pollution and degradation are beginning to show tangible results.

However, when broken down by component, different dynamics are observed. The Air Quality Index (IKU) is often the component with the highest value, reflecting relatively well-maintained air quality, although air pollution in large cities, particularly from the transportation sector, remains a serious challenge (KLHK, 2024). On the other hand, the Water Quality Index (IKA) tends to have lower and fluctuating values, indicating that pollution of water sources, whether rivers, lakes, or groundwater, remains a major challenge in many provinces (KLHK, 2024). This issue is highly relevant to this research, given that increasing population density and the number of motorized vehicles have the potential to significantly increase the

pollution burden, particularly domestic wastewater and vehicle emissions. Table 1 below illustrates the environmental quality in Indonesia from 2019 to 2023.

Table 1. Overview of Indonesia's Environmental Quality 2019-2023.

Province	Environmental Quality Index By Year				
	2019	2020	2021	2022	2023
Aceh	76.01	75.61	75.54	78.29	78.53
North Sumatra	62.49	69.9	71.15	74.11	72.8
West Sumatra	69.66	72.79	73.68	74.98	75.85
Riau	62.39	69.41	70.72	72.1	70.42
Jambi	68.08	69.87	70.87	70.32	68.53
South Sumatra	61.41	69.92	70.92	70.12	70.2
Bengkulu	64.41	69.91	69.92	71.67	72.1
Lampung	57.37	67.46	68.56	69.1	69.91
Bangka Belitung	64.85	73.5	72.05	71.67	71.62
Riau Islands	67.01	70.51	73.19	74.17	74.26
DKI Jakarta	42.84	52.98	54.43	54.65	54.57
West Java	51.69	59.4	62.68	64.66	64.77
Central Java	60.97	67.62	66.27	66.85	68.59
DI Yogyakarta	49.24	66.65	65.65	65.96	66.29
East Java	60.25	67.07	68.72	69.92	66.59
Banten	51.09	59.37	64.14	63.41	62.52
Bali	63.09	69.79	70.7	70.89	71.38
West Nusa Tenggara	64.59	70.83	69.89	70.56	71.92
East Nusa Tenggara	69.67	73.28	74.97	73.49	74.18
West Kalimantan	65.91	70.07	72.9	71.9	73.73
Central Kalimantan	65.91	70.07	72.9	71.9	73.73
South Kalimantan	61.94	68.43	71.03	71.97	73.5
East Kalimantan	80.79	76.46	75.06	74.46	75.47
North Kalimantan	78.98	78.49	80.85	80.67	80.77
Sulawesi Utara	65.15	70.69	72.82	72.37	70.88
Sulawesi Tengah	80.23	77.53	77.78	78.86	79.93
Sulawesi Selatan	67.63	70.7	73.2	74.17	74.3
Sulawesi Tenggara	72.03	72.82	74.97	76.88	78.41
Gorontalo	74.97	75.31	73.37	72.79	79.52
West Sulawesi	72.03	73.6	75.72	76.77	78.5
Maluku	79.55	75.98	75.92	75.72	78.75
North Maluku	78.44	74.71	77.45	78.84	80.36
Papua	83.96	78.65	81.8	84.22	83.31

Source: Ministry of Environment and Forestry (KLHK) Indonesia

Table 1 shows that Indonesia's environmental quality index fluctuated between 2019 and 2023, but tended to improve overall. This indicates efforts and progress in environmental management, although some provinces experienced year-on-year declines. The highest environmental quality index (IKLH) score in 2022 was 84.22, followed by North Kalimantan, Papua, and North Maluku. Meanwhile, Jakarta consistently had the lowest IKLH score year after year, with a score of only 42.84 in 2019, although this score increased to 54.57 in 2023. This extreme difference indicates a gap in environmental quality between regions with significant forest cover and natural land cover (such as Papua and Kalimantan) and highly urbanized and densely populated areas like Jakarta.

The 2019-2023 period saw a shift from decline to increase in environmental quality in Indonesia. There are several provinces that show a consistent increasing trend, namely West Sumatra from IKLH worth 69.66 in 2019 to 75.85 in 2023, Southeast Sulawesi from IKLH worth 72.03 in 2019 to 78.41 in 2023, West Sulawesi from IKLH worth 72.03 to 78.05 in 2023, and Gorontalo 74.97 in 2019 to 79.52 in 2023. However, there are also provinces that experienced a decrease in IKLH in the last year such as Jambi which fell from 70.87 in 2020 to 68.15 in 2023, Banten from 64.14 in 2021 to 65.52 in 2023, and East Kalimantan from 80.79 in 2019 to 75.47 in 2023. This decline could be caused by various factors, such as increased industrial and mining activities, deforestation, uncontrolled urbanization, or the low effectiveness of environmental policies in the area.

Population Density

During the 2019–2023 period, national population density continued to increase as the population grew. Provinces on the island of Java consistently ranked as the regions with the

highest population density. Jakarta is the most densely populated province, with figures reaching tens of thousands of people per square kilometer, far exceeding the national average. This phenomenon aligns with development theory, which states that economic centers tend to attract migration, which in turn increases demographic pressure.

The high population density in these densely populated provinces has direct consequences for the environment. The increase in the number of households and human activity linearly increases the volume of waste, domestic waste, and the need for transportation infrastructure. This can have an inverse relationship with environmental quality, with highly dense areas often struggling with problems such as a lack of green open space, congestion, and water/air pollution.

In contrast, provinces outside Java and eastern Indonesia, such as Papua, West Papua, or North Kalimantan, have very low population densities. This disparity indicates significant differences in environmental pressures between provinces, making them interesting to analyze within a panel econometric framework. The following is a table that describes population density in Indonesia in 2019-2023:

Table 2. Population Density Overview in Indonesia 2019-2023.

Province	Population Density Per Square Km (Km2) By Year				
	2019	2020	2021	2022	2023
Aceh	93	91	92	95	96
North Sumatra	200	203	205	209	212
West Sumatra	130	132	133	134	137
Riau	80	73	75	74	74
Jambi	72	71	72	74	75
South Sumatra	92	92	93	101	101
Bengkulu	100	101	102	103	104
Lampung	244	260	260	273	277
Bangka Belitung Islands	91	89	90	90	91
Riau Islands	267	252	258	264	260
DKI Jakarta	15900	15907	16158	16158	16146
West Java	1394	1365	1379	1334	1346
Central Java	1058	1113	1120	1078	1093
DI Yogyakarta	1227	1171	1185	1186	1178
East Java	831	851	855	857	865
Banten	1338	1232	1248	1310	1316
Bali	750	747	755	790	788
West Nusa Tenggara	273	286	290	278	283
East Nusa Tenggara	112	109	111	118	120
West Kalimantan	34	37	37	38	38
Central Kalimantan	18	17	18	18	18
South Kalimantan	110	105	106	113	114
East Kalimantan	29	29	30	30	31
North Kalimantan	9	9	9		

Source: Central Statistics Agency of Indonesia (BPS).

Table 2 shows a relatively stable population density across Indonesia's 34 provinces from 2019 to 2023, with an increasing trend in most provinces. This increase is generally driven by natural population growth and urbanization, where people tend to move to larger cities or areas with better economic facilities. On average, population density in Indonesia has increased slowly over the past five years. Some provinces recorded significant growth, while others experienced stagnation or even slight decline due to outmigration or changes in regional administration. The province with the highest population density consistently is DKI Jakarta, with a figure significantly higher than other provinces, namely 15,900 people/km² in 2019, increasing to 16,146 people/km² in 2023. Then West Java with 1,346 people/km², Banten with 1,316 people/km², Central Java with 1,093 people/km², and DI Yogyakarta with 1,178 people/km². These five provinces are all on the island of Java, which is the center of national economic, governmental, and educational activities. Meanwhile, the provinces with the lowest population density in 2023 were West Papua with 12 people/km², Papua with a density of 14 people/km², North Kalimantan with 10 people/km², Central Kalimantan with 18 people/km², East Kalimantan with 31 people/km². These provinces are located in eastern Indonesia and Kalimantan, with vast geographic areas, dense forests, and relatively small populations. Despite their abundant natural resources, their population tends to be sparse and scattered.

Economic Growth Rate

The Economic Growth Rate (EGR), measured as the percentage growth of Gross Regional Domestic Product (GRDP) at constant prices, exhibited significant fluctuations during the 2019–2023 study period. This period is unique because it encompasses the period before, during, and after the peak of the COVID-19 pandemic.

Differences in EGR between provinces are also worth noting. Provinces that rely heavily on export commodities, such as mining in East Kalimantan or plantations in Sumatra and Sulawesi, often exhibit highly volatile EGRs depending on global commodity prices. Meanwhile, service- and industry-based provinces, such as West Java and Banten, exhibit a more stable LPE (BPS, 2024). Fluctuations in the LPE during 2019–2023 provide ideal data variation to test this hypothesis. The following table illustrates the rate of economic growth in Indonesia from 2019–2023:

Table 3. Overview of Indonesia's Economic Growth Rate 2019–2023.

Province	2019	2020	2021	2022	2023
Aceh	4.14	-0.37	2.81	4.21	4.23
North Sumatra	5.22	-1.07	2.61	4.73	5.01
West Sumatra	5.01	-1.61	3.29	4.36	4.62
Riau	2.81	-1.13	3.49	4.36	4.21
Jambi	4.35	-0.51	3.57	5.12	4.61
South Sumatra	5.69	-0.11	3.58	5.24	5.08
Bengkulu	4.94	-0.02	3.27	4.31	4.28
Lampung	5.26	-1.66	2.77	4.28	4.55
Bangka Belitung Islands	3.32	-2.29	5.05	4.4	4.38
Riau Islands	4.83	-3.8	3.43	5.06	5.16
DKI Jakarta	5.82	-2.39	3.55	5.25	4.96
West Java	5.02	-2.52	3.41	5.45	5.47
Central Java	5.36	-2.65	3.33	5.31	4.97
DI Yogyakarta	6.59	-2.67	5.58	5.15	5.07
East Java	5.53	-2.33	3.56	5.34	4.95
Banten	5.26	-3.39	4.40	5.03	4.81
Bali	5.6	-9.34	-2.46	4.84	5.71
West Nusa Tenggara	3.9	-0.62	2.3	6.95	1.8
East Nusa Tenggara	5.25	-0.84	2.52	3.08	3.47
West Kalimantan	5.09	-1.82	4.8	5.07	4.46
Central Kalimantan	6.12	-1.41	3.59	6.45	4.14
South Kalimantan	4.09	-1.82	3.84	5.11	4.84
East Kalimantan	4.7	-2.9	2.55	4.48	6.22
North Kalimantan	6.89	-1.09	3.99	5.32	4.94
West Sulawesi	5.65	-0.99	4.16	5.42	5.48
Central Sulawesi	8.83	4.86	11.68	15.22	11.91
South Sulawesi	6.91	-0.71	4.64	5.1	4.51
Southeast Sulawesi	6.5	-0.65	4.1	5.53	5.35
Gorontalo	6.4	-0.02	2.4	4.03	4.5
West Sulawesi	5.56	-2.34	2.57	2.26	5.23
Maluku	5.41	-0.91	3.63	5.31	5.21
North Maluku	6.25	5.39	16.79	22.94	20.49
Papua Barat	2.66	-0.76	-0.51	2.03	5.18
Papua	-15.74	2.39	15.16	8.97	4.22

Source: Central Statistics Agency of Indonesia (BPS).

Table 3 illustrates the economic growth rates across Indonesia's 34 provinces from 2019 to 2023, with varying degrees of high economic growth, stable growth, and fluctuating or low growth. North Maluku, the province with the highest economic growth rate from 2019 to 2023, experienced a remarkable surge of 16.79% in 2021, 22.94% in 2022, and 20.49% in 2023. This growth was driven by the expansion of the nickel processing industry and smelters as part of the national downstream program. This was followed by Central Sulawesi and Papua. Several provinces exhibited stable and sustainable growth patterns, including West Java, which recorded 5.45% growth in 2022 and 5% growth in 2023, and Central Java, which recorded 5.31% growth in 2022 and 4.97% growth in 2023.

Number of Motor Vehicles

The number of motorized vehicles is a key variable suspected to be a major contributor to air pollution, particularly in densely populated areas and economic centers. Data from the Statistics Indonesia (BPS) and the Indonesian National Police Traffic Corps (Korlantas Polri) show that the number of motorized vehicles in Indonesia continues to experience a substantial increase from year to year. The total motorized vehicle population in Indonesia surpassed 133 million units in 2019 and will continue to grow, approaching 157 million units by 2023 (Kompas.com, citing BPS, 2025). This growth reflects increasing purchasing power and limited efficient public transportation options in many regions.

For the purposes of this analysis, the data is divided into two categories: (a) Two-Wheeled Vehicles (Motorcycles): In absolute terms, motorcycles are the most dominant type of vehicle in Indonesia. BPS data shows that they account for over 80% of the total national motorized vehicle population (Kompas.com, 2025). The highest concentration is undoubtedly on the island of Java. This massive increase in the number of two-wheeled vehicles indicates a significant increase in mobile emission sources, which directly impacts the Air Quality Index (IKU) in urban areas. (b) Four-Wheeled Vehicles (Passenger Cars, Buses, Trucks, etc.): Although far fewer in number than motorcycles, four-wheeled vehicles contribute significantly to emissions. The number of four-wheeled vehicles, especially private passenger cars, continues to increase.

This exponential growth in motorized vehicles has direct implications for traffic congestion, fossil fuel consumption, and the release of exhaust gases (carbon monoxide, nitrogen oxides, sulfur dioxide, and particulates), which are the main triggers for the decline in the Air Quality Index and indirectly affect overall environmental quality. This statistical correlation will be further examined in a regression analysis. The following table illustrates the number of motorized vehicles in Indonesia for the period 2019-2023:

Table 4. Overview of the Number of Motor Vehicles in Indonesia 2019-2023.

Number	Province	Year	Four-Wheeled Motor Vehicles	Two-Wheeled Motor Vehicles
1	Aceh	2019	158406	1933053
		2020	160334	1978138
		2021	166601	2086604
		2022	174453	2180812
		2023	200917	2325669
2	Sumatera Utara	2019	647775	5724881
		2020	658330	5821157
		2021	691252	6076695
		2022	730264	6318408
		2023	813329	6658953
3	Sumatera Barat	2019	261992	1979526
		2020	265241	2022227
		2021	274513	2127503
		2022	285254	2228335
		2023	370081	2464700
4	Riau	2019	327669	3185951
		2020	334144	3253261
		2021	354651	3431857
		2022	380764	3627077
		2023	426607	3858987
5	Jambi	2019	159007	1949188
		2020	162107	1991271
		2021	171178	2099801
		2022	182176	2213171

		2023	205320	2338498
		2019	360474	2954630
		2020	366969	3006479
6	Sumatera Selatan	2021	387151	3137227
		2022	409464	3271433
		2023	433976	3430721
		2019	103400	867559
		2020	104579	884151
7	Bengkulu	2021	107540	925394
		2022	110743	964276
		2023	125017	1017638
		2019	271216	3187035
		2020	274765	3229304
8	Lampung	2021	286139	3330518
		2022	299817	3433426
		2023	333983	3583340
		2019	77559	917129
		2020	78504	924322
9	Kep. Bangka Belitung	2021	81599	971047
		2022	85621	1025876
		2023	96449	1066582
		2019	138167	826662
		2020	141044	847289
10	Kepulauan Riau	2021	148135	891953
		2022	159694	947219
		2023	216174	1223957
		2019	3310426	15868191
		2020	3365467	16141380
11	DKI Jakarta	2021	3544492	16711638
		2022	3772850	17347866
		2023	3836691	18229176
		2019	3628502	11737547
		2020	3652233	12043160
12	Jawa Barat	2021	3724612	12689634
		2022	3803808	13341328
		2023	3872048	13580671
		2019	1348353	15846499
		2020	1363756	16131478
13	Jawa Tengah	2021	1405334	16800333
		2022	1450700	17443730
		2023	1600074	18411641
		2019	356506	2441874
		2020	359776	2487138
14	DI Yogyakarta	2021	368188	2572811
		2022	377930	2665625
		2023	382480	2779524

		2019	1858782	18977474
		2020	1883822	19349741
15	Jawa Timur	2021	1950975	20031820
		2022	2039556	20750505
		2023	2076146	21122769
		2019	227547	2161809
		2020	232939	2234539
16	Banten	2021	247020	2371748
		2022	263103	2508475
		2023	344866	3254771
		2019	455993	3742000
		2020	459369	3798850
17	Bali	2021	466300	3862635
		2022	479690	3978552
		2023	508943	4267059
		2019	96118	1615817
		2020	97186	1659389
18	Nusa Tenggara Barat	2021	99787	1740049
		2022	103331	1823857
		2023	118530	1972501
		2019	57654	780734
		2020	58062	795011
19	Nusa Tenggara Timur	2021	59532	841384
		2022	61325	877060
		2023	71233	945412
		2019	138484	2294387
		2020	141397	2343626
20	Kalimantan Barat	2021	152238	2480296
		2022	165951	2627031
		2023	183746	2801883
		2019	87814	1195196
		2020	90135	1224863
21	Kalimantan Tengah	2021	97136	1299078
		2022	104914	1369862
		2023	122946	1465831
		2019	215641	2228765
		2020	219216	2274317
22	Kalimantan Selatan	2021	229544	2379834
		2022	242522	2489139
		2023	267428	2633938
		2019	261006	2563074
		2020	266296	2607262
23	Kalimantan Timur	2021	280670	2714323
		2022	300897	2841342
		2023	325201	2852364
24	Kalimantan Utara	2019	11959	123120

		2020	12385	128750
		2021	13601	143955
		2022	14846	164549
		2023	15112	167501
		2019	117122	730409
		2020	119266	744342
25	Sulawesi Utara	2021	127406	795264
		2022	136876	843874
		2023	158563	888529
		2019	82901	1011019
		2020	83966	1024025
26	Sulawesi Tengah	2021	89833	1090209
		2022	96717	1163869
		2023	110247	1266547
		2019	494698	3438236
		2020	503113	3513739
27	Sulawesi Selatan	2021	530350	3702188
		2022	559426	3908744
		2023	607423	4281789
		2019	178253	678658
		2020	180130	698407
28	Sulawesi Tenggara	2021	187061	754731
		2022	195136	818856
		2023	198637	916739
		2019	33282	360575
		2020	33978	368600
29	Gorontalo	2021	35981	396839
		2022	37948	424292
		2023	41331	461388
		2019	18726	304369
		2020	19221	311452
30	Sulawesi Barat	2021	21082	333988
		2022	22980	355523
		2023	25081	376690
		2019	23383	260557
		2020	23700	267263
31	Maluku	2021	24674	286360
		2022	25558	307277
		2023	29692	338944
		2019	18449	237618
		2020	18747	244970
32	Maluku Utara	2021	19906	268416
		2022	21383	291875
		2023	24251	322798
		2019	34329	282377
33	Papua Barat	2020	34585	287292

		2021	35601	303320
		2022	36730	321687
		2023	38958	341026
		2019	30826	365217
		2020	32984	385846
34	Papua	2021	34016	400660
		2022	36435	430381
		2023	103813	785143

Source: Central Statistics Agency of Indonesia (BPS).

Table 4 shows an overview of the number of motorized vehicles in Indonesia for the period 2019-2023. The province with the largest number of vehicles is DKI Jakarta, which in 2023 had 3,836,691 four-wheeled vehicles and 18,229,176 two-wheeled vehicles. Other large provinces such as West Java, Central Java, and East Java also showed a significant upward trend in motorized vehicles. Provinces with high growth in the number of vehicles include Banten, which experienced a surge in four-wheeled vehicles from 227,547 units in 2019 to 344,866 units in 2023, and two-wheeled vehicles, which increased from 2,161,809 units to 3,254,771 units.

Multiple Linear Regression with Panel Data

Multiple linear regression with panel data is an analytical tool that aims to examine the influence of population density, economic growth rate, and the number of motorized vehicles on environmental quality in Indonesia from 2019 to 2023. The following are the results of the multiple linear regression analysis processed using Eviews 12:

$$Y_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + u_{it}$$

The results of the linear analysis are shown in the following table:

Table 5. Results of Multiple Regression Analysis with Panel Data.

Dependent variable: Environmental Quality				
Variabel	Coefficient	Std. Error	t-Statistic	Prob.
C	75,25317	11,15973	6,743281	0.0000
KP	-0,033242	0,016647	-1,996899	0,0479
LPE	-0,136794	0,067152	-2,037092	0,0436
KBRE	2,11E-05	1,61E-05	1,307872	0,1932
KBRD	3,08E-06	2,08E-06	1,484877	0,1400

Source: Eviews Data Processing Results 12, 2025

Based on the Eviews 12 output results above, the following regression equation is obtained:

$$IKLH = 75.25317078 - 0.0332423502169 * KP - 0.136793884788 * LPE + 2.10729286215e-05 * KBRE + 3.08307674894e-06 * KBRD$$

Where:

C = Constant $\beta_0 = 75.2531$

X1 = Population Density $\beta_1 = -0.0332$

X2 = Economic Growth Rate $\beta_2 = -0.1367$

X3 = Number of Four-Wheeled Motor Vehicles $\beta_3 = 0,00002107$

X4 = Number of Two-Wheeled Motor Vehicles $\beta_4 = 0,0000038$

The coefficients of the multiple linear regression equation above can be interpreted as follows:

- The regression equation shows that the constant value of 75.2531 indicates the variable Environmental Quality Level in Indonesia. This means that if the independent variables Population Density, Economic Growth Rate, and Number of Motorized Vehicles are zero (0), then the poverty rate variable will remain at 75.2531 percent in Indonesia.
- Based on the regression coefficient, the Population Density variable exhibits a negative value of -0.0332, indicating that for every increase in Population Density of 1 (one) person per km², the Environmental Quality Index is predicted to decrease by 0.0332 percent..

- Based on the regression coefficient, the Economic Growth Rate variable has a negative value of -0.1367 . This indicates that for every 1% increase in the Economic Growth Rate, the Environmental Quality Index is predicted to decrease by 0.1367 percent.
- Based on the regression coefficient, the equation indicates that the Four-Wheeled Motor Vehicle variable has a positive coefficient of 0.00002107. This implies that for every one-unit increase in the number of four-wheeled motor vehicles, the Environmental Quality Index is predicted to increase by 0.00002107 percent.
- Based on the regression coefficient variable, it shows that the equation for the Number of Two-Wheeled Motor Vehicles variable has a negative value of 3.0830, meaning that if the Number of Two-Wheeled Motor Vehicles variable increases by 1 (one) unit and is considered constant, then the Environmental Quality variable will experience an increase of 3.0830 percent.

Simultaneous or Joint Test (F Test)

The F-test value functions to test all independent variables against the dependent variable together to have a significant effect on environmental quality in Indonesia.

Table 6. Simultaneous Test Results.

R-squared	0.862662
Adjusted R-squared	0.824165
S.E. of regression	2.963725
Sum squared resid	1159.444
Log likelihood	-404.4108
F-statistic	22.40893
Prob(F-statistic)	0.000000

Source: Eviews Data Processing Results 12, 2025

The calculated F value is $22.40893 > F$ table which is 2.426438 and the sig. value is $0.000000 < 0.05$, so H_0 is rejected and H_a is accepted. This means that the variables of population density, economic growth rate and number of motorized vehicles have an effect on environmental quality in Indonesia.

Partial significance test (t-statistic test).

The t-test value, also known as the partial test, is used to prove the influence of population density, economic growth rate, and number of motorized vehicles on environmental quality. To test the independent variable partially against the related variable, to ensure a significant level ($\alpha = 0.05$) with the measure, H_0 is accepted if; t at probability $> \alpha$ and H_0 is rejected if; t at probability $< \alpha$. Based on Table 5 above, the t-test results for the dependent variable, environmental quality, show:

- a. Testing the population density variable
The t-test results for the population density variable (X1) yielded a calculated t-value of -1.996899 , $<$ the t-table value of 1.974185, and a sig. value of $0.479 > 0.05$. The coefficient is negative, indicating that the population density index variable has a negative and significant effect on environmental quality in Indonesia.
- b. Testing the Economic Growth Rate Variable
The t-test results for the economic growth rate variable (X2) yielded a calculated t-value of -2.037092 , $<$ the t-table value of 1.974185, and a sig. value of $0.436 > 0.05$. The coefficient is negative, indicating that the economic growth rate index variable has a negative and significant effect on environmental quality in Indonesia.
- c. Testing the Four-Wheeled Motor Vehicle Variable
The t-test results for the four-wheeled motor vehicle variable (X3) yielded a calculated t-value of 1.307872, $<$ the t-table value of 1.974185, and a sig. value of $0.1932 > 0.05$. The coefficient value is positive, indicating that the four-wheeled motor vehicle index variable has a positive but insignificant effect on environmental quality in Indonesia.
- d. Testing the Two-Wheeled Motor Vehicle Variable
The t-test results for the two-wheeled motor vehicle variable (X4) yielded a calculated t-value of 1.484877, $<$ the t-table value of 1.974185, and a sig. value of $0.1400 > 0.05$. The coefficient value is positive, indicating that the two-wheeled motor vehicle index variable has a positive but insignificant effect on environmental quality in Indonesia.

5. Comparison

Comparison with previous research indicates that this study's results align with those of Kondolele and Mustari (2025), Padilah & Karimi (2025), and Hariz and Karimi (2024). However, some differences were found regarding the impact of economic growth, which can vary depending on regional conditions and the environmental policies implemented.

6. Conclusions

Based on the research and discussion conducted to analyze the influence of Population Density, Economic Growth Rate, and the Number of Motorized Vehicles in Indonesia, the following conclusions can be drawn:

1. The development of Environmental Quality (KLH) in Indonesia from 2019 to 2023 shows complex dynamics. Although the government has generally made efforts to improve the KLH index (as measured by the Water, Air, and Land Cover Quality Index), this improvement remains fragile and uneven across all provinces.

2. Partially, population density has a significant negative effect, economic growth rate has a negative and significant effect, while four-wheeled and two-wheeled motorized vehicles have a positive and significant effect on environmental quality in Indonesia. Meanwhile, collectively, the variables population density, economic growth rate, and number of motorized vehicles have a significant effect on environmental quality in Indonesia.

References

- Bernadet, L., Listyarini, S., & Warlina, L. (2023). The effect of air pollution policies in the transportation sector on air quality index (IKU) values in DKI Jakarta. *Scientific Journal of Environmental Education and Development*, 24(01), 1-13. <https://doi.org/10.21009/plpb.v24i01.30798>
- Din, A. U., Ming, J., Rahman, I. U., Han, H., Yoo, S., & Alhrahshah, R. R. (2023). Environmentally friendly road transportation management and environmental sustainability: The impact of population density. *Heliyon*, 9(9), e19771. <https://doi.org/10.1016/j.heliyon.2023.e19771>
- Din, A. U., Ming, J., Vega-Muñoz, A., Salazar Sepúlveda, G., & Contreras-Barraza, N. (2022). Population density: An underlying mechanism between road transportation and environmental quality. *Frontiers in Environmental Science*, 10, 1-12. <https://doi.org/10.3389/fenvs.2022.940911>
- Fatimah, & Nuryaningsih. (2018). *Textbook*.
- Hasni, & Azhar. (2021). The effect of investment, population density, and transportation on environmental degradation in Indonesia.
- Kondolele, Y. B., & Mustari, B. (2025). Determinants of environmental quality in Indonesian population centers. *Yusliaty Bubun Kondolele 1, Bakhtiar Mustari 2*, 4, 71-93.
- Kondolele, Y. B., Rahmatia, & Mustari, B. (2023). Analysis of determining environmental quality in Java. *Journal of Economics and Social Dynamics*, 2, 45-65.
- Kurnia, A. L. (2021). 4518-Article text-16101-1-10-20211209. *GRAVITASI Journal of Physics and Science Education*, 4, 1-9.
- Kurniawan, (2024). Economic growth as a reflection of a country's economic development. *Journal of Management and Business Economics*, 2(3), 40-47. <https://doi.org/10.54066/jmbe-itb.v2i3.1898>
- Kurniawan, B., Restia Sunarya, S., Naofal, F., & Mukdas Sudarjah, G. (2021). Export price index, inflation, unemployment, and their effects on national income in Indonesia and Korea. *Journal of Economic Research*, 1(3), 120-130. <https://doi.org/10.23969/jrie.v1i3.19>
- Latipa, K., Di, H., & Sari, Y. (2024). Proceedings of the national conference of the University of Jambi, 1, 177-184.
- Muhammad. (2021). *Islamic economic research methodology: A quantitative approach*. Jakarta: PT. Rajagrafindo Persada.
- Nababan, A. A., Jannah, M., Aulina, M., & Andrian, D. (2023). Air quality prediction using Xgboost with synthetic minority oversampling (Smote) technique based on the air pollution standard index (Ispu). *JTIK (Jurnal Teknik Informatika Kaputama)*, 7(1), 214-219. <https://doi.org/10.59697/jtik.v7i1.66>
- Padilah, F., & Karimi, K. (2020). Macroeconomic impact on the environmental quality index in Indonesia. *July*, 1-23.
- Palar, M. S., & Prijadi, R. (2024). E ISSN 2723 radiation global warming and climate change have become one of the greatest challenges facing humanity today. Atmospheric hot gases and the resulting temperature increase have increasingly significant impacts that trigger increased activity. *21(2)*, 11-26.
- Patra Yuda, M. A., & Idris, I. (2022). Analysis of population density, economic growth, and environmental budgets on environmental quality in Indonesia. *Journal of Economic and Development Studies*, 4(2), 53.
- Putra, & Karimi. (2025). The influence of population, vehicle number, and industrial sector GDP on the air quality index in Indonesia.

- Putra, A. D., & Sari, M. (2021). The impact of motor vehicle growth on urban air quality in Indonesia. *Journal of Environment and Development*, 12(2), 134-145.
- Putra, W. (2022). The effect of population and road length on economic growth through increased vehicle numbers. *Proceedings of the Annual National Academic Seminar on Economics and Development Studies*, 5(1), 170-179.
- Qa A'yun, I., & Tiyaningsih, S. (2023). The impact of economic development and population density on environmental quality in Indonesia. *IOP Conference Series: Earth and Environmental Sciences*, 1151(1). <https://doi.org/10.1088/1755-1315/1151/1/012013>
- Rahmawati, A. (2019). The effect of population, number of motorized vehicles, GRDP per capita, and fiscal policy on oil energy consumption in Indonesia. *Journal of Development and Equity (JPP)*, 10(1), 1-28.
- Rahmawati, S., & Pratama, I. N. (2023). The effect of sustainable transportation use on air quality and public welfare. *Journal of Environmental Policy and Technology*, 1(2), 90-99.
- Ramadhan, A., & Kurniawan, B. (2022). Motor vehicle waste management for environmental pollution mitigation in urban areas. *Journal of Environmental Science*, 19(1), 70-82.
- Saputra, R., & Yuliana, D. (2020). Urban heat island and transportation contribution in metropolitan areas of Indonesia. *Journal of Environmental Engineering*, 8(1), 51-62.
- Soehartono, I. (2022). *Social research methodology*. Bandung: Remaja Rosdakarya.