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Environmental Quality Analysis from the Perspective of Infrastructure Development and Investment Policy in Indonesia

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ABSTRACT

The primary objective of the research is to ascertain the degree to which infrastructure affects environmental quality. The investigation employed a quantitative methodology, utilizing secondary data along with panel data derived from 34 provinces in Indonesia spanning the years 2015 to 2019. The panel data regression analysis was executed utilizing the standard effect model in Statistical Package for the Social Sciences (SPSS), followed by the application of Moderate Regression Analysis (MRA). The findings of the research indicated the following: first, the results elucidated that infrastructure exerts a significant positive influence on environmental quality. Second, investments were found to have a substantial adverse effect on environmental quality. Third, the agricultural sector was shown to impose a significant negative impact on environmental quality as a consequence of infrastructure. Fourth, the trade sector demonstrates a beneficial and substantial moderating effect on the relationship between infrastructure and environmental quality. Fifth, the industrial sector exhibits a favorable and considerable moderating influence on the interplay between infrastructure and environmental quality. Sixth, the agricultural sector does not constrain the effect of investment on environmental quality. Seventh, the trade sector moderates the negative and significant influence of investment on environmental quality. Eighth, the industrial sector moderates the negative and substantial effect of investment on environmental quality.

1. INTRODUCTION

Infrastructure projects are a public good where government policy plays an important role in influencing the project's effects on economic development and social needs. An adequate infrastructure should improve the smooth production and distribution of goods and services between regions. Infrastructure is the foundation for social and economic development. Infrastructure can also be used as a driving force for national development and become connectivity between regions in Indonesia. Improvements in the infrastructure sector can encourage interest in foreign and domestic investment. Infrastructure can have a positive impact, but the infrastructure can also hurt environmental quality. The replacement of infrastructure in the form of industrial facilities in the city replaced by shopping and entertainment centers will reduce environmental quality; the construction of silk road infrastructure can reduce environmental quality due to land clearing, which results in reduced land cover, the impact of heavy equipment on environmental quality can cause pollution.

The influence of infrastructure can have positive and negative impacts on environmental quality through agriculture as a moderator. Digital infrastructure can help farmers monitor and optimize the use of resources, such as water and fertilizer, thereby reducing waste and improving environmental sustainability [1]. Infrastructure can contribute negatively to environmental quality, and agriculture can cause pollution through increased use of fertilizers and pesticides [2]. Infrastructure can cause habitat fragmentation, soil erosion, and water pollution, negatively impacting environmental quality. Agriculture can reduce this impact by influencing the type and location of infrastructure development. For example, sustainable agricultural practices such as agroforestry and conservation agriculture can help reduce soil erosion and improve soil health, thereby mitigating the negative impacts of infrastructure development on environmental quality.

Additionally, the location of infrastructure development can be influenced by agricultural land use patterns, with careful planning and management helping to minimize negative impacts on natural ecosystems and biodiversity. Overall, the influence of infrastructure on environmental quality with agriculture as a moderator depends on various factors, including the type and location of infrastructure development, the agricultural practices used, and the broader socio-economic context in which the activities are carried out. On the positive side, infrastructure such as roads and irrigation systems can increase agricultural productivity and reduce food

insecurity, reducing pressure on natural ecosystems and biodiversity.

Investment in agricultural research and development, acting as a moderating factor, has the potential to facilitate the adoption of innovative technologies that enhance productivity while concurrently reducing environmental degradation. For instance, investments directed towards the development of genetically modified crops, which bolster environmental quality by augmenting resistance to pests and diseases, can diminish the reliance on chemical pesticides, thereby safeguarding the environment. Such investments can exert both beneficial and detrimental effects on environmental quality within the agricultural sector. The practices associated with agriculture and rural development may lead to water pollution as a consequence of fertilizer and pesticide application, resulting in the contamination of groundwater resources. Conversely, investments aimed at promoting sustainable agricultural practices can yield favorable outcomes for environmental quality. For example, research conducted in Tanzania has demonstrated that the implementation of solar-powered irrigation systems can enhance the environmental quality for small-scale food producers. Furthermore, community investments in sustainable agricultural methodologies, such as organic farming, can significantly enhance environmental quality and bolster food security. Empirical evidence suggests that the correlation between economic growth and environmental quality is not invariably negative, as the adoption of cleaner production techniques can be employed to mitigate pollution. It is critical to acknowledge that agriculture can produce both advantageous and adverse effects on environmental quality. The essential objective is to achieve an equilibrium between economic advancement and environmental conservation, promoting sustainable practices and cleaner production methodologies to curtail the negative repercussions of agricultural activities on the environment.

According to reference [3], the exports are an economic activity selling domestic products to foreign markets, while imports buy foreign products for domestic use or marketing. Nchofoung and Asongu [4] examined the impact by explaining the results of the GMM system methodology in 36 African countries between 2003-2019 showing that infrastructure development worsened CO_2 emissions in Africa. When infrastructure interacts with the openness of the trade sector, where trade is moderated, it produces a negative net effect up to the threshold of trade sector openness.

Nzumile and Taifa [5] examined the effects of removing trade barriers in African countries, finding that improvements in infrastructure can expedite trade delivery times, minimize product rejections, and enhance environmental protection. This, in turn, helps to eliminate trade barriers and positively moderates the impact of infrastructure on environmental quality [6]. From 1970 to 2019, researchers explored the varying impacts of physical infrastructure and land openness on Pakistan's ecological footprint. They discovered that both land openness and infrastructure could reduce the asymmetric ecological footprint in the short term and the symmetric footprint over the long term. Additionally, trade openness, which reflects a country's economic integration into the global trade system, can influence the relationship between infrastructure and environmental quality. For instance, a study assessing the impact of infrastructure on CO_2 emissions in Africa concluded that the effect of infrastructure on environmental quality is contingent upon trade openness and governance dynamics [7]. The environmental impact of infrastructure development is impacted by the extent of trade openness and the effectiveness of environmental governance.

However, well-planned infrastructure can improve environmental quality by encouraging sustainable practices and minimizing resource use. Trade can mitigate this impact by affecting the type of infrastructure produced and the environmental standards used. Trade agreements, for example, can influence the strictness of environmental legislation as well as the use of greener technologies in infrastructure projects. A technical breakdown of carbon emissions and worries about the impact of FDI and trade openness in the United States reveals that FDI and trade openness have a favorable influence on carbon emissions. However, institutional quality can offset the harmful impact of FDI and trade openness on the environment. In the development process, the industrial sector is prioritized and is intended to lead the way in developing other sectors [8]. Leading the sector entails developing the industrial sector to stimulate and elevate the development of other sectors, such as agriculture and services.

Patnaik [9] posits that although the industrial sector may negatively correlate with environmental quality, it holds the potential to enhance the long-term sustainability of an environmentally favorable system. Supporting research [10] indicates that sustainable development can strengthen ecological sustainability, thereby improving environmental performance and yielding more beneficial outcomes than previously observed.

The industrial sector plays a crucial role as a moderator: it can significantly impact whether infrastructure development exacerbates or alleviates environmental repercussions. For example, corporate investments in environmental sustainability can mitigate the negative effects of infrastructure development on environmental performance [11]. Conversely, if the industrial sector neglects to adopt cleaner technologies and processes, the adverse effects of infrastructure development on the environment could intensify significantly.

Environmental regulations can also moderate the interaction between green financial development, industrial structure improvements, and the pursuit of high-quality economic growth. Infrastructure itself can greatly influence environmental quality, especially when the industrial sector acts as a moderating agent. Well-designed infrastructure, such as efficient transportation systems and effective waste management facilities, can significantly reduce the environmental impact of industrial activities. For instance, well-planned transportation infrastructure can decrease emissions and alleviate congestion, while adequate waste management facilities can lower pollution levels.

However, inadequately designed or insufficient infrastructure has the potential to exacerbate environmental challenges associated with industrial operations. The industrial sector, functioning as a mediator, can play a pivotal role in shaping both the development and upkeep of infrastructure to promote environmental sustainability. A scholarly investigation published in the "Journal of Environmental Management" revealed that the caliber of infrastructure, particularly within the domains of transportation and waste management, significantly affects environmental quality in industrial regions. This research underscores the critical importance of well-maintained infrastructure in mitigating the environmental repercussions of industrial activities. Additionally, a study featured in the

"International Journal of Environmental Research and Public Health" delineates the function of industry as a mediator in shaping infrastructure development to enhance environmental quality. The industrial sector may engage in collaborative efforts with policymakers and urban planners to guarantee that infrastructure fosters sustainable industrial practices while minimizing adverse environmental outcomes. In summation, infrastructure is integral in shaping environmental quality, and the industrial sector can serve as a mediator to influence infrastructure development and maintenance to mitigate the environmental consequences of industrial activities.

The influence of investment on environmental quality can be assessed through a multitude of variables, including the specific industry in question. Investments aimed at environmentally sustainable technologies and practices may yield beneficial effects on the environment. Nonetheless, a definitive correlation between investment and environmental quality remains ambiguous, given that the industrial sector may exert an influence upon it. Numerous studies have identified a positive correlation between investment and environmental quality, with the industrial sector acting as a mediator. For instance, Bleischwitz [12] indicated that the relationship between environmental investments across various industries and pollutant emissions was minimal.

The influence of investment on environmental quality can be ascertained through a multitude of determinants, encompassing the nature of the investment and the specific industry in question. While certain studies indicate a positive correlation between environmental investment and environmental quality, others yield conflicting results. Additional scholarly investigation is imperative to enhance comprehension of the relationship between investment and environmental quality across various sectors. In prior investigations, the researchers employed moderating variables from the agricultural, trade, and industrial sectors to attenuate the effects of infrastructure/investment on environmental quality; consequently, this study endeavored to replicate this methodological approach by incorporating the same sectoral variables. The industry is subjected to scrutiny to investigate the ramifications of infrastructure and investment on environmental quality. For this reason, the author has framed the theme of this research as an Analysis of Environmental Quality Policy in the Agricultural Sector, Trade Sector, and Industrial Sector as Moderators within the context of Indonesia. Therefore, the research variables diverge from those in previous studies, encompassing infrastructure (road stability), investment (DI and FI), the agricultural sector (GRDP within agricultural business domains-agriculture, forestry, fisheries, and plantations-adjusted for constant prices), the trade sector (GRDP within the trade business domain-wholesale and retail trade-adjusted for constant prices), the industrial sector (GRDP within the industrial processing domain-processing industry-adjusted for constant prices), and environmental quality (Environmental Quality Index).

The structure of this article consists of an introduction, literature study and relevant research, research methods, results discussions and conclusions.

2. LITERATURE REVIEW

2.1 Environmental damage

Environmental degradation refers to a decline in the quality of the environment. As noted in reference [13], environmental economics plays a leading role in discussions about green issues, emphasizing that the environment should not be considered independently from the economy. Environmental degradation results from the depletion of natural resources, including air, water, and land, as well as the destruction of ecosystems and the extinction of wildlife.

2.2 Investment

Laopodis [14] states that the many financial assets (or instruments) that people and organizations can purchase and sell, as well as the exchanges where these assets are exchanged, make up the investing environment. Assets fall into two categories: financial and fundamental. Real assets are observable and can be exploited to generate products and services. Factory buildings, machinery, and land are examples of tangible assets. The intangible (electronic entries) financial assets are revenue claims derived from physical assets or from accusations made by various entities, including governments. In contrast to tangible assets, financial assets indirectly support the development of tangible assets rather than producing goods or services themselves. Financial assets comprise securities issued by the government as well as owned bonds or shares.

In this research, "investment" refers specifically to real investment. Capital for real investment in a country can originate domestically or abroad. Investment from abroad is typically referred to as FDI, while investment from within the country is called Domestic Investment (DI) [15]. It has been noted that foreign capital inflows in the form of FDI have risen significantly in developing countries over the past few decades. These FDI inflows help meet the growing investment demands necessary to accelerate economic growth and contribute to economic stabilization.

Gunarto [16] shows a clear relationship between energy usage and carbon dioxide emissions. Furthermore, there does not appear to be a significant association between FDI and carbon dioxide emissions. Over time, the coefficient associated with FDI is negligible, creating confusion in decision-making about whether FDI contributes to higher carbon dioxide emissions. Furthermore, FDI is connected with environmental pollution [17].

In line with Sustainable Development Goal (SDG) 13, investigating these concerns is critical for preserving the environment from the combined effects of climate change. It will also give policymakers with critical insights into whether West Africa's emissions levels are caused by the industrial sector or the presence of multinational firms. Furthermore, it has been claimed that FDI inflows boost environmental innovation practices by enhancing resource efficiency outcomes.

The sample's overall Environmental Performance (EP) showed no significant effect from FDI. The effect of FDI on EP varies between developed and developing countries. Furthermore, the influence of FDI on EP differs with quantile in developed countries [18-20]. In industrialized nations, the effect is statistically insignificant at lower EP quantiles, but becomes significantly positive at middle quantiles, and continues to strengthen with higher EP quantiles.

2.3 Agriculture

Harris and Fuller [21] suggest that the designation

"agricultural sector" encompasses a multitude of methodologies through which domesticated flora and fauna sustain the global human populace by providing sustenance and ancillary products. Nevertheless, agriculture may also exert adverse environmental effects, including the exacerbation of air pollution [22]. As articulated in references [23, 24], a positive relationship exists between transportation, facilitated by infrastructural development, and environmental quality, as it engenders time and cost efficiencies for agricultural producers. Baba et al. [25] underscores the significance of agriculture in fostering rural development by indirectly alleviating poverty, augmenting agricultural output, and stimulating non-agricultural job creation. Moreover, Djokoto [26] contends that governmental support for affordable technological advancements is imperative to encourage their adoption by small-scale farmers. Simultaneously, Maryati et al. [24] observes that a well-established agricultural infrastructure can contribute to time savings and cost reductions.

Rohila et al. [27] suggests that environmental problems result from agricultural intensification, which represents unsustainable resource usage and the use of modern inputs such as pesticides and machines. Water, land, air, and biodiversity are among the most commonly damaged areas by agricultural operations. As a result, any environmental impacts from agriculture will show in these sectors.

Noubissi Domguia and Njangang [28] show a U-shaped association between agricultural growth and environmental quality, particularly CO_2 emissions. This argues that agricultural production can only be attained by reducing environmental quality. The study also found that rising temperatures have a U-shaped effect on agricultural income. In this study, the phrase "agricultural sector" refers to the growth of GRDP in agriculture-related fields (such as agriculture, forestry, and fisheries) at constant prices across 34 provinces in Indonesia.

2.4 Trading

Nchofoung and Asongu [4] concluded that infrastructure positively influences the trade sector, but its interactions with the environment have a negative impact, specifically regarding environmental pollution manifested as CO_2 emissions. Sheraz et al. [29] indicated that the GDP of the trade sector can contribute to reducing carbon emissions through financial support, which also enhances environmental quality while achieving sustainable economic objectives. In terms of the trade sector's impact on environmental quality, the econometric results from the two methodologies vary per transition country. This study's findings show that in the short run, trade sector openness has no effect on measures of economic development or environmental quality [30].

Nevertheless, over an extended temporal horizon, the liberalization of the trade sector exerts a significant adverse effect on economic growth, as quantified by the ratio of exports to imports. In this study, the trade sector is delineated as the augmentation of Gross Domestic Product (GDP) within the trade domain (including wholesale and retail trade) evaluated at constant prices across 34 provinces of Indonesia.

Table 1. Relevant studies

Reference	Results	Topics Discussed
[9]	This research elucidates that a detrimental correlation exists between the industrial sector and the environment, thus mandating the transition of the industrial sector towards the eco-industrial paradigm, which engenders prospects for offering enduring environmental and socioeconomic advantages while concurrently enhancing the sustainability of the optimal interaction between the industrial sector and the environment.	Discusses infrastructure, industrial sector, and environmental quality
[32]	Infrastructure and institutional quality were found to have a positive correlation with industrial sector growth. According to current research findings, it is desirable to strengthen institutions and invest more in infrastructure.	Discusses infrastructure and industrial sectors
[33]	Empirical studies indicate a considerable U-shaped association between environmental preservation and corporate value. Additionally, disclosure of environmental information has a moderating influence. This has a "strengthening" effect on the relationship between environmental investment protection and firm value. Insufficient investment in environmental protection and excessive transparency might lead to a fall in company value. When environmental investments meet regulations, adequate disclosure can contribute to increased corporate value.	Discusses investment and environmental quality
[34]	The study found a negative correlation between the flow of production from raw materials to end products, including energy, information, and waste disposal, and its environmental impact. However, the combination of Industrial Sector 4.0 and sustainable development goals accelerates the construction of environmental sustainability supported by ecology, ensuring higher environmental performance with a greater positive impact than previously.	Discusses investment, industrial sector and environmental quality

2.5 Industry

Sholihah et al. [31] indicated that the industrial sector was declared a development priority in the development process and was intended to be a leading sector or developing other sectors [8]. The effect of economic growth on labour absorption starts from investment in the industrial sector, and overall capital accumulation in the modern sector will lead to an expansion of output in the modern sector. The shift of labour from the agrarian sector to the modern sector (industrial sector) will boost output growth and labour absorption in the latter [9]. The industrial sector can have a harmful impact on the environment. However, it can improve the system's sustainability, which is very good for the environment in the long term because it is supported by Oláh et al. [10]. Sustainable development can enhance ecological sustainability, which guarantees environmental performance so that it can have a positive impact than before.

The study's findings show a negative relationship between the production process flow from input to output, which includes raw materials, energy requirements, information, waste disposal, and environmental impact. However, merging Industry 4.0 with sustainable development goals increases environmental sustainability by providing ecological support

that ensures excellent environmental performance with greater benefits than before. This study reveals a detrimental relationship between the industrial sector and the environment [9]. As a result, the industrial sector must be shifted to the eco-industrial sector, which offers opportunities for long-term environmental and socioeconomic benefits while also increasing the overall sustainability of the industrial-environmental system. In this study, the phrase "industrial sector" refers to the increase in GDP in the industrial sector (processing industry sector) at constant prices in 34 Indonesian provinces.

2.6 Relevant studies

Additional relevant studies can be explained in Table 1.

3. METHODOLOGY

The study was conducted using a quantitative approach, using secondary data panel data from 34 provinces in Indonesia from 2015 to 2019. The panel data regression model was estimated using the common effect method using SPSS and the Moderate Regression Analysis (MRA) stages. Data collection is carried out to obtain the information needed to achieve research objectives. In this research, data collection techniques were carried out using documentation, namely by researching documents to obtain data related to research variables. The data obtained will be analyzed using statistical tests to find facts about each variable studied and determine the influence between the independent variable and the dependent variable and the moderating variable.

3.1 Research scope and variables

Following the choice of the discussion topic, this research tries to analyze the Environmental Quality Index in 34 Indonesian provinces in terms of Infrastructure development (Road Stability) and Investment (foreign investment and Domestic Investment).

3.2 Data types and sources

The dataset employed in the present research comprises panel data pertinent to variables associated with infrastructure (X_1), investment (X_2), the agricultural sector (Z_1), the trade sector (Z_2), the industrial sector (Z_3), and environmental quality (Y). This dataset encompasses time series data spanning the years 2015 to 2019, alongside cross-sectional data collected from 34 provinces across Indonesia. The data and information were procured from reputable sources, including the Central Statistics Agency Library, Bappenas Library, various University Libraries, provincial governments of Indonesia, scholarly journals, and additional credible repositories.

3.3 Operational definition

Referring to the description of the literature review, the operational definition of each variable can be identified as follows:

Infrastructure (X_1). Infrastructure is the length of national, provincial, city/district roads in stable condition in 34 provinces in Indonesia from 2015 to 2019, in units of Km.

Investment (X_2). Investment is the amount of foreign investment (FI) and domestic investment (DI) in 34 provinces in Indonesia from 2015 to 2019 in units of IDR million.

Agricultural sector (Z_1). The agricultural sector is the GDP production of agricultural business fields (agriculture, forestry, fisheries and plantation sectors) based on constant prices in 34 provinces in Indonesia from 2015 to 2019 in units of IDR million.

Trade sector (Z_2). The trade sector is the GRDP production of business fields in the trade sector (wholesale and retail trade) based on constant prices in 34 provinces in Indonesia from 2015 to 2019 in units of IDR million.

Industrial sector (Z_3). The industrial sector is the GRDP production of the industrial sector (processing industry sector) based on constant prices in 34 provinces in Indonesia from 2015 to 2019 in units of IDR million.

3.4 Environmental quality (Y)

Environmental quality is the Environmental Quality Index, which has indicators of water quality, air quality, and land cover and is available in 34 provinces in Indonesia from 2015 to 2019. A summary of the operational definitions of each variable, as well as indicators and measurement scales, is summarized in Table 2.

3.5 MRA

Moderating variables possess the capacity to affect both the independent and dependent variables in either a beneficial or detrimental manner. The statistical software package SPSS and the MRA phase were employed for the analysis of data in this investigation. A specific application of linear multiple regression is MRA or interaction test, wherein the regression equation incorporates the multiplicative interaction of two or more independent variables to enhance the characteristics of interaction.

$$Y = a + bi \ln Xi + ci \ln Zi + di \ln Xi \ln Zi + e$$

Y is the dependent variable, Xi is the independent variable, Zi is the moderating variable, Xi Zi represents the interaction (multiplication) between the independent and moderating variables, and e is the error correction. The multiplicative variable between Xi and Zi is also known as a moderate variable since it describes how the variable Zi modifies the relationship between Xi and Y. Meanwhile, the variables Xi and Zi have a direct influence on Y. If the variable Zi is a moderating variable, then the coefficient di must be significant at the specified significance level.

Table 2. Operational definition of research variables

Variable	Operational Definition	Indicator	Measurement Scale
Infrastructure (X_1)	Infrastructure is the length of national, provincial, city/district roads in good condition in 34 provinces in Indonesia from 2015 to 2019.	Infrastructure is measured by Road Stability from 34 provinces in Indonesia from 2015 to 2019	km
Investment (X_2)	Investment is the amount of foreign investment (DI) and domestic investment (FI) in 34 provinces in Indonesia from 2015 to 2019.	Investment is measured by the amount of DI and FI from 34 provinces in Indonesia from 2015 to 2019	IDR Million
Agricultural sector (Z_1)	The agricultural sector is the business sector in the agricultural sector (agriculture, forestry, fisheries and plantations) based on constant prices in 34 provinces in Indonesia from 2015 to 2019.	The agricultural sector is measured by the growth of GDP in business fields in the agricultural sector, agriculture, forestry, fisheries and plantations) based on constant prices from 34 provinces in Indonesia for the period 2015 to 2019	IDR Million
Trade sector (Z_2)	The trade sector is the trade sector business field (wholesale trade sector and retail trade sector) based on constant prices in 34 provinces in Indonesia for the period 2015 to 2019.	The trade sector is measured by the growth of GDP in business fields in the trade sector (wholesale and retail trade sectors) based on constant prices from 34 provinces in Indonesia for the period 2015 to 2019	IDR Million
Industrial sector (Z_3)	The industrial sector is the processing business field in the industrial sector (Industrial sector) based on constant pricing in 34 provinces in Indonesia between 2015 and 2019.	The industrial sector is measured by the increase of GDP in business sectors (processing industry sector) based on constant prices from 34 provinces in Indonesia between 2015 and 2019	IDR Million
Environmental quality (Y)	The Environmental Quality Index measures water, air, and land cover quality in 34 Indonesian provinces from 2015 to 2019.	From 2015 to 2019, the Environmental Quality Index was used to assess environmental quality in Indonesia's 34 provinces	Index

4. RESULTS AND DISCUSSION

4.1 Prerequisite test

This research tested using MRA method. The first thing to do was carry out a prerequisite test where, in this research, the (1) normality test and (2) heteroscedasticity test were carried out.

4.2 Normality test

The results of the Shapiro-Wilk normality test conducted using the SPSS program are reported in Table 3.

Table 3. Recap of significant values normality test

No.	Normality Test	Significant Value
1	The Impact (X_1) on (Y)	0.531
2	Impact (X_1) on (Y) in (Z_1)	0.290
3	The Impact of (X_1) on (Y) in the (Z_2)	0.748
4	The Impact of (X_1) on (Y) in the (Z_3)	0.427
5	The Impact of (X_2) on (Y)	0.531
6	The Impact of (X_2) on (Y) in the (Z_1)	0.073
7	The Impact of (X_2) on (Y) in the (Z_2)	0.482
8	The Impact of (X_2) on (Y) in the (Z_2) in the (Z_3)	0.155

Based on Table 3, using the *Shapiro-Wilk normality test*, where the data is normally distributed, *the significant value* is > 0.05 for all estimation models. The normal distribution is an opportunity distribution for ideal data distribution (data is spread evenly) to avoid biased judgments towards specific categories.

4.3 Heteroscedasticity test

The heteroscedasticity assessment was conducted to ascertain whether the independent variable exerted a significant impact on the absolute value of the residuals. In instances where the significance level associated with the independent variable exceeds 0.05, it can be concluded that heteroscedasticity is absent. The heteroscedasticity evaluation for this research was executed through the implementation of the glacial heteroscedasticity test. Table 4 presents the findings of the heteroscedasticity assessments conducted on glaciers utilizing the SPSS software.

According to Table 4, using the Glacier Heteroscedasticity Test, the significant values of the eight regression equations in the study yielded five influences with significant values > 0.05 and no heteroscedasticity. The impact of infrastructure on environmental quality and investment on environmental quality, with the agricultural sector acting as a moderator, with

a significant value <0.05, heteroscedasticity occurs. With 2 regression equation models that experience heteroscedasticity, it is necessary to make corrections using weighted least squares regression.

Table 4. Recap of significant values of heteroscedasticity test glacier

No.	Heteroscedasticity Test	Significant Value
1	The Impact (X_1) on (Y)	0.002
2	The Impact (X_1) on (Y), with (Z_1) serving as a moderator	0.062
3	The Impact (X_1) on (Y), with (Z_2) serving as a moderator	0.239
4	The Impact (X_1) on (Y), with (Z_3) serving as a moderator.	0.844
5	The Impact of (X_2) on (Y)	0.002
6	The Impact of (X_2) on (Y), with (Z_1) serving as a moderator	0,000
7	The Impact of (X_2) on (Y), with (Z_2) serving as a moderator	0.225
8	The Impact of (X_2) on (Y), with (Z_3) serving as a moderator	0.452

Table 5. Heteroscedasticity test weighted least squares regression

No.	Heteroscedasticity Test	Significant Value
1	Influence of infrastructure on environmental quality	0.610
2	The effect of investment on environmental quality	0.610
3	The influence of investment on environmental quality with the industrial sector as a moderator	0.111

From Table 5, it can be seen that there are no longer any symptoms *of* heteroscedasticity where the significant value is > 0.05.

4.4 Estimation model

This research employed MRA methodology to derive estimation outcomes. The effect of moderating variables is assessed through the MRA methodology, chiefly to ascertain whether they augment or mitigate the correlation between the independent and dependent variables. The primary objective of this investigation was to analyze the influence of infrastructure on environmental quality initially. Secondly, the study considers environmental quality infrastructure, with the agricultural sector functioning as a moderating variable. Thirdly, the analysis examines the effect of infrastructure on environmental conditions, with the trade sector serving as a moderator. Fourthly, the industrial sector is posited as a moderator in the correlation between infrastructure and environmental quality. Fifthly, the examination delves into how investments impact environmental quality. The sixth aspect pertains to the effect of investments in the trade sector as a moderating variable on environmental quality. The seventh dimension explores the role of commerce as a moderator regarding the quality of the environment in relation to investments. The moderating influence of the industrial sector on the environmental quality associated with investments is also scrutinized. The outcomes of data analysis conducted via SPSS are presented in Tables 6 and 7. A variable is considered significant if its p-value is less than 0.05, indicating relevance.

$$Y = 82.725 + 0.922_{ln}$$

Table 6. Results of analysis of the effect of infrastructure on environmental quality

Model		Unstandardized Coefficients		t	Sig.
		B	Std. Error		
1	(Constant)	82.725	8.901	9.924	0.000
	Infrastructure (X_1)	0.922	1.905	0.842	0.401
Y = Environmental Quality					

Table 7. Results of analysis of the effect of infrastructure on environmental quality with the agricultural sector as moderator

Model		Unstandardized Coefficients		Pin	Sig.
		B	Std. Error		
1	(Cons t an t)	58.774	6.703	8.768	0.000
	Infrastructure	1.371	-996	1.376	0.171
2	(Constant)	68.785	8.039	8.556	0.000
	Infrastructure (X_1)	3.391	1.346	2.519	0.013
	Agricultural Sector (Z_1)	-2.356	1.071	-2.200	0.029
3	(Constant)	-197.412	42.186	-4.680	0.000
	Infrastructure (X_1)	41.362	6.051	6.836	0.000
	Agricultural Sector (Z_1)	27.865	4.816	5.786	0.000
	Agricultural Sector Infrastructure (X_1Z_1)	-4.297	0.671	-6.405	0.000
Y = Environmental Quality					

In Table 7, it is explained that in model 1, the linear equation is: $Y = 58.774 + 1.371 \ln X_1$.

The linear equation illustrates that infrastructure (X_1) exerts a positive effect of 1.371, signifying that infrastructure (X_1) contributes positively to environmental quality (Z). An increase in infrastructure (X_1) correlates with an enhancement in environmental quality (Z). In the second model, the linear regression equation is derived as follows:

$$Y = 68.785 + 3.391 \ln X_1 - 2.356 \ln Z_1$$

The linear regression equation shows that the coefficient of influence of infrastructure on environmental quality is 3.391, while the coefficient of influence of the agricultural sector on environmental quality is -2.356. A negative coefficient value means that the agricultural sector negatively influences environmental quality. The agricultural sector (Z_1) influences environmental quality (Y) with a significant value of 0.029 < 0.050.

In model 3, the linear regression equation is obtained as follows:

$$Y = -197.412 + 41.362 \ln X_1 + 27.865 \text{ Ln } Z_1 - 4.297 \text{ Ln } X_1 \ln Z_1$$

The linear equation indicates that the coefficient of influence exerted by infrastructure on environmental quality is quantified at 41.362, while the coefficient representing the

agricultural sector's impact on environmental quality is determined to be 27.865, and the coefficient reflecting the interaction effect between infrastructure and the agricultural sector is calculated to be -4.297. A negative coefficient signifies that the agricultural sector attenuates the relationship between infrastructure and environmental quality. The significant value associated with the interaction between infrastructure and the agricultural sector (X_1 Z_1) regarding environmental quality (Y) is recorded at 0.000, which is less than the threshold of 0.05.

Both the significant value of the agricultural sector (Z_1) and the significant value of the interaction between infrastructure and the agricultural sector (X_1 Z_1) are observed to be less than 0.05, thereby suggesting that the moderating effect of infrastructure on environmental quality, with the agricultural sector acting as a moderator, can be categorized as a quasi moderator (pseudo moderator). The agricultural sector functions as a moderating variable that diminishes the influence of infrastructure on environmental quality.

Table 8. Results of analysis of the effect of infrastructure on environmental quality with the trade sector as moderator

	Model	Unstandardized Coefficients		t	Sig.
		B	Std. Error		
1	(Constant)	58.774	6.703	8.768	0.000
	Infrastructure	1.371	0.996	1.376	0.171
2	(Constant)	94.878	7.351	12.906	0.000
	Infrastructure (X_1)	2.818	0.873	3.229	0.001
	Trade Sector (Z_2)	-4.700	0.597	-7.867	0.000
3	(Constant)	163.057	31.662	5.150	0.000
	Infrastructure (X_1)	-7.979	4.956	-1.610	0.109
	Trade Sector (Z_2)	-11.242	3.016	-3.728	0.000
	Infrastructure, Trade Sector (X_1 Z_2)	1.037	0.469	2.212	0.028

Y = Environmental Quality

In Table 8, it is explained that in model 1, the linear equation is: $Y = 58.774 + 1.371 \ln X_1$.

The linear equation elucidates that infrastructure (X_1) exerts a positive effect quantified at 1.371, thereby suggesting that infrastructure (X_1) significantly enhances environmental quality (Z). An increase in infrastructure correlates with an improvement in environmental quality. In the second model, the linear regression equation is articulated as follows:

$$Y = 94.878 + 2.818. \ln X_1 - 4.70 \ln Z_2$$

The linear equation shows that the coefficient of influence of infrastructure on environmental quality is 2.818, while the coefficient of influence of the trade sector on environmental quality is -4.700. A negative coefficient value means that the trade sector negatively influences environmental quality. The trade sector (Z_2) influences environmental quality (Y) with a significant value of $0.000 < 0.050$.

In model 3, the linear regression equation is obtained as follows:

$$Y = -163.057 - 7.979 X_1 - 11.242 Z_2 1.037 X_1 Z_2$$

The linear equation elucidates that the coefficient representing the impact of infrastructure on environmental quality is -7.979, the coefficient representing the trade sector's impact on environmental quality is -11.242, and the coefficient denoting the interaction effect (infrastructure x trade sector) is +1.037. A positive coefficient value indicates that the trade sector enhances the influence of infrastructure on environmental quality. The significance level of the interaction between infrastructure x trade sector (X_1 Z_2) concerning environmental quality (Y) is 0.028, which is less than 0.05.

The significance level of the trade sector (Z_2) on environmental quality, as well as the significance level of the interaction between infrastructure and the trade sector (X_1 Z_2) on environmental quality, are both less than 0.05, thus indicating that the nature of the moderation of infrastructure's influence on environmental quality, with the trade sector acting as a moderator, is classified as quasi moderator (pseudo moderator).

The impact of infrastructure across 34 provinces in Indonesia is anticipated to enhance environmental quality, particularly in conjunction with the influence exerted by the trade sector within Indonesia. The trade sector bolsters infrastructure development due to its necessity for the efficient distribution of goods and services, which significantly affects the regional economy.

Table 9. The influence of infrastructure on environmental quality with the industrial sector as a moderator

	Model	Unstandardized Coefficients		Q	Sig.
		B	Std. Error		
1	(Constant)	58.774	6.703	8.768	0.000
	Infrastructure	1.371	0.996	1.376	0.171
2	(Constant)	80.145	6.605	12.133	0.000
	Infrastructure (X_1)	2.660	0.893	2.979	0.003
	Industrial sector (Z_3)	-3.075	0.431	-7.131	0.000
3	(Constant)	166.041	28.860	5.753	0.000
	Infrastructure (X_1)	-10.322	4.340	-2.378	0.019
	Industrial sector (Z_1)	-11.495	2.790	-4.121	0.000
	Infrastructure Industrial sector (X_1 Z_3)	1.267	0.451	3.053	0.003

Y = Environmental Quality

In Table 9, it is explained that in model 1, the linear equation is $Y = 58.774 + 1.371 \ln X_1$.

The linear equation shows that infrastructure has a positive effect of 1.371 (X_1), which shows that infrastructure positively influences environmental quality (Y). As the road's stability increases, the environment's quality increases.

In model 2, the linear regression equation is obtained as follows:

$$Y = 80.145 + 2.660 \ln X_1 - 3.075 \ln Z_3$$

According to the linear regression model, the coefficient representing the effect of infrastructure on environmental quality is quantified at 2.660, whereas the coefficient denoting the influence of the industrial sector on environmental quality is calculated at -3.075. A negative coefficient value signifies that the industrial sector exerts a detrimental influence on environmental quality. The industrial sector (Z_3) demonstrates a substantial impact on environmental quality (Y), with a statistical significance value of 0.000, which is less than the threshold of 0.050. In the third model, the linear regression equation is articulated as follows:

$$Y = 166.041 - 10.322.\ln X_1 - 11.495 \ln Z_3 + 1.267 \ln X_1 \ln Z_3$$

The linear equation elucidates that the coefficient representing the impact of infrastructure on environmental quality is quantified at -10.322, while the coefficient denoting the influence of the industrial sector on environmental quality is calculated at -11.495, and the coefficient reflecting the interaction effect between infrastructure and the industrial sector is +1.267. A positive coefficient value signifies that, upon adjustment, the industrial sector amplifies the effect of infrastructure on environmental quality. The interplay between infrastructure and industrial sectors (X_1 Z_3) exerts a statistically significant influence on environmental quality (Y) with a p-value of 0.003 ($p < 0.05$).

The significance levels pertaining to the industrial sector (Z_3) and the interaction between infrastructure and the industrial sector (X_1 Z_3) concerning environmental quality are both less than 0.05, which suggests that the role of infrastructure on environmental quality, moderated by the industrial sector, can be classified as a quasi-moderator (pseudo-moderator) (Table 10). The influence of infrastructure across 34 Indonesian provinces is poised to elevate environmental quality, paralleling the effects attributable to Indonesia's industrial sector. The industrial sector serves as a moderating variable, thereby reinforcing the correlation between the influence of infrastructure and environmental quality.

Table 10. Results of analysis of the effect of infrastructure on environmental quality coefficients

Model		Unstandardized Coefficients		Q	Sig.
		B	Std. Error		
1	(Constant)	82.725	8.901	9.294	0.000
	Investment (X_2)	-1.324	0.489	-2.705	0.008
Y = Environmental Quality					

Table 11. Results of analysis of the effect of investment on environmental quality with the agricultural sector as moderator

Model		Unstandardized Coefficients		t	Sig.
		B	Std. Error		
1	(Constant)	87.359	8.087	10.802	0.000
	Investment	-1.267	0.524	-2.415	0.017
2	(Constant)	101.142	9.477	10.673	0,000
	Investment (X_2)	-2.267	0.530	-4.280	0,000
	Agricultural Sector (Z_1)	0.218	0.709	0.308	0.758
3	(Constant)	327.259	81.125	4.034	0.000
	Investment (X_2)	-15.878	4.879	-3.254	0.001
	Agricultural Sector (Z_1)	-23.335	8.423	-2.770	0.006
	Investment, Agricultural Sector (X_2 Z_1)	1.418	0.505	2.806	0.006
Y = Environmental Quality					

Investments with a negative influence have a significant value of $0.008 < 0.050$; that is, as investment increases, the quality of the environment decreases, with the regression equation $Y = 82.725 - 1.324 \ln$ with environmental quality.

In Table 11, it is explained that in model 1, the following linear regression equation is obtained:

$$Y = 87.359\text{-}1.267 \ln X_2$$

The impact of capital allocation on ecological integrity is quantified as -1.267; this negative coefficient indicates that investment exerts a detrimental effect on environmental quality. In the second model, the linear regression equation is derived as follows.

$$Y = 327.259 - 15.878 \ln X_2 - 23.335 \ln Z_1 + 1.418 \ln X_2 \ln Z_1$$

According to the linear regression model, the coefficient representing the impact of investment on environmental quality is -2.267, while the coefficient denoting the influence of agriculture on environmental quality is 0.218. The agricultural sector (Z_1) does not exert a statistically significant effect on environmental quality (Y), evidenced by a p-value of 0.758, which exceeds the conventional threshold of 0.05. In the third model, the linear regression equation is articulated as follows:

$$Y = 327.259 - 15.878 \ln X_2 - 23.335 \ln Z_1 + 1.418 \ln X_2 \ln Z_1$$

According to the linear regression analysis, the coefficient reflecting the impact of investment on environmental quality is -15.878, while the coefficient representing the agricultural sector's influence on environmental quality is -23.335; additionally, the coefficient pertaining to the interaction effect (investment x agricultural sector) is +1.418. The interaction between investment and the agricultural sector (X_2 Z_1) concerning environmental quality (Y) yields a statistically significant value of 0.006, which is less than the threshold of 0.05.

Table 12. Results of analysis of the effect of investment on environmental quality with the trade sector as a moderator

Model		Unstandardized Coefficients		t	Sig.
		B	Std. Error		
1	(Constant)	87.359	8.087	10.802	0.000
	Investment	-1.267	0.524	-2.415	0.017
2	(Constant)	96.001	7.094	13.532	0.000
	Investment (X_2)	2.081	0.634	3.281	0.001
	Trade Sector (Z_2)	-6.160	0.815	-7.558	0.000
3	(Constant)	-66.047	54.035	-1.222	0.223
	Investment (X_2)	11.910	3.309	3.599	0,000
	Trade Sector (Z_2)	11.731	5.970	1.965	0.051
	Investment, Trade Sector (X_2 Z_2)	-1.081	0.357	-3.024	0.003
Y = Environmental Quality					

The statistical significance associated with the agricultural sector (Z_1) and the significance of the interaction between investment and the agricultural sector, functioning as a moderator (specifically identified as a pure moderator), indicates that investments across 34 provinces in Indonesia exert a notable influence on environmental quality, with the agricultural sector serving in the capacity of a moderating variable.

In Table 12, it is explained that in model 1, the following

linear regression equation is obtained:

$$Y = 87.359 - 1.267 \ln X_2$$

The impact of investment (X_2) on environmental quality (Y) is quantified at -1.267; a negative coefficient indicates that investment exerts a detrimental effect on environmental quality. In the second model, the linear regression equation is articulated as follows:

$$Y = 96.001 + 2.081. \text{Ln } X_2 - 6.160 \ln Z_2$$

The linear equation delineates that the coefficient representing the impact of investment on environmental quality is 2.081, whereas the coefficient denoting the influence of the trade sector on environmental quality is -6.160. A coefficient exhibiting a negative value signifies that the trade sector exerts a detrimental impact on environmental quality. The trade sector (Z_2) demonstrates a significant effect on environmental quality (Y), with a statistical value of 0.000 < 0.050. In the context of model 3, the linear regression equation is articulated as follows:

$$Y = -66.047 + 11.910 \ln X_2 + 11.731 \ln Z_2 – 1.081 \ln X_2 \ln Z_2$$

The linear equation delineates that the coefficient representing the impact of investment on environmental quality is 11.910, that corresponding to the trade sector's influence on environmental quality is 11.731, and that pertaining to the interaction effect (investment x trade sector) is -1.081. A coefficient value that is negative signifies that the trade sector attenuates the effect of investment on environmental quality (Y). The interaction of investment and the trade sector (X_2 Z_2) possesses a significant value of 0.003, which is indeed less than 0.05.

The significant value associated with the trade sector (Z_2) regarding environmental quality, along with the significant value of the interaction between investment and the trade sector (X_2 Z_2), are both below 0.05, thereby indicating that the moderation of the influence of investment on environmental quality, with the trade sector acting as a moderator, is classified as a Quasi moderator (pseudo moderator).

Investment across 34 provinces in Indonesia is anticipated to exert a detrimental effect on environmental quality, with the commerce sector functioning as a moderator. The commerce sector diminishes the effect of investment on environmental quality within the Indonesian context.

In Table 13, it is explained that in model 1, the following linear regression equation is obtained:

$$Y = 87.359\text{-}1.267 \ln X_2$$

The effect of investment (X_2) on environmental quality (Y) is -1.267. A negative coefficient value indicates that investment has a negative impact on environmental quality. In model 2, the linear regression equation is as follows:

$$Y = 81.044 + 1.530 \text{ Ln } X_2 - 3.572 \ln Z_3$$

$$Y = -12.534 + 7.385 \ln X_2 + 6.523 \ln Z_3 - 0.637 \ln X_2 \ln Z_3$$

The linear regression analysis elucidates that the coefficient representing the influence of investment on environmental quality is 7.385, the coefficient signifying the industrial sector's impact on environmental quality is 6.523, and the coefficient associated with the interaction effect (investment x industrial sector) is -1.637. A negative coefficient value signifies that the presence of the industrial sector attenuates the effect of investment on environmental quality (Y). The interaction between investment and the industrial sector (X_2 Z_3) yields a statistically significant value of 0.023, which is below the conventional threshold of 0.05.

Table 13. Results of analysis of the effect of investment on environmental quality with the industrial sector as moderator

	Model	Unstandardized Coefficients		t	Sig.
		B	Std. Error		
1	(Constant)	87.359	8.087	10.802	0.000
	Investment	-1,267	0.524	-2.415	0.017
2	(Constant)	81,044	7.313	11.082	0,000
	Investment (X_2)	1,530	0.638	2.400	0.018
	Industrial sector (Z_3)	-3.572	0.578	-6.492	0,000
3	(Constant)	-12.534	41,360	-0.303	0.762
	Investment (X_2)	7.385	2.625	2.814	0.005
	Industrial sector (Z_3)	6.523	4.508	1.447	0.150
	Investment, Industrial sector (X_2 Z_3)	-0.637	0.277	-2.298	0.023

Y = Environmental Quality

The statistical significance of the industrial sector (Z_3) concerning environmental quality, along with the significant value of the interaction between investment and the industrial sector (X_2 Z_3), both being less than 0.05, suggests a quasi-moderator (pseudo-moderator) effect of investment on environmental quality. Investment across 34 provinces in Indonesia is predicted to detrimentally affect environmental quality, with the industrial sector functioning as a moderating variable. The industrial sector serves to mitigate the influence of investment on environmental quality within the context of Indonesia.

4.5 Coefficient of determination test

Table 14. Recap of R square values

No.	Determination Test	R Square
1	The Impact (X_1) on (Y)	0.042
2	The Impact (X_1) on (Y), with (Z_1) serving as a moderator	0.229
3	The Impact (X_1) on (Y), with (Z_2) serving as a moderator	0.299
4	The Impact (X_1) on (Y), with (Z_3) serving as a moderator	0.282
5	The Impact of (X_2) on (Y)	0.042
6	The Impact of (X_2) on (Y), with (Z_1) serving as a moderator	0.143
7	The Impact of (X_2) on (Y), with (Z_2) serving as a moderator	0.317
8	The Impact of (X_2) on (Y), with (Z_3) serving as a moderator	0.252

The objective of the determination test is to assess the degree to which the independent variable influences the dependent variable, with a particular focus on the ramifications of infrastructure and investment on environmental quality, whilst also accounting for a moderating

effect; an elevation in the value of r squared signifies a more significant impact of the independent variable on the dependent variable; in contrast, a negative r squared value indicates that the independent variable does not have a discernible effect on the dependent variable. The findings of the R Square Test are delineated in Table 14.

Table 14 presents the following findings: (1) Infrastructure has a 4.2% influence on environmental quality; (2) Infrastructure has a 22.90% influence on environmental quality with the agricultural sector acting as a moderator; (3) Infrastructure has a 29.90% influence on environmental quality with the trade sector acting as a moderator; and (4) Infrastructure has a 28.2% influence on environmental quality with the industrial sector acting as a moderator. These findings indicate that the presence of the agricultural, trade, and industrial sectors has a greater positive impact on the influence of infrastructure on environmental quality. The influence grows when the moderating variable is included. (5) Investment has a 4.2% impact on environmental quality. (6) Investments in the agricultural sector have a 14.3% moderating effect on environmental quality; (7) trade sectors have a 31.7% moderating effect on environmental quality; and (8) the industrial sectors have a 25.2% moderating effect on environmental quality. As the agriculture sector's influence on environmental quality grew, so did the value of the influence of investment, rising from 9.2% to 14.3%. Meanwhile, the existence of the commerce and industrial sectors has a more important impact.

4.6 Hypothesis test (t-test)

The considerable impact of the independent variable on the dependent variable is assessed through the utilization of the t-test. The alternative hypothesis (Ha) is rejected and the null hypothesis (H0) is supported if the computed t-value is inferior to the critical t-value. In contrast, the null hypothesis (H0) is rejected and the alternative hypothesis (Ha) is supported if the computed t-value surpasses the critical t-value, thus signifying that the independent variable has a notable effect on the dependent variable.

Table 15 shows that of the eight (8) research hypotheses, only one hypothesis was not proven, namely that infrastructure influences environmental quality, while seven (7) other hypotheses have been proven to influence environmental quality.

Table 15. Hypothesis test results

No.	Hypothesis Testing	t_Calculated Value	t_Table	Conclusion
H_{a1}	Infrastructure influences environmental quality	0.842	1.97427	H_{a1} is rejected
H_{a2}	Infrastructure influences environmental quality with the agricultural sector as a moderator	-6.4050	1.97436	H_{a2} accepted
H_{a3}	Infrastructure influences environmental quality with the trade sector as a moderator	2.2120	1.97436	H_{a3} accepted
H_{a4}	Infrastructure influences environmental quality with the industrial sector as a moderator	3.0530	1.97436	H_{a4} accepted
H_{a5}	Investment affects environmental quality	-2.705	1.97427	H_{a5} accepted
H_{a6}	Investment influences environmental quality with the agricultural sector as a moderator	2.806	1.97436	H_{a6} accepted
H_{a7}	Investment influences environmental quality with the trade sector as a moderator	-3.0240	1.97436	H_{a7} accepted
H_{a8}	Investment influences environmental quality with the industrial sector as a moderator	-2.2980	1.97436	H_{a8} accepted

5. DISCUSSION

5.1 The influence of infrastructure on environmental quality

The analysis results show that infrastructure does not affect the quality of the environment; this means that improving infrastructure (increasing road stability) will not affect the quality of the environment; this is because to maintain road stability, all that is needed is road surface maintenance. The work to maintain road stability will not damage air quality, water quality and land clearing. Road maintenance to maintain road stability will not improve environmental quality because road maintenance work, such as patching road damage, improving drainage, cutting grass, etc., is improbable to enhance or damage air quality, water quality or land openness.

In this research, road stability does not have a positive or negative effect on environmental quality, as evidenced by data from each province where road stability from year to year in each province continues to increase and developments in environmental quality have also increased, and some have experienced a decline, and it is clear that the stability of the road does not influence the quality of the environment. As can be seen in West Sumatra Province, 2015 the road stability was initially 16,259 km in 2019 to 20,922 km, and the Environmental Quality Index in 2015 was 59.07, increasing in 2019 to 69.01, meaning that the environmental quality in West Sumatra has increased in influenced by other variables.

The discrepancies between the findings of this research and those of previous studies can be attributed to differences in the infrastructure variables utilized. In references [35-37], researchers observed that certain types of infrastructure negatively impact environmental quality. Specifically, Bespalov and Kotlyarova [35] discusses how replacing industrial facilities in urban areas with shopping and entertainment complexes can degrade environmental quality. Teo et al. [36] examines the infrastructure associated with the economic development of the 21st-century Silk Road and Maritime Silk Road, which connects Asia, Africa, and Europe. Meanwhile, Robinah et al. [37] focuses on the use of heavy construction equipment, such as graders, wheel loaders, and excavators, which can lower air quality. These variations in infrastructure types contribute to the differing results seen in studies on infrastructure's environmental impact.

5.2 The role of the agricultural sector in moderating the influence of infrastructure on environmental quality

According to the analytical assessment, the agricultural sector (Z_1) negatively impacts environmental quality (Y) when compared to infrastructure (X_1). This suggests that expanding the agricultural sector could reduce or limit the positive influence of infrastructure on environmental quality. In other words, infrastructure's moderation of environmental impacts, previously neutral when influenced by agriculture, is now associated with adverse effects. Research [22, 27, 28] supports that the agricultural sector indeed affects environmental quality, although the specific nature of this impact varies; some effects are beneficial, while others are detrimental.

In this research, the development of the agricultural sector can reduce the quality of land cover and land quality due to the use of drugs and disinfectants. However, developing the agricultural sector will also improve an area's air quality. In this research, the agricultural sector variable indicator used is the business field, including the agricultural sector (livestock, forestry, fisheries and plantations), where each sub-business field can hurt environmental quality.

Agriculture can also help to mitigate the effects of infrastructure on environmental quality. For example, sustainable farming methods can help to mitigate the negative environmental impact of infrastructural development. Implementing strategies such as agroforestry, conservation tillage, and precision farming can reduce the environmental impact of infrastructure projects. These practices can help reduce soil erosion, water pollution, and habitat destruction caused by infrastructure development, thereby improving environmental quality. In addition, integrating green infrastructure in agricultural landscapes can further enhance environmental quality. Eco-friendly infrastructure, such as vegetated swales, riparian buffers, and constructed wetlands, can help manage stormwater, enhance water quality, and provide wildlife habitat. The overall environmental impact can be minimized by incorporating green infrastructure into agricultural areas impacted by infrastructure development. In summary, agriculture can play an essential role in moderating the positive influence of infrastructure on environmental quality through adopting sustainable practices and integrating green infrastructure in agricultural landscapes.

Therefore, the agricultural sector's development of environmental quality can have positive and negative influences. In future research, it is recommended to use specific sub-fields of business, namely the agricultural sector, as moderator variables so that the results of their influence will be more specific to strengthen or weaken the relationship between the independent and dependent variables.

5.3 The role of the trade sector moderates the influence of infrastructure on environmental quality

The empirical findings suggest that the trade sector (Z_2) exerts a beneficial impact on the relationship between infrastructure (X_1) and environmental quality (Y). This suggests that the advancement of the commerce sector will amplify or intensify the beneficial effects of infrastructure on environmental quality. The commerce sector generates tax revenue for the government, leading to an augmentation of Regional Original Income; PAD is subsequently allocated for the upkeep of roadways and the improvement of infrastructure, thereby promoting more seamless and effective mobility. Well-maintained roadways reduce air pollution and improve water quality.

The impact of the trading sector on environmental quality varies across different nations and regions [38]. Concurrently, reference [3] suggests that the liberalization of the trade sector may have a detrimental long-term effect on environmental quality. The findings from these studies confirm a moderating role within the relationship between infrastructure and environmental quality. Therefore, the interplay among trade, infrastructure, and environmental quality is complex and highly context-dependent. In conclusion, improvements in environmental quality resulting from infrastructure investments could be enhanced or magnified by the expansion of the commerce sector.

5.4 The role of the industrial sector in moderating the influence of infrastructure on environmental quality

The analytical findings indicate that the industrial sector (Z_3) exerts a positive modification on the influence of infrastructure (X_1) with respect to environmental quality (Y). This observation implies that the expansion of the industrial sector will enhance or augment the beneficial effects of infrastructure on environmental quality. This study characterizes the industrial sector as encompassing the processing industry. The notion of the processing industrial sector is extensive, considering the dimensions of raw materials, production processes, and the resultant products, in addition to the economic scale intrinsic to the industrial sector, thereby resulting in variable impacts on environmental quality.

The industrial sector contributes taxes to governmental entities to augment Original Regional Income. Such revenues are allocated for the maintenance of road infrastructure, thereby facilitating smoother and more effectively managed transportation. Well-maintained roadways contribute to the reduction of air pollution and the enhancement of water quality. In essence, this research posits that advancements in environmental quality resultant from infrastructure improvements will be amplified by enhancements within the industrial sector. The repercussions of industrialization on environmental quality have also been explored within the framework of the digital economy. Environmental regulations imposed on industries with high pollution levels can enhance environmental quality while simultaneously increasing the scale of external impacts, thereby diminishing negative environmental externalities. Moreover, the optimization of industrial structure is advantageous for elevating environmental quality and improving the living conditions of residents.

Industrialization and industrial activities have a profound impact on the environment, influencing air, water, land, and the overall ecosystem. Comprehending these repercussions is essential for making informed decisions and enacting measures to alleviate the environmental ramifications of industrialization.

The impact of industry can serve to moderate the beneficial influence of infrastructure on environmental quality. For instance, the spatial planning of the timber industry in Peru has been evaluated to understand the positive socio-environmental and economic outcomes, with the objective of enhancing both quality of life and environmental conditions. With the escalating adoption of sustainable practices within the industrial sector, beginning with the selection of raw materials, processing techniques, and technologies that prioritize

sustainability, it is evident that there exists a positive correlation between the processing industrial sector and environmental quality, thereby allowing for a more effective utilization of the moderating role of the industrial sector in the relationship between infrastructure and environmental quality. The influence exerted by industry can moderate the effects of infrastructure on environmental quality and, when coupled with appropriate interventions, can yield beneficial outcomes.

5.5 The effect of investment on environmental quality

The results of the analysis show that investment hurts environmental quality. FI and DI in this study use direct investment. Direct investment can be in property development, road construction, office building construction, shopping center construction and apartment construction, agricultural sector development, and industrial sector development. The development caused by FI and DI can result in various environmental problems such as flooding, lack of clean water, which results in reduced water quality, increasing air pollution, resulting in reduced air quality, and land clearing, which can result in animal extinction, resulting in reduced land cover.

There is continuous research into the link between investment and environmental quality. Increased investment will lower environmental quality. This finding is consistent with studies [17-19], which indicated that investment degrades environmental quality. Some studies show that investment can be harmful to the environment, while others show that it can be beneficial. For example, one study discovered that FDI can positively benefit environmental quality in developing nations, while another found that FDI can negatively affect environmental quality in developing countries.

The direct investment value is the indicator for the investment variable in this study. Investment takes the form of capital, which has no effect on environmental quality. Environmental quality is influenced by the use or utilization of capital for business development, such as property development, road construction, office building construction, shopping center construction, apartment construction, agriculture, mining, industrial, tourism, and other sectors.

5.6 The role of the agricultural sector in moderating the effect of investment on environmental quality

The analysis's findings show that investment (X_2) and environmental quality (Y) are positively impacted by the agriculture industry (Z_1). This suggests that increasing investment in environmental quality will be supported or enhanced by growing the agriculture industry. Put another way, investment has a positive effect on environmental quality, balanced by agriculture. The flow of FDI has the following advantages: (1) it may be used to diversify investments and reduce the risk of capital ownership; (2) it provides the finest spread for the formation of corporate governance, accounting regulations, and legality in.

In terms of agriculture's position as a moderator, there has been some research into the interaction between agriculture and the environment, but it is unclear how it interacts with investment. One study concluded that agricultural intensification is harmful to the environment, but another discovered that sustainable farming techniques are beneficial.

In general, it seems that there are context-specific and intricate relationships between investment, agriculture, and environmental quality. In order to fully understand this relationship and its implications, more research is needed. According to this study, the right activities can have a favorable impact on how infrastructure affects environmental quality, and the influence of agriculture can counteract or intensify this impact.

In this research, the agricultural sector variable indicator used is the business field, including the agricultural sector (livestock, forestry, fisheries and plantations), where each sub-business field can have different environmental quality impacts, both negative and positive. Therefore, in future research, it is recommended to use specific sub-fields of business, namely the agricultural sector, as moderator variables so that the results of their influence will be more specific to strengthen or weaken the relationship between the independent and dependent variables.

5.7 The trade sector's role moderates investment's influence on environmental quality

The analytical findings suggest that the effect of investment (X_2) on environmental quality (Y) is subject to moderation by the trade sector (Z_2). This indicates that the detrimental effects of investment on environmental quality may be reduced or mitigated through the growth of the commerce sector. Insignificant amounts will weaken the correlation between FI and DI with respect to environmental quality due to the existence of a robust trade sector and diverse trade segments. Investors commonly seek to minimize production expenses in the trade sector, often neglecting the implications for environmental quality, thereby resulting in the degradation of water quality, air quality, and land cover.

Halicioglu and Ketenci [38] have indicated that the impact of the trade sector on environmental quality varies across different nations and regions. In contrast, Belloumi and Alshehry [30] argue that the liberalization of the trade sector tends to have a negative long-term effect on the environment. These findings suggest that investments can have a moderating influence on environmental quality within the context of trade. Trade and foreign investment interact in complex ways to influence environmental outcomes, often due to the tendency of trade liberalization to increase pollution as both trade and industrial activities expand.

To counteract the potentially harmful effects of trade and foreign investment on the environment, it is crucial to implement policies that promote sustainable development and environmental stewardship. Governments can foster environmentally sustainable practices in trade and foreign investment by enacting regulations and offering incentives.

In conclusion, while trade can sometimes mitigate the impact of FDI on environmental quality, the relationship is complex and influenced by various factors, including government interventions.

5.8 The role of the industrial sector in moderating the influence of investment on environmental quality

The analytical findings indicate that, in comparison to investment (X_2), the industrial sector (Z_3) has a negative moderating influence on environmental quality (Y). Since the industrial sector would first contaminate the air and water when it opens, this suggests that growing the industrial sector will reduce or lessen the detrimental impact of investment on environmental quality. Capitalists, after all, exploit natural

resources without taking the environment into account. The reduction in environmental quality brought on by increased investment will be lessened or mitigated by an increase in the industrial sector.

The processing industry sector is how this study describes the industrial sector. Because the processing industry sector encompasses a wide range of raw materials, industrial processes, items produced, and economies of scale, its effects on environmental quality will differ. The industrial sector is negatively impacted by environmental quality, according to studies [9, 10]. However, as sustainable industrial sector processes gain traction—starting with the selection of sustainable raw materials, methods, and processing technology—it becomes evident that the processing industrial sector has a positive impact on environmental quality, making better use of the industrial sector's moderating role in the relationship between investment and environmental quality.

It is a complex matter to determine how FDI affects industrial environmental quality. Research indicates that the nature of the industrial sector, government policy, and technological advancements are some of the variables that can alter the relationship between environmental quality and FDI. The environmental impact of FDI in the industrial sector is impacted by technical advancement, the severity of environmental restrictions, and the type of industry. They claim that in certain circumstances, foreign investment can improve environmental quality by introducing cleaner technologies and best practices, but in others, it can exacerbate environmental deterioration due to poor laws and unsustainable industrial practices.

In conclusion, there is a complex relationship between FDI and environmental quality in the industrial sector that is subject to change. Through the transfer of technology and best practices, foreign investment has the potential to improve environmental quality; nevertheless, the overall impact is dependent on the features of the industrial sector and the regulatory framework.

5.9 Summary of the moderating role of the agricultural sector, trade sector and industrial sector

Infrastructure development should be accorded precedence over investments in FI and DI, as the former harbors the capacity to enhance environmental quality, while the latter is anticipated to detract from it. In relation to the repercussions of infrastructure on environmental quality, forecasts indicate that the agricultural sector will exert a detrimental effect. With respect to the interplay between infrastructure and environmental quality, it becomes imperative to alleviate the negative aspects associated with the trade sector in order to amplify the beneficial impacts of infrastructure on environmental quality. In terms of the interconnection between advancements in the trade sector and environmental quality, when considered alongside infrastructure, it is crucial to implement improvements within the industrial sector, as this will augment the advantageous consequences of infrastructure on environmental quality. The agricultural sector has the capacity to enhance the positive implications of investment on environmental quality by serving as a moderating factor. The detrimental effects of investment on environmental quality are expected to be alleviated by the relationship between investment and environmental quality within the commercial and industrial sectors.

6. CONCLUSIONS

The subsequent research findings can be observed across 34 provinces in Indonesia, taking into consideration the aims of the study, the results of the analysis and discourse, as well as the methodological framework employed in the research: The outcomes indicate that infrastructure does not exert an influence on environmental quality, signifying that the enhancement of infrastructure—specifically, the stabilization of roadways—will not affect environmental quality since the maintenance of road stability solely necessitates the upkeep of the road surface. The efforts undertaken to preserve road stability will not adversely impact air quality, water quality, or land clearing activities. Maintenance activities aimed at preserving road stability are unlikely to enhance environmental quality, as such maintenance tasks—like repairing road damage, improving drainage systems, and grass trimming—are not expected to either improve or detrimentally affect air quality, water quality, or land accessibility.

The agricultural sector imposes a significant and detrimental impact on environmental quality; its mere presence has the potential to undermine the capacity of infrastructure to enhance environmental quality, as evidenced by the proliferation of commercial enterprises within the agricultural sector. Considering that the agricultural sector necessitates vast expanses for its activities and must allocate existing land resources in alignment with infrastructural demands, the interaction between infrastructure and environmental quality is adversely affected by the agricultural sector's existence. The effect of infrastructure on environmental quality is positively and significantly moderated by the trade and industrial sectors; the presence of the trade sector can amplify the benefits of improved infrastructure on environmental quality. The government levies taxes on the trade sector to bolster Original Regional Income. The funding for road maintenance is sourced from PAD to improve infrastructure and facilitate more efficient and organized transportation systems. Well-maintained roadways contribute positively to the enhancement of water quality and the alleviation of air pollution.

Investment adversely affects the quality of the environment; specifically, as investment levels rise, environmental quality tends to decline. Investments encompass property development, road construction, the erection of office buildings, the establishment of shopping centers and apartment complexes, agricultural sector advancements, and industrial sector growth. The development driven by both FI and DI can lead to a variety of environmental challenges, including flooding and insufficient access to clean water, which results in diminished water quality, heightened air pollution, and decreased air quality, alongside land clearing activities that may lead to the extinction of wildlife and a reduction in land cover.

Investment in environmental quality is promoted by the agricultural sector. The findings of the analysis indicate that investment (X_2) and environmental quality (Y) are positively influenced by the agricultural sector (Z_1). This implies that an increase in investment towards environmental quality will be supported or reinforced by the expansion of the agricultural sector. In other words, investment has a favorable impact on environmental quality when moderated by the agricultural sector.

Due to the fact that capital investment diminishes production expenses within the trade sector without taking into

account the implications for environmental quality, which subsequently leads to a decline in water quality, air quality, and land cover, the trade sector serves to mitigate the adverse effects of investment on environmental quality. Furthermore, the mere presence of the trade sector can attenuate the impact of investment on environmental quality. Conversely, the industrial sector exerts a significant and detrimental moderating influence on the relationship between investment and environmental quality; its presence may curtail the enhancement of investment aimed at improving environmental quality. Upon the initial establishment of the industrialization sector, it is anticipated to generate air and water pollution as investors exploit natural resources with little consideration for environmental quality, prioritizing the reduction of manufacturing expenses.

The subsequent theoretical inferences have been derived from the research outcomes: First, enhancing infrastructure, including the augmentation of roadway stability, does not compromise environmental integrity. Second, the agricultural sector exerts detrimental effects on environmental integrity. Third, the trade sector plays a pivotal role in alleviating the repercussions of infrastructure on environmental integrity.

The findings of this study are used by relevant parties. Stakeholders are encouraged to prioritize infrastructure development to strengthen roads above investment since infrastructure development improves environmental quality while investment degrades it. It is recommended that stakeholders significantly augment the commercial and industrial domains, as this expansion would mitigate the adverse impacts of investment on environmental quality while simultaneously amplifying the beneficial effects of infrastructure on environmental quality. These implications are explained below:

-The industrial sector aids in reducing the negative effects of infrastructure on the state of the environment.

-Investment has a detrimental effect on the environment.

-Investments in environmental quality are positively impacted by the agriculture sector.

-The trade industry lessens the influence of investments on the state of the environment.

-Investments on environmental quality have a less impact when they are in the industrial sector.

Based on the aforementioned, all other stakeholders involved in implementing government policy are required to take into account the influence of infrastructure on environmental quality when creating regulations related to it, with a focus on investment, trade, industry, and agriculture as moderating factors. The aforementioned theoretical implications suggest that road stability infrastructure has a more positive effect on environmental quality than investment. However, environmental quality is decreased when the farm sector mitigates the effects of infrastructure on it, whereas environmental quality is increased by the trade and industrial sectors. Agricultural methodologies, conversely, amplify the effects of capital investment on environmental quality when the agricultural domain actively alleviates that impact, whereas both the trade and agricultural sectors diminish the repercussions of investment on environmental quality.

When discussing the research findings, it was revealed that there were limitations to this study, so future research should use infrastructure indicators in the form of transportation and warehousing business activities that allow goods and people to move from one location to another. The mode of transportation used will have an impact on environmental quality, including air and sound quality. More research is needed to use other infrastructure indicators, such as economic infrastructure including rail, sea, and air transportation.

Future studies should make use of investment variable indicators in the form of business domains including mining, agriculture, tourism, industry, and other sectors that gain from this investment. It is recommended that future studies make use of more accurate agriculture sector variable indicators in order to better target their influence and strengthen or weaken the relationship between the independent and dependent variables. The industrial sector concept is complete in terms of raw materials, processes, goods produced, and economic size, therefore its impact on environmental quality will vary. To better detect the role of moderation, it is best to employ a more precise industrial sector concept, such as small or large-scale enterprises, manufacturing, food, garment, and other sectors.

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