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Infrastructure, Investment, and Environmental Degradation: A Study of Economic Development in West Sumatra

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ABSTRACT

This study investigates how infrastructure, investment, agriculture, trade and industry influence economic growth and environmental degradation in West Sumatra Province. The research was conducted with a quantitative approach in West Sumatra Province, using time series data for research variables from 2011-2020. Data analysis includes descriptive and inferential analysis as well as testing the assumptions of normality, multicollinearity and autocorrelation using Eviews. These findings demonstrate the significant impact of infrastructure on agriculture and trade, as well as investment in agriculture. However, the investment did not show a significant impact on the industry. Likewise, agriculture significantly influences economic growth and environmental degradation, while trade and industry show mixed impacts. This research recommends that stakeholders prioritize infrastructure development to pave the way rather than foreign and domestic investment, because infrastructure development can improve the quality of the environment while investment reduces the quality of the environment. Apart from that, efforts are needed to increase trade and industrial development. Apart from strengthening the positive influence of infrastructure on environmental quality, it will also weaken the negative influence of investment on environmental quality.

1. INTRODUCTION

Environmental degradation has become an important problem in various parts of the world, including regions in Indonesia. The emergence of public awareness of environmental issues has triggered efforts to understand more clearly and begin to take steps to the real reasons for the problems and causes of environmental degradation. In the early 1970s, environmental issues became an important pillar of economic development. This has become the main goal of various development policies, both at global and national levels. Tyagi et al. [1] stated that environmental degradation is environmental damage due to the depletion of natural resources such as air, water, and soil, the destruction of ecosystems, and the extinction of wildlife. The main cause of environmental damage is human disturbance. The level of environmental impact varies depending on the grounds, habitat, plants, and animals that inhabit it.

Notes from the Central Bureau of Statistics (CBS) of West Sumatra Province for the period 2011-2020, the Environmental Quality Index (EQI), which is closely related to environmental degradation, as shown in Table 1.

Table 1 shows that the IKLH of West Sumatra province is in the range of 70.18 to 90.90, which, according to the Ministry of Environment (KLH) criteria, is still very good and very good. However, if viewed from the perspective of the trend, it can be seen that the IKLH of West Sumatra Province tends to decline (deteriorating), from an IKLH of 90.90 in 2011 to an IKLH of 76.14 in 2020. The decline in environmental quality is quite alarming.

The author's search on West Sumatra Province documents in numbers for the period 2011-2020 shows the rate of development of Gross Regional Domestic Product (GRDP) at constant prices as shown in Table 2.

Table 2 shows that the GRDP growth rate of West Sumatra Province in the period 2011-2020 experienced a significant decline, from 6.34% in 2011 to -1.60% in 2020. The GRDP growth rate in 2020 can be excluded because the impact of a pandemic causes it. COVID-19 in 2019 caused economic disruption in all sectors and all parts of the world, including the province of West Sumatra. Apart from the GRDP rate in 2020 due to the pandemic, the overall development of the GRDP growth rate for the province of West Sumatra also experienced a downward trend, from 6.34% in 2011 to 5.01% in 2019. An economic condition that is also quite alarming.

Table 1. EQI West Sumatra Province 2011-2020

Y	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
EQI	90.90	86.81	71.94	73.29	73.49	70.18	76.67	76.7	77.17	76.14

Source: [2, 3]

Table 2. GRDP West Sumatra Province 2011-2020

Y	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
GRDP	6.34	6.31	6.08	5.86	5.41	5.27	5.3	5.14	5.01	-1.6

Source: [2, 3]

The description of the EQI and the rate of GRDP mentioned above implies that the Province of West Sumatra from 2011 to 2020 is facing quite serious challenges, namely the decline in the rate of economic growth and the decline in the quality of the environment (experiencing environmental degradation). Many factors (internal and external) influence GRDP and environmental degradation in the regional context; in this study, the influencing factors are limited to infrastructure development (transportation), investment (FDI), agriculture, trade, and the manufacturing industry. Thus, the purpose of this study is to determine the extent to which (1) infrastructure affects agriculture, (2) infrastructure has an effect on trade, (3) infrastructure has an effect on the industry, (4) investment has an effect on agriculture, (5) investment has an effect on trade, (6) investment has an effect on the industry, (7) agriculture has an effect on economic growth, (8) agriculture has an effect on environmental degradation, (9) trade has an effect on economic growth, (10) trade has an effect on environmental degradation, (11) industry affects economic growth, (12) industry affects environmental degradation, and (13) economic growth affects environmental degradation. Many factors (internal and external) influence GRDP and environmental degradation in the regional context; in this study, the influencing factors are limited to infrastructure development (transportation), investment (FDI), agriculture, trade, and the manufacturing industry. Thus, the purpose of this study is to determine the extent to which (1) infrastructure affects agriculture, (2) infrastructure has an effect on trade, (3) infrastructure has an effect on the industry, (4) investment has an effect on agriculture, (5) investment has an effect on trade, (6) investment has an effect on the industry, (7) agriculture has an effect on economic growth, (8) agriculture has an effect on environmental degradation, (9) trade has an effect on economic growth, (10) trade has an effect on environmental degradation, (11) industry affects economic growth, (12) industry affects environmental degradation, and (13) economic growth affects environmental degradation.

Environmental degradation

According to Tyagi et al. [1], worldwide, the greatest impact on individual and population health is due to environmental degradation and social injustice. Causes include overpopulation, air and water pollution, deforestation, global warming, unsustainable agricultural and fishing practices, overconsumption, inappropriate distribution of wealth, the rise of corporations, the Third World debt crisis, and militarization and war. Mining is also a destructive development activity where the ecology suffers for the sake of the economy. The consequences of environmental damage include air pollution, water pollution, toxic pollutants, deforestation, solid waste pollution, global warming, drought, desertification, and water scarcity. In this study, what is meant by environmental degradation is measured by the Environmental Quality Index (EQI), which is an early description or indication that provides a quick conclusion of an environmental condition in a certain scope and period.

Economic growth

According to Raharjo [4], economic growth is an effort to increase production capacity to achieve additional output, which is measured using the Gross Domestic Product (GDP) and Gross Regional Domestic Product (GRDP) in a region. In this study, what is meant by economic growth is the rate of GRDP growth at constant prices.

Agriculture

Harris and Fuller [5] in their research revealed that agriculture is the most comprehensive word used to denote how crops and domesticated animals sustain the global human population by providing food and other products. In this study, agriculture means the contribution rate of the business's agricultural, forestry, and fishery sectors.

Trade

Globalization currently experienced by all countries has indirectly resulted in almost every country running an open economic system. Each of these countries is open to international trade. International trade is the link between the domestic economy and the foreign economy. This global trade activity arises because each country cannot fulfill its own needs. International trade activities are exchanging goods and services between two or more countries. In this study, what trade means is wholesale and retail trading activities.

Industry

According to Sholihah et al. [6], in the development process, the industrial sector is used as a development priority, which is expected to have a role as a leading sector or a leading sector for developing other sectors. In this study, what industry means is secondary industry (manufacturing).

Infrastructure

According to Nss et al. [7], infrastructure generally includes roads, bridges, water and sewage systems, airports, ports, and public buildings. Also, it has schools, health facilities, prisons, recreation, power generation, security, fire, landfill, and telecommunications. In this study, infrastructure means the growth rate of transportation and warehousing.

Investment

According to Laopodis [8], in a narrow sense, the investment environment refers to the various investment assets (or instruments) that individuals and institutions can buy and sell and the markets in which these assets are traded. Purchases can be grouped into two main categories: tangible assets and financial assets. Tangible assets are tangible and can be used

to produce goods or services. Financial assets are intangible (or electronic entries) and represent income claims generated from real purchases or allegations made by entities, including governments. In this study, what is meant by investment is the development of the realization of Foreign Direct Investment (FDI).

Relevant research

The researchers explained that their research results concluded that agricultural roads provide time savings and cost reductions [9]. However, the benefits farmers obtain vary depending on the location of agricultural land and roads. Even though the distribution of benefits is different, the farmers do not consider this unfair because the farmer group determines the route. Meanwhile, Luo and Xu [10] stated in their paper that overcoming infrastructure bottlenecks is necessary to provide a window of opportunity for the economy to develop in accordance with its comparative advantages. If conditions are right, good infrastructure can support economies, especially less developed countries, to benefit from participation in global value chains to improve economic structure.

Shehnaz and Idrees [11] further explained that the quality of infrastructure and institutions was positively related to industrial growth. Based on current research results, strengthening institutions and investing more in infrastructure development would be beneficial. Eka [12] explained that the test results show that investment opportunity set-based industrial growth in Indonesia can mediate profitability on company value. Chen and Xie [13] in their research, China's industrial policy has a significant positive influence on economic growth, and rationalization of industrial structure is an important channel for industrial policy to increase economic growth. Meanwhile, Ndiaya and Lv [14] explained that econometric analysis shows that increasing industrial output will boost economic growth in Senegal. Therefore, there is a significant relationship between industrial development and Senegal's economic growth. However, research results show that industrialization will be very helpful in encouraging economic growth.

Ali and de Oliveira [15] explained that it is necessary to consider society's shift towards a circular economy, the need to consider a more integrated framework for analyzing empirical evidence linking pollution and economic development, as well as its implications for human well-being and achieving sustainable development goals. Ma and Jiang [16] presented the results of their study, which showed that effective implementation of environmental regulations can reduce the negative impact of economic development on carbon emissions.

For infrastructure and environmental quality, a study from Teo et al. [17] is the largest infrastructure scheme in our lifetime, bringing unprecedented geopolitical and economic changes far greater than those of other countries. They were developed before. The researchers describe an interdisciplinary framework for considering the nature of environmental impacts, showing how effects interact and aggregate across multiple spatial and temporal scales to create cumulative impacts. Meanwhile, Qiu et al. [18] concluded that FDI is correlated with environmental pollution. There is a positive correlation between economic growth and environmental pollution. Industrial structure, capital-labor levels, and environmental pollution are positively correlated, while pollution control and environmental pollution are negatively correlated.

Research Model

Empirical research by Ogunleye et al. [19] indicates the effect of infrastructure investment on agriculture so that the first hypothesis of the study can be identified:

H1: Researches proved the relationship and influence of infrastructure investment on trade [20-23]; so that the two research hypotheses can be identified:

H2: Researches proved the relationship and influence of infrastructure investment on industry [24-26]; so that the three research hypotheses can be identified:

H3: Empirical research proves the relationship and influence of domestic and foreign investment on the agricultural sector so that the four research hypotheses can be identified [27-31]:

H4: The empirical research proved that there is a relationship and influence of domestic and foreign investment on the trade sector so that the fifth research hypothesis can be identified [32-34]:

H5: The researchers prove the relationship and influence of domestic and foreign investment on the industrial sector so that the sixth research hypothesis can be identified [35, 36]:

H6: They prove the relationship and influence of the agricultural sector on economic growth so that the seven research hypotheses can be identified [37-40]:

H7: The researchers prove the relationship and influence of the trade sector on economic growth so that the eight research hypotheses can be identified [41-45]:

H8: Empirical research to prove the relationship and influence of the trade sector on economic growth so that the nine research hypotheses can be identified [46]:

H9: Empirical research suggests a strong relationship between agriculture and Environmental Degradation so that the ten research hypotheses can be identified [47-49]:

H10: Previous research conducted by studies [50, 51] indicated the influence of trading activities on Environmental Degradation; so that the eleventh research hypothesis can be identified:

H11: Empirical research by studies [52, 53] indicates the influence of industry on Environmental Degradation; so that the twelfth research hypothesis can be identified:

H12: Research and empirical data imply a strong relationship between economic growth and environmental degradation so that the thirteenth research hypothesis can be identified [54-56]:

H13: Economic growth affects environmental degradation.

The hypothesis can be described in the research model as follows (Figure 1):

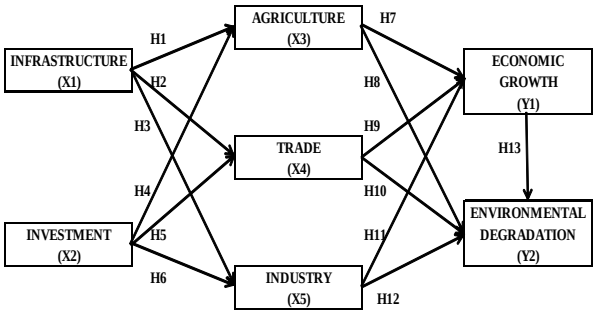

Figure 1. Research model

2. METHODS

The research was conducted quantitatively in West Sumatra Province, using time series data for research variables from 2011-2020. Data analysis includes descriptive and inferential analysis and testing the assumptions of normality, multicollinearity, and autocorrelation using Eviews.

The data used in this research is panel data related to infrastructure, investment, agriculture, trade, industry, and environmental quality research variables, consisting of time series data for 2015 - 2019 and cross-section data taken from 34 provinces in Indonesia.

Data was collected from authentic data and information sources, namely the Central Statistics Agency library, Bappenas library, University and Provincial Government libraries in Indonesia, and from scientific journals and other sources. The data sample in this research is all secondary data related to research variables from 2015-2019 from 34 provinces in Indonesia. Data is collected to obtain the information needed to achieve research objectives. Data collection techniques can be used using interviews, questionnaires, observation, and documentation [57].

Data analysis in this research includes descriptive analysis and inferential analysis. Descriptive analysis in this research is intended to present data descriptively so that readers can easily understand statistical measures to obtain an overview of the characteristics of the distribution of values for each variable studied. Descriptive analysis includes data, central measures, and spread measures. Major efforts include the mean, median, and mode. Measures of spread include variance and standard deviation.

3. RESULTS AND DISCUSSION

Hypothesis testing of each research substructure shows a summary of the results of the analysis as follows:

Table 3. Summary of analysis results

Substructure Equation	Independen Variable	Significance t (Partial)	Significance F (Simultant)	R-Squared	Category
X3 = 3 + 0.08 X1 + 0.53 X2	X1 (Infrastructure)	0.0000	0.000002	0.502104	Categorized as moderate
	X2 (Investment)	0.0157			
X4 = -8.51 + 0.45 X1 + 2.00 X2	X1 (Infrastructure)	0.0000	0.000000	0.645866	Categorized as moderate
	X2 (Investment)	0.0072			
X5 = 4.97 + 0.20 X1 – 1.03 X2	X1 (Infrastructure)	0.0048	0.005633	0.244184	Categorized as weak
	X2 (Investment)	0.2308			
Y1 = 0.40 + 1.02 X3 + 0.19 X4 – 0.08 X5	X3 (Agriculture)	0.0019	0.000161	0.423773	Categorized as moderate
	X4 (Trade)	0.0491			
	X5 (Industry)	0.4530			
Y2 = 12.84 + 3.15 X3 +0.20 X4 + 0.25 X5 – 0.68 Y1	X3 (Agriculture)	0.0033	0.004318	0.344657	Categorized as moderate
	X4 (Trade)	0.4848			
	X5 (Industry)	0.4347			
	Y1 (Economic Growth)	0.1559			

Tests of normality and multicollinearity requirements are met, while all variables have autocorrelation symptoms. Autocorrelation is a situation where observations in a time series are statistically related. This can happen if factors cause dependency between observations at different times [50].

The interpretation of Table 3 can be explained as follows:

1. **Substructure-1: Agriculture (X3) as a function of infrastructure (X1) and investment (X2)**

The analysis results show that both partially and simultaneously, the infrastructure growth variable (transportation and warehouse) and the investment variable (PMA) significantly affect agricultural growth. The results of this analysis align with the opinion of the researchers [19] and [9], which indicates the influence of infrastructure investment on agriculture. The results of this analysis are also in line with the opinion [27-31], which proves the relationship and influence of domestic and foreign investment on the agricultural sector.

The results of this analysis prove that the growth of the agricultural sector in West Sumatra Province is strongly supported by the development of the transportation and warehousing infrastructure sector and the evolution of PMA investment. PMA investments in the agricultural industry generally occur in investments in the oil palm plantation sector. The results of this analysis are supported by an R-squared value of 0.502104, which implies that the transportation and warehouse infrastructure variables, as well as the PMA investment variable, influence the agricultural sector by 50.21%. In comparison, the remaining 49.79% is determined by other factors such as communication infrastructure, banking infrastructure, and PMDN investment.

2. Substructure-2: Trade (X4) as a function of infrastructure (X1) and investment (X2)

The analysis results show that both partially and simultaneously, the infrastructure growth variable (transportation and warehouse) and the investment variable (PMA) significantly affect trade growth. The results of this analysis are in line with the opinions of the researchers [20-23], which prove that there is a relationship and influence of investment in infrastructure towards trade. The results of this analysis are also in line with the opinion of the researchers [32-34], which proves the relationship and influence of domestic and foreign investment on the trade sector.

Transportation and warehousing infrastructure and FDI investment in West Sumatra province generally support the growth of trade in agricultural commodities, especially palm oil plantations. The results of this analysis are supported by an R-squared value of 0.645866, which implies that the transportation and warehouse infrastructure variables, as well as the PMA investment variable, influence the trade sector by 64.59%. The remaining 35.41% is determined by other factors such as communication infrastructure, banking infrastructure, export-import activities, and investment. PMDN and others.

3. Substructure-3: Industry (X5) as a function of infrastructure (X1) and investment (X2)

The analysis results show that simultaneously, the infrastructure growth variable (transportation and warehouse) and the investment variable (PMA) significantly affect industrial growth. However, partially, only the infrastructure variable has a significant effect on industrial development, while investment has no effect. The results of this analysis are in line with the opinion of the researchers [24-26], which proves the relationship and influence of investment in infrastructure on the industrial sector. However, the results of this analysis are not in line with the opinion of the researchers [35, 36], which proves the relationship and influence of domestic and foreign investment on the industrial sector.

The growth of the industrial sector in West Sumatra province is developing with the support of infrastructure development but does not receive support from PMA investment. However, it is suspected that the industrial sector continues to receive investment support from the PMDN sector. This is reinforced by the R-squared value resulting from the analysis of 0.244184, which is very small, implying that the industrial sector's growth is determined by infrastructure and PMA investment of only 24.42%. In comparison, the larger remaining 75.58% is determined by other factors such as banking infrastructure, communication, PMDN investment, etc.

4. Substructure-4: Economic growth (Y1) as a function of Agriculture (X3), Trade (X4) and Industry (X5)

The analysis results show that simultaneously, agricultural, trade and industrial variables have a significant effect on economic growth. However, partially, only agricultural variables and trade variables have a substantial effect on industrial development, while industrial variables have no effect. The results of this analysis are in line with the opinion of the researchers [37-40], which proves the relationship and influence of the agricultural sector on economic growth. The results of this analysis are also in line with the opinion of the researchers [41-45], which proves the relationship and influence of the trade sector on economic growth. However, the results of this analysis are not in line with the opinion of the researchers [48], proving that there is a relationship and influence of the industrial sector on economic growth.

This condition shows that agricultural/plantation growth and trade are growing more rapidly than industrial growth. Hence, the contribution of the farming/plantation sector and the trade sector is greater than the industrial sector's contribution to the economic growth (GRDP) of West Sumatra Province. This condition is also reinforced by the R-squared value from the analysis, which is only 0.423773, which means that economic growth in West Sumatra Province is mainly determined by the agricultural and trade sectors, amounting to 42.38%. In comparison, the remaining 57.62% is determined by other factors outside the industrial sector, such as tourism. the hospitality services sector, the MSME sector supporting tourism, and others.

5. Substructure-5: Environmental degradation (Y2) as a function of Agriculture (X3), Trade (X4), Industry (X5) and Economic growth (Y1)

The analysis results show that simultaneously, agricultural, trade, industrial, and economic growth variables significantly affect the occurrence of environmental degradation (IKLH) in West Sumatra Province. However, only agricultural variables partially influence environmental degradation (IKLH), while trade, industrial, and economic growth variables have no effect. The results of this analysis are in line with the opinion of the researchers [47-49], which implies a strong relationship between agriculture and environmental degradation. However, the results of this analysis are not in line with empirical research:

a. The researchers [50, 51] indicate trading activities' influence on environmental degradation.
b. The researchers [52, 54] suggest the industry's influence on environmental degradation.
c. The researchers [54-56] which implies a strong relationship between economic growth and environmental degradation.

This condition proves that the growth of the agricultural and plantation sectors is the main cause of environmental degradation (decrease in IKLH), namely the change in land cover from forest land to farmland and plantations, where the initial process is often carried out by burning forests which can reduce air quality. Another thing that needs attention is that the analysis results show an R-squared value of 0.344657, which means that the variables agriculture, trade, industry, and economic growth only affect 34.47% of environmental degradation. The larger remainder, namely 65.53%, is influenced by other factors. Other factors that influence environmental degradation that were not examined in this research may include forest destruction due to illegal logging, population growth, tourism development that does not pay attention to environmental aspects, and perhaps also due to smoke from land burning in other provinces.

Environmental degradation in this research is IKLH, which is greatly influenced by land cover conditions, conditions of clean water sources and river watersheds, and air conditions. Meanwhile, economic growth, socio-cultural development, and environmental preservation determine the sustainability of development. Therefore, this research analysis shows that many other variables influence environmental degradation apart from economic development factors alone.

Based on the research findings, the following research discussion can be identified: First, the growth of the

agricultural sector in West Sumatra Province is strongly supported by the development of the transportation and warehousing infrastructure sector as well as the growth of FDI. Foreign Direct Investment in the agricultural industry generally occurs when investing in the oil palm plantation sector. Second, transportation and warehousing infrastructure, as well as FDI in the province of West Sumatra, generally support the growth of trade in agricultural commodities, especially oil palm plantations. Third, the growth of the industrial sector in the province of West Sumatra develops with the support of infrastructure development but does not receive the support of foreign investment. However, it is suspected that the industrial sector still receives support from domestic investment. Fourth, the growth of agriculture/plantation and trade is growing more rapidly than industrial growth. Hence, the contribution of the agricultural/plantation sector and trade sector is greater than the industrial sector's contribution to the economic growth (GRDP) of West Sumatra Province. Fifth, the development of the agricultural and plantation sectors is the main cause of environmental degradation (decreased EQI), namely the change in land cover from forest land to agricultural and plantation land, where the initial process is often carried out by burning forests, which can reduce air quality. Sixth, environmental degradation in this study is EQI, which is strongly influenced by land cover conditions, conditions of clean water sources and watersheds, as well as air conditions. Meanwhile, economic growth, socio-cultural development, and environmental preservation determine the sustainability of development. Therefore, the results of the analysis of this study indicate that there are still many other variables that affect environmental degradation apart from the economic development factor alone.

4. CONCLUSION

The findings of the analysis and discussion of research indicate that:

1. Infrastructure has a significant effect on agriculture with f-statistics 0.0000 0.05
2. Infrastructure has a significant effect on trade with f-statistics 0.0000 0.05
3. Infrastructure has a significant effect on industry with f-statistics 0.0048 0.05
4. Investment has a significant effect on agriculture with f-statistics 0.0157 0.05
5. Investment has a significant effect on trading with f-statistics 0.0072 0.05
6. Investment has no effect on industry with f-statistic 0.2308 > 0.05
7. Agriculture has a significant effect on economic growth with f-statistics 0.0019 0.05
8. Agriculture has a significant effect on environmental degradation with f-statistics 0.0033 0.05
9. Trade has a significant effect on economic growth with f-statistics 0.0491 0.05
10. Trade has no effect on environmental degradation with f-statistic 0.4848 > 0.05

Based on the research findings that have been concluded in the previous description, phenomena can be identified that occur in West Sumatra province that require the attention of the Regional Government and further research. First, environmental degradation in West Sumatra is not influenced by economic growth, the industrial sector, and the trade sector. Still, it is significantly affected by the agricultural sector, where the farm sector is influenced considerably by infrastructure development and investment (PMA). So, it is recommended that the Regional Government be more careful in developing the agricultural (plantation) sector, supported by infrastructure development and PMA investment. Be cautious in analyzing the environmental impacts of agricultural land (plantation) and infrastructure development. Second, West Sumatra's economic growth is not influenced by the industrial sector, while the industrial sector is not affected by investment (PMA). This shows that PMA investment is not interested in the industrial sector but is more interested in the agricultural (plantation) and trade sectors; in other words, the agricultural (plantation) sector and trade in agricultural products (plantation) are still the prima donnas that attract foreign investors. So, to develop the industrial sector, it is recommended that the Regional Government create attractive industrial sector innovations in West Sumatra. Or it was developing the people's craft industry sector, which has the potential for exports as well as job creation.

This research recommends that stakeholders prioritize infrastructure development to pave the way rather than foreign and domestic investment because infrastructure development can improve the quality of the environment while investment reduces the quality of the environment. Apart from that, efforts are needed to increase trade and industrial development. Apart from strengthening the positive influence of infrastructure on environmental quality, it will also weaken the negative impact of investment on environmental quality.

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