

Analysis of Economic Sectors Related To Environmental Pollution

Putri Wulandari Atur Rejeki¹, Septiana Dwiputrianti², Ali Akbar³, Adhisti Dara Narda⁴,
Salma Azzahra⁵, Aditya Pratama Rosadi⁵

{putriwulandari@poltek.stialanbandung.ac.id¹, septiana.dwiputrianti@poltek.stialanbandung.ac.id²,
22110179@poltek.stialanbandung.ac.id³, 22110118@poltek.stialanbandung.ac.id⁴,
22110141@poltek.stialanbandung.ac.id⁵, 22110119@poltek.stialanbandung.ac.id⁶}

Polytechnic of STIA LAN Bandung, Bandung, Indonesia

Abstract. The COVID-19 pandemic has influenced global economic progress in various ways. While businesses in various sectors have reduced their carbon emissions, their activities have been constrained. However, the situation has reversed significantly following the end of the pandemic. This study aims to determine which business sectors in Indonesia have the strongest correlation with environmental damage. The research method uses a quantitative approach. The data utilized were economic growth data by business field and air quality data from all provinces in Indonesia in 2021–2023. Data analysis was conducted using correlation analysis. The results of data processing indicate that the real estate business field sector and the air quality index is negative and the largest, namely $r = -0.858$ with a significance level of $\alpha = 0.000$. To maintain a balance between economic growth and environmental conditions, it is advised that the government restrict business sectors and investment from this industry.

Keywords: real estate sector; air quality; economic growth

1 Introduction

The Covid-19 pandemic as a global phenomenon has brought impacts that have implications for the restrictions of most human activities [1]. Furthermore, a series of community mobility that previously ran normally and massively, became shackled by the transformation of restrictions that prohibited physical contact between individuals in the community [2]. Drawing attention to the underlying causes, Nanda et al (2022) explained that the mobility restrictions imposed in each country are aimed at controlling the transmission level of the spread of Covid-19 virus infection [3]. However, the restrictions imposed with the aforementioned intentions can have a domino effect as a consequence.

The impact of restrictions on physical contact between individuals in society can be clearly seen in economic activities that have undergone major changes during the Covid-19 pandemic [4]. As a result of these restrictions, it is known that many countries have experienced economic contraction [5]. This is certainly a concern for stakeholders in every country who feel the need to pay attention to the Covid-19 pandemic phenomenon. However, when looking at the current readiness, most developed countries have fiscal reserves that they can utilize at this time. Therefore, the ability to inject fiscal funds can be realized during the transition period towards the post-COVID-19 period. As a result of these restrictions, it is known that many countries

have experienced economic contraction [6]. Meanwhile, a striking difference from the existing comparison with developing countries is their limited budgets [6] [7]. Developing countries with limited budgets are required to allocate funds to improve health facilities and at the same time need to improve deteriorating economic conditions [6]. The impact of this problem in developing countries has been felt by Indonesia as one of the developing countries in the Asian region.

Indonesia, during the Covid-19 Pandemic, has experienced a fairly dynamic economic shock situation. This certainly cannot escape the intervention of the sector that underlies the movement in the pace of the country's economy. Based on a study conducted by Susilawati et al (2020) entitled "Impact of COVID-19's Pandemic on the Economy of Indonesia" states that there is a decrease in the productivity level of the economic sector in Indonesia [8]. According to her, the main sectors that are most affected are the accommodation, transportation, retail, and manufacturing sectors which cause the current account deficit [8]. This is generally due to a decrease in the intensity of production processes, energy consumption, and transportation mobility that were previously running normally. Thus, the resulting efforts in value-added creation are different from the results in the years before the Covid-19 Pandemic [9]. However, as the productivity of each sector declined, the situation seemed to reverse when the increase in air quality levels increased during the Covid-19 Pandemic.

Thus, emphasizing the situation of a decline in the productivity of the economic sector, has a relationship with the level of air quality that actually improves when the decline occurs [10]. This can be said because when referring to previous studies, Xiong and Xu (2021) elaborated the concept of the Environmental Kuznets Curve (EKC) to explain the relationship between economic growth and environmental pollution. The EKC shows that in the early stages of economic growth, increased economic activity and energy consumption tend to lead to increased environmental pollution. This is because developing countries often rely on their industrial growth on traditional, dirtier energy sources, such as oil and coal. However, after reaching a certain income level, these countries begin to adopt cleaner technologies and practices, which can reduce emissions and negative environmental effects [11].

However, the consistency of the increase in air quality caused by the sluggish economic sector did not last long when the Covid-19 Pandemic began to end. With the start of normal community activity, the level of air quality is also accompanied by a decrease in the resulting quality trend [12]. Furthermore, the decline is closely related to the productivity turmoil in the economic sector that has begun to spread to various activities.

Although many previous studies have linked the discussion of the relationship between economic growth and air quality, there are still gaps in the understanding of the implications of economic sectors based on business fields, on the function of the Air Quality Index as a parameter of air quality. Therefore, the results outlined in the main elaboration of this research can explore an integrated series of which sectors of the business sector have a damaging relationship with air quality in Indonesia.

Therefore, the author feels interested in analyzing the economic sectors that have the highest relationship to air pollution after the Covid-19 Pandemic in all provinces in Indonesia. In addition, there are also objectives of this study are to answer the following questions (1) how has economic growth in each sector in Indonesia after the Covid-19 Pandemic; (2) how is the level of air quality in each province in Indonesia after the Covid-19 Pandemic; (3) is there a significant relationship between each business sector to environmental pollution in each province in Indonesia after the Covid-19 Pandemic; and (4) what should be done by the government in overcoming this.

2 Method

The method used in this research is a quantitative method with secondary data. The secondary data used is data obtained from pre-existing sources, such as annual reports, official publications, and relevant statistical data. This research focuses on correlation analysis to determine the relationship between the level of the economic sector and air pollution in the environment that occurs in Indonesia based on per-province data from each economic sector studied during the period 2021 to 2023.

According to Sugiyono [13], the correlation analysis method aims to identify and measure the strength and direction of the relationship between two variables. In the context of this research, the variables analyzed are the level of the economic sector and the level of environmental pollution. Thus, this research aims to find out which economic sectors have a significant relationship with environmental pollution, especially air pollution that occurs. The data used in this research is taken from various reliable sources, such as the Central Bureau of Statistics (BPS) and environmental reports.

To analyze the relationship between the two variables, namely the economic sector and air pollution, correlation analysis was used [14]. This coefficient is obtained using the following formula:

Formula as follows:

$$r = \frac{\frac{1}{n-1} \sum (X_{1i} - \bar{X}_1)(X_{2i} - \bar{X}_2)}{s_{x_1} s_{x_2}} \quad (1)$$

Or it can be written as follows:

$$r = \frac{\sum X_{1i} X_{2i} - n \bar{X}_1 \bar{X}_2}{\sqrt{(\sum X_{1i}^2 - n \bar{X}_1^2)(\sum X_{2i}^2 - n \bar{X}_2^2)}} \quad (2)$$

Where r is the correlation coefficient, X is the economic sector, and Y is air quality.

The resulting r criteria can be categorized as follows:

r = 0 means there is no linear relationship between the economic sector and environmental pollution

r = 1 means there is a perfect positive correlation

r = -1 means there is a perfect negative correlation. [14].

Through correlation statistical analysis, the researcher sought to gain a better understanding of the relationship between the most significant economic sectors affecting air pollution in the environment, as well as provide relevant recommendations for resource management and environmental policy.

3 Result and Discussion

3.1 Economic Growth by Business Field in Indonesia

In an effort to stimulate the welfare state of society, the development of the country as an implication of such an effort concretely provides a positive relationship in the pace of the process [15]. Thus, to be able to access information relevant to the results of the development process, economic growth can be one of the indicators used as a benchmark for development results (Islam, 2016). Meanwhile, when examining further about economic growth, Surya et al (2021) state that economic growth is a form of capacity escalation from downstream improvements in the production activities of goods and services in a country, by comparing it to the previous period [17]. On the other hand, Mdingi and Ho (2021) provide an understanding that economic growth is a form of increasing the country's production capacity within a certain period of time, usually this growth can be indicated in the increase in real Gross Domestic Product (GDP) [18]. As such, the two statements have provided a wedge that highlights the level of production of goods and services. This has explicitly given an emphasis that represents the essence of the process of economic growth.

As explained earlier the level of production capacity is a key issue in the process of economic growth, it seems to have cohesiveness with the economic sector or business field which is the fulcrum of economic stability [19]. Furthermore, the framework of understanding the business sector with respect to the scope of economic growth can clearly cover various elements of economic activity. This is evidenced in the statement explained by Donaldson and Walsh (2015) who suggest that business fields within the scope of the economy are areas or sectors where economic activities take place, including the production, distribution, and consumption of goods and services [20]. Thus, the meaning of the statement can be synthesized from the condition of the business field in Indonesia, which is one of the developing countries that is in a period of long-term economic strengthening [21].

As a concrete reflection of the business field that houses much of the economic activity in Indonesia, the visualization of Table 1 below is able to provide a trend analysis referring to the past three years.

Table 1. Data on Economic Growth in Indonesia by Employment in 2021-2023

No.	Business Field	ADHK GRDP by Business Field		
		2021	2022	2023
1.	Agriculture, Forestry, and Fisheries (A)	1404190,9	1435853,2	1454587
2.	Mining and Quarrying (B)	822099,5	858146,6	910679,4
3.	Processing Industry (C)	2284821,7	2396603	2507800
4.	Electricity and Gas Procurement (D)	114861,1	122451,9	128460,5
5.	Water Supply, Waste Management, Waste and Recycling (E)	9919,3	10240,1	10741,4
6.	Construction (F)	1102517,7	1124725,2	1179989
7.	Wholesale and Retail Trade; Repair of Automobiles and Motorcycles (G)	1449831,4	1529951,8	1604114

8.	Transportation and Warehousing (H)	406169,3	486873,8	554854,9
9.	Provision of Accommodation and Drinking Food (I)	310737,6	347854,6	382674,5
10.	Information and Communication (J)	696506,1	750319	807304,6
11.	Financial and Insurance Services (K)	464637,7	473623,8	496236,8
12.	Real Estate (L)	333282,9	339014,9	343864,8
13.	Company Services (M, N)	197106,7	214399	232076,1
14.	Government Administration, Defense, and Compulsory Social Security (O)	364246,6	373404	378989,1
15.	Education Services (P)	350660	352673,5	358952,1
16.	Health Services and Social Activities (Q)	157085,5	161397,8	168926,2
17.	Other Services (R, S, T, U)	200773,2	219778,4	242891,7
	Real Gross Domestic Product	11120059,7	11710247,9	12301394

By observing the data outlined in Table 1, the overall condition of the business sector in Indonesia has increased in terms of real GDP capacity over the past three years. However, the increase does not only appear to have an unclear cause, in fact, the increase in the number of people with human capital, which includes aspects of education, health, and per capita expenditure, has also contributed to the transformation of the business sector structure, especially from the industrial and service sectors [22].

In addition, the money circulation factor that affects the pace of business development in Indonesia is still largely dominated by domestic demand. This was stated by Thorbecke (2023) in his study entitled "Sectoral evidence on Indonesian economic performance after the pandemic" that most of Indonesia's economic growth is driven by domestic demand [23]. Data from the study shows that around 70% of Indonesia's economic growth in 2021 and 80% in 2022 will come from domestic demand. Projections for 2023-2025 show that between 92% and 102% of Indonesia's economic growth will come from domestic demand.

Meanwhile, when examined further regarding the amount of each sector in Table 1, the sector of the manufacturing industry has occupied the first position in its contribution to GDP, respectively amounting to 2284821.7 billion Rupiah in 2021, 2396603 billion Rupiah in 2022 and 2507800 billion Rupiah in 2023. This is because the largest contribution to the growth of the manufacturing industry comes from capital, which accounts for around 90.4% of the growth of the industry [24]. This shows that investment in capital is essential to increase production capacity and industrial efficiency.

3.2 Air Quality Levels in All Provinces in Indonesia

In an effort to increase production capacity within the economy, attention to the environment is often overlooked. Thus, the importance of highlighting the balance between economic growth and air quality levels requires the construction of harmony aimed at

strengthening sustainable economic development [25]. When drawing the substance of air quality as a concept, Tan et al (2021) describe air quality as an atmospheric condition influenced by the concentration of various pollutants in the air [26]. In addition, the air quality index can be used to measure and convey information about air quality levels to the public [26].

Furthermore, measurements involving the air quality index as a reflection of the existing conditions of air quality levels can be seen in the development of air quality levels in Indonesia. As a complementary illustration, the following Table 2 outlines the existing air quality levels in each province in Indonesia.

Table 2. Air Quality Index Data after Covid-19 Pandemic 2021-2023

No.	Province	Air Quality Index		
		2021	2022	2023
1.	Aceh	89.63	90.62	90.94
2.	North Sumatra	89.55	89.69	90.9
3.	West Sumatra	90.22	90.65	90.53
4.	Riau	90.13	90.69	90.89
5.	Jambi	87.08	89.85	90.57
6.	South Sumatra	86.28	89.1	87.76
7.	Bengkulu	90.81	91.27	92.49
8.	Lampung	85.46	87.32	88.04
9.	Bangka Belitung Islands	90.39	89.75	90.15
10.	Riau Islands	90.91	90.27	90.13
11.	DKI Jakarta	66.52	68.06	68.46
12.	West Java	79.34	80.31	81.39
13.	Central Java	84.6	85.14	86.35
14.	DI Yogyakarta	88.59	89.16	89.01
15.	East Java	83.2	84.28	84.73
16.	Banten	74.14	73.97	66.67
17.	Bali	89.28	89.19	88.99
18.	West Nusa Tenggara	88.52	89.3	90.21
19.	East Nusa Tenggara	90.51	91.52	92.03
20.	West Kalimantan	90.71	90.9	92.03
21.	Central Kalimantan	90.39	91.25	91.47
22.	South Kalimantan	89.15	89.52	92.85
23.	East Kalimantan	88.84	87.59	89.64
24.	North Kalimantan	93.43	94.52	93.91
25.	North Sulawesi	91.27	92.41	93.52
26.	Central Sulawesi	91.33	91.86	91.88
27.	South Sulawesi	89.13	90.35	90.58
28.	Southeast Sulawesi	90.89	92.05	92.83
29.	Gorontalo	93.96	94.47	94.43
30.	West Sulawesi	90.97	91.88	93.33
31.	Maluku	90.7	91.46	92.47
32.	North Maluku	91.64	92.74	93.19
33.	West Papua	95.6	95.79	96.22
34.	Papua	94.02	95.32	95.87

By looking at the measurement results of the air quality level in Table 2, the results of the understanding that can be poured can also be directed through each province. However, it is known that the highlights that are considered from each of the existing provinces, give rise to the form of different numerical patterns. This is certainly caused by differences in regional conditions of each level of air quality in each province.

Thus, this can be seen in West Papua Province, which has the highest level of air quality with a magnitude of 96.22 (2023) when compared to other provinces. The low level of air quality in West Papua Province is not caused without cause, but is caused by the lack of industrial and household activities that produce pollution (Hariyant et al., 2021) Muhammad et al., 2024). In addition, West Papua Province has a relatively low population and population density is not high. This reduces pollutant emissions from human activities, such as transportation and industry [27]. On the other hand, the Indonesian Ministry of Public Works and Public Housing through the local government in West Papua Province, especially the Regional Government of Sorong City, has given its attention by organizing the construction of the 3R Integrated Waste Processing Site (TPST 3R). [29]. Through TPSK 3R, the Sorong City area is helped in protecting the quality of air, soil, and water from pollution caused by waste, especially those from landfills that are not well managed [29].

Meanwhile, when looking at the lowest level in terms of existing air quality, Banten Province occupies the lowest position when compared to other provinces. With an acquisition rate of 66.67 (2023), Banten Province has a connection between the causes that underlie the consequences of low air quality. Puspaningtyas et al (2024) explained that the low level of air quality in Banten Province is caused by the combustion process of one of the existing power plants at PT PLN (PLTU) [30]. The combustion indirectly has an effect by releasing the remnants of processing as emissions released from the combustion process. Not only that, as the cause of most of the industries in the western part of Banten Province, it also triggers the spread of excessive pollutants to the surrounding areas [31]. Therefore, the consequence of the low air quality level of the issue gives Banten Province the province with the lowest position in terms of air quality level in Indonesia.

3.3 Relationship between Economic Growth by Business Field and Air Quality Level in Indonesia

As a description that highlights the consequences of economic growth through the perspective of environmental balance in the level of air quality, the scope of activities that include the business sector as a sub-activity that exists has provided a correlation to it. As a supporting argument in a previously conducted study, Bergstra et al (2022) explained that there is a significant correlation between economic sector activities, especially heavy industry, and air quality levels [32]. Results from these studies show that exposure to industrially generated air pollution, such as PM10, NOX, and SO₂, is associated with increased incidence of chronic diseases, including cardiovascular disease (CVD) and inflammatory conditions [32]. Intensive industrial activities, such as petrochemical plants and fertilizer factories, produce pollutant emissions that can affect the surrounding air quality. As a result of the study, Bergstra proved that the higher the level of exposure to pollutants from industrial sources, the higher the likelihood of chronic diseases in the population studied.

Meanwhile, Feng et al (2023) suggested that the significant correlation between economic sector activities and air quality levels can be traced through the production restriction policy

implemented in China as the locus of the study [33]. The policy action is aimed at reducing pollutant emissions from industry. As such, it has proven effective in reducing the concentration of pollutants such as sulphur dioxide (SO₂) and nitrogen oxides (NO_x), but it also brings with it a noteworthy economic impact, where production restrictions can hurt the economic performance of companies and reduce investment in green technologies [33]. In addition, the improved air quality resulting from these environmental policies provides significant health benefits, such as the avoidance of premature deaths, which supports long-term economic growth.

Thus, the intersection that arises in the two studies can be digested from the range of activities provided by existing industries or economic sectors. As the linkages generated in the wedge, the reference that can be seen to measure the correlation of the business sector as a sub of economic activity to the level of air quality in Indonesia can be obtained in the Pearson Product Moment correlation analysis (Pearson Correlation). Based on data processing that has previously been carried out in the economic growth variable through the Real Estate (L) business field with the Air Quality Index (AQI) variable, the value obtained is $r = -0.858$ with a significance level of $\alpha = 0.000$. This provides a correlation between the business field of Real Estate and air quality in all provinces in Indonesia is negative and strong. In addition, five businesses are highly correlated and contribute to the growth of carbon emission levels, which can be visualized in Table 3 below.

Table 3. Data from the Highest Correlation Between Five Business Fields and Air Quality in 2021-2023

No.	Sector	Correlation	Sig.
1.	Real Estate	-0.858	.000
2.	Health and Social Services	-0.784	.000
3.	Information and Communication	-0.769	.000
4.	Other Services	-0.766	.000
5.	Education Services	-0.750	.000

By looking at Table 3 above, the Real Estate sector has a high correlation value compared to the four sectors below it with a correlation score. As stated by Fu and Zhou (2023) the real estate sector can contribute a large amount of carbon emissions and is caused by several key factors [34]. First, the construction process involves the use of heavy equipment and the consumption of large amounts of building materials, such as steel and cement, which generate significant carbon emissions [34]. Secondly, after construction, buildings require large amounts of energy for heating, cooling, and daily electricity use, with much fossil energy use contributing to carbon emissions [34]. In addition, with a correlation value of -0.784 with a significance level of $\alpha = 0.000$, Health Services and Social Activities also contributed to the level of carbon emissions in Indonesia. Or and Seppänen (2024) explains that the reason the sector contributes is due to its use of energy and resources, as well as indirectly through the products and technologies it relies on [35]. Meanwhile, the information and communication sector contributes -0.769 with a significance level of $\alpha = 0.000$. This is due to the increased demand for digital services and new devices that contribute to greater energy consumption [36].

On the other hand, there is also the other services sector with education services in the 4th and 3rd position with a correlation of -0.766 and -0.750 respectively, and a significance level of .000. Both sectors have a deep share in economic activity, especially the education sector. The education sector has a significant correlation with carbon emission levels, especially through the implementation of online education [37]. Online education can reduce carbon emissions in

two main ways: first, it reduces the travel required to attend educational institutions, which in turn reduces emissions from public transportation. Second, the physical closure of educational facilities reduces energy consumption from power plants. [37]. However, if the situation is changed to the conventional way of education, then some facilities such as transportation with building facilities will be reused and produce emissions as well.

4 Conclusion

The results show that the Real Estate Sector has the highest correlation to the decline of air quality in Indonesia. In addition to Real Estate, four other top sectors contribute to air quality degradation in Indonesia, namely the health services sector, social activities, information and communication sector, other services, and education services. These five sectors are believed to produce harmful carbon substances and can damage environmental quality, especially air quality. Therefore, the recommendation that we can convey to the government is the need to integrate the concept of a green building economy by taking into account various existing matters, such as optimizing the level of space utilization, and the adverse effects of construction technology and building materials that are not environmentally friendly [38]. As a follow-up, the government can also reduce business opportunities from the sector and not provide sustainable investment so that the harmony between economic growth and environmental conditions, especially air quality, can be well maintained [39].

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