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The Influence of Social SDGs on Economic SDGs with Environmental SDGs as a Moderating Variable in Indonesia

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A B S T R A C T

This study examines the influence of Social Sustainable Development Goals (SDGs) on Economic SDGs in Indonesia, including the direct contribution of Environmental SDGs and their moderating role. This study used a quantitative explanatory design and annual secondary data for 1990-2024, with 35 observations for seven indicators: Poverty Gap, Primary Completion Rate, Gini Coefficient, Infant Mortality Rate, GDP per capita, Trade Openness, and Access to Electricity, obtained primarily from the World Bank. The data were analyzed using SmartPLS through descriptive statistics and PLS-SEM, including assessment of the structural model, predictive relevance, direct effects, and moderation effects. The results show that the model explains 98.5% of the variance in GDP per capita, 94.5% in Infant Mortality Rate, and 62.9% in Trade Openness, with Q-Square values of 0.680, 0.760, and 0.215, respectively. Of the 21 hypotheses tested, five are supported: Poverty Gap significantly increases Infant Mortality Rate ($O = 1.036$; $p = 0.004$) and decreases GDP per capita ($O = -0.449$; $p = 0.011$), Gini Coefficient positively affects GDP per capita ($O = 0.153$; $p = 0.035$), Access to Electricity positively affects GDP per capita ($O = 0.581$; $p = 0.004$), and the interaction between Access to Electricity and Poverty Gap significantly affects GDP per capita negatively ($O = -0.747$; $p < 0.001$). The remaining 16 direct and moderation relationships are statistically insignificant. These findings show that Social and Environmental SDGs do not influence economic outcomes uniformly, while Access to Electricity significantly moderates the relationship between Poverty Gap and GDP per capita, highlighting the need for SDG policies that consider indicator-specific interactions rather than treating the three dimensions as independent development components.

Contribution to Sustainable Development Goals (SDGs):
SDG 1: No Poverty
SDG 3: Good Health and Well-being
SDG 7: Affordable and Clean Energy

1. INTRODUCTION

1.1. Research Background

Sustainable development has become a central issue in the global development agenda since the United Nations adopted the Sustainable Development Goals (SDGs) in 2015. The SDGs consist of 17 interconnected goals designed to address global challenges, including poverty, inequality, environmental degradation, and inclusive prosperity. Unlike earlier development approaches that frequently considered economic, social, and environmental objectives separately, the SDGs emphasize their interdependence and the need to balance these three dimensions in pursuing long-term development [1], [2]. Within this framework, the social dimension encompasses poverty reduction,

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health, education, equality, and social resilience, which collectively contribute to developing productive and adaptive human resources. Improvements in education and health can increase labor productivity, innovation, and economic competitiveness, while stronger social protection and poverty reduction can improve participation in economic activities and household purchasing capacity [3], [4].

However, the relationship between social and economic development cannot be separated from environmental conditions. Economic activities depend on natural resources and ecological systems, while social welfare is also influenced by the availability and quality of environmental resources. Environmental degradation, climate change, pollution, and unsustainable exploitation of natural resources can reduce the economic benefits generated from improvements in social conditions and create long-term economic losses [5]. This suggests that environmental SDGs may function not merely as an independent development objective but also as a contextual factor that determines whether improvements in social conditions translate into stronger economic outcomes. In Indonesia, this relationship becomes particularly relevant because the country faces diverse environmental pressures, including deforestation, pollution, climate vulnerability, and dependence on natural resources. Bappenas in 2023 shows that Indonesia continues to face challenges in achieving balanced progress across the social, economic, and environmental dimensions of the SDGs.

The empirical situation in Indonesia further demonstrates the importance of examining these relationships. Although Indonesia's national poverty rate has continued to decline, poverty remains unevenly distributed across provinces. According to Statistics Indonesia (BPS), the national poverty rate in March 2025 was 8.47%, equivalent to approximately 23.85 million people, while several provinces recorded substantially higher poverty rates, including Highland Papua at 30.03%, Central Papua at 28.90%, and West Papua at 20.66%. This disparity suggests that improvements in social development do not automatically generate equivalent economic outcomes across regions. Provinces with high poverty levels may also face geographical isolation, limited infrastructure, environmental vulnerability, and heavy dependence on primary natural resources, which can constrain the translation of social improvements into productive and sustainable economic activity. Consequently, differences in environmental conditions may explain why similar improvements in social development can produce different economic outcomes across Indonesian regions.

Despite the increasing attention to SDG interlinkages, existing empirical studies have not fully explained how the social, economic, and environmental dimensions interact within the sustainable development framework. Previous research has primarily examined the direct relationships among SDG dimensions or identified their individual contributions to sustainable development. For instance, study [2] showed that Social SDGs positively influence Economic SDGs and that Environmental SDGs also have a positive direct contribution. Similarly, study [6] identified positive effects of economic and social factors on SDG performance, with green innovation strengthening the relationship between social factors and sustainability. Although these findings establish the relevance of interconnections among SDG dimensions, they do not fully explain whether environmental conditions alter the relationship between social development and economic outcomes.

Studies [10] and [11] showed that interactions among SDG dimensions may be nonlinear and involve both synergies and trade-offs, while [14] and [16] highlighted differences in SDG performance across economic, social, and environmental dimensions. These findings suggest that the relationship between social and economic development cannot necessarily be understood through direct effects alone. However, empirical evidence concerning the moderating role of Environmental SDGs in the relationship between Social SDGs and Economic SDGs remains limited, particularly in Indonesia. This limitation provides the basis for examining Environmental SDGs not only as an independent determinant of economic outcomes but also as a variable that may change the strength or direction of the relationship between social and economic development.

In response to this research gap, the present study examines the relationships among Social SDGs, Economic SDGs, and Environmental SDGs in Indonesia using a moderation framework. Social SDGs are represented by Poverty Gap, Primary Completion Rate, and Gini Coefficient, while Economic SDGs comprise Infant Mortality Rate, GDP per Capita, and Trade Openness. Environmental SDGs are represented by Access to Electricity. By examining the direct effects of social and environmental indicators alongside their interaction effects, this study empirically assesses whether environmental conditions influence the relationship between different social development indicators and economic outcomes.

1.2. Literature Review

Previous studies demonstrate that the SDGs represent interconnected social, economic, and environmental dimensions whose relationships can generate both synergies and trade-offs. Study [9] found that renewable energy and good governance improve environmental sustainability, while non-renewable energy harms environmental performance; [10] showed that SDG interactions are nonlinear and dynamic; and [6] found that economic and social factors positively affect SDG performance, with green innovation strengthening the social-sustainability relationship. Study [11] identified both synergies and trade-offs between urbanization and SDG achievement, while [12] highlighted governance, social capital, and intellectual capital as major determinants of sustainable competitiveness. [13] demonstrated positive effects of economic and social SDG commitments on consumer trust and loyalty, whereas [14] identified disparities among economic, social, and environmental SDG pillars across U.S. regions. [15] proposed a multidimensional SDG framework encompassing social, economic, environmental, and governance dimensions, while [16] found that approximately 70% of national SDG performance variation can be explained by socioeconomic, environmental, and social-equality dimensions.

Study [2] provided direct evidence that social SDGs positively influence economic SDGs (0.796), while environmental SDGs also contribute positively (0.196). Study [17] showed that economic growth and fossil-fuel dependence increase environmental pressures, while [18] emphasized tensions between continuous economic growth and ecological limits. Study [19] found that education, innovation, equality, income, and sustainable consumption jointly support opportunity-driven entrepreneurship, while [20] confirmed that entrepreneurship contributes to economic growth depending on development conditions.

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These findings confirm the interdependence of SDG dimensions and demonstrate that social, economic, and environmental factors can influence sustainable development through different pathways. Nevertheless, the literature provides more evidence on their direct relationships than on their conditional relationships. Study [2], for example, established the positive direct contribution of Social SDGs and Environmental SDGs to Economic SDGs, but the findings do not establish whether Environmental SDGs change the relationship between the two dimensions. Meanwhile, studies [6], [10], and [11] indicate that sustainability outcomes may depend on interactions among different development factors. Building on these findings, the present study extends the existing literature by empirically testing the moderating role of Environmental SDGs in the relationship between Social SDGs and Economic SDGs in Indonesia.

The novelty of this study lies in the operationalization of this moderation framework through three Social SDG indicators, three Economic SDG indicators, and one Environmental SDG indicator. Specifically, the study examines the direct relationships between Poverty Gap, Primary Completion Rate, and Gini Coefficient and each Economic SDG indicator, as well as the direct contribution of Access to Electricity. Furthermore, it tests whether Access to Electricity moderates each relationship between the three social indicators and the three economic indicators. This approach allows the study to identify which relationships are statistically significant and whether environmental conditions influence these relationships differently across economic outcomes.

1.3. Research Objective

Based on these conditions, this study examines the influence of social SDGs on economic SDGs in Indonesia while considering environmental SDGs as a moderating variable. The study first describes the conditions of social, economic, and environmental SDGs to identify the development profile across the observed dimensions. It then analyzes whether social SDGs have a significant influence on economic SDGs and whether environmental SDGs independently contribute to economic SDGs. Furthermore, the study tests whether environmental SDGs strengthen or weaken the influence of social SDGs on economic SDGs, thereby capturing the interaction among the three dimensions of sustainable development. This approach is consistent with the principle that sustainable development requires simultaneous progress across social, economic, and environmental dimensions rather than improvements in one dimension at the expense of another.

2. MATERIALS AND METHODS

This study employed a quantitative research design with an explanatory approach to examine the relationships among Social SDGs, Economic SDGs, and Environmental SDGs in Indonesia. A quantitative approach was selected because it enables systematic, objective processing of numerical data, while explanatory research aims to explain relationships between independent and dependent variables and test previously formulated hypotheses. According to [21] explanatory research seeks to understand why a phenomenon occurs by identifying patterns, relationships, and potential causal mechanisms, and is therefore closely associated with causal research. In this study, the explanatory approach was applied to determine the direction and strength of the influence of Social SDGs on Economic SDGs, the influence of Environmental SDGs on Economic SDGs, and the moderating role of Environmental SDGs in the relationship between Social and Economic SDGs. The analysis therefore focuses on empirical relationships that can support inference and generalization based on available secondary data.

The variables consisted of an independent variable, a dependent variable, and a moderating variable. Social SDGs (X_1) were represented by *poverty gap*, *primary completion rate*, and *Gini coefficient*. Economic SDGs (Y_1) were represented by *infant mortality rate per 1,000 live births*, GDP per capita, and *trade openness*, while Environmental SDGs (Y_2) were represented by *access to electricity*. These seven indicators were selected to operationalize the three SDG dimensions examined in this study, with Social SDGs comprising three indicators, Economic SDGs comprising three indicators, and Environmental SDGs comprising one indicator. The population covered all Social SDGs, Economic SDGs, and Environmental SDGs data, including both officially recorded information and economic realities that may not be formally recorded in institutional databases, such as informal economic activities, non-formal cross-regional trade, and natural-resource utilization for household consumption in remote areas. The sample comprised secondary data for the selected indicators available from relevant institutions for 1990-2024, using the full available annual dataset as the research sample. The observation period consisted of 35 annual observations for each selected indicator. The data were obtained primarily from the World Bank and can be accessed through the World Bank Data platform.

Table 1 shows the selected indicators and their data sources.

Table 1. Research Data Sources

No.	Variable	SDG	Indicator	Data Source
1	X1 Social SDGs	SDG 1	Poverty Gap	World Bank WDI
		SDG 4	Primary Completion Rate	World Bank WDI
		SDG 10	Gini Coefficient	World Bank WDI
2	Y1 Economic SDGs	SDG 3	Infant Mortality Rate (per 1,000 live births)	World Bank WDI
		SDG 8	GDP per capita	World Bank WDI
		SDG 17	Trade Openness	World Bank WDI
3	Y2 Environmental SDGs	SDG 7	Access to Electricity	World Bank WDI

The research instrument was documentation, consisting of secondary quantitative data obtained from authoritative national and international institutions. This instrument was selected because the study relies on previously collected and published data that have undergone institutional data-collection and validation procedures. The geographical scope was limited to Indonesia at the national level, without comparisons among provinces, regions, or countries, and the analysis used aggregate

macro-level annual data. The study specifically focused on selected indicators representing the social, economic, and environmental dimensions of the SDGs rather than all 17 SDGs. Data collection was conducted by identifying, accessing, selecting, and organizing relevant indicators from the World Bank, Statistics Indonesia (BPS), and the Ministry of Environment, without direct surveys, interviews, or field observations.

The data were analyzed using *Smart Partial Least Squares* (SmartPLS), which is suitable for regression-based analysis and evaluation of measurement models, including formative and reflective measurement approaches [22]. Descriptive analysis was first conducted to summarize the data using the mean, minimum, maximum, and standard deviation, while cross-tabulation was used to describe relationships between variables in rows and columns [23]. Subsequently, *Structural Equation Modelling* (SEM) was employed as a multivariate technique for simultaneously analyzing multiple variables and their relationships. SEM consists of covariance-based SEM (CB-SEM), generally used for theory confirmation, and PLS-SEM, which is commonly applied for prediction and theory development [22]. In this study, PLS-SEM was selected because it enables the examination of relationships among the research constructs and the moderating effect of Environmental SDGs. The analysis followed a *path model* consisting of an outer model and an inner model, with the path model visually representing the hypothesized relationships among the constructs [22]. The conceptual framework specifies the direct relationship between Social SDGs and Economic SDGs, the direct contribution of Environmental SDGs to Economic SDGs, and the moderating role of Environmental SDGs in the relationship between Social SDGs and Economic SDGs.

The outer model was evaluated using convergent validity, discriminant validity, and reliability. Convergent validity was assessed through indicator *outer loadings* and *Average Variance Extracted* (AVE), with an outer loading of ≥ 0.70 and AVE of ≥ 0.50 considered acceptable [22]. Discriminant validity was evaluated using *cross-loadings* and the *Fornell-Larcker criterion*, where an indicator's loading on its associated construct should exceed its cross-loadings on other constructs and the square root of each construct's AVE should be greater than its correlations with other constructs [22]. The inner model was subsequently assessed through the coefficient of determination (R^2), *path coefficients*, and hypothesis testing. R^2 indicates the proportion of variance in an endogenous variable explained by its predictors, with values of 0.75, 0.50, and 0.25 generally interpreted as strong, moderate, and weak, respectively [24], [25]. Path coefficients range approximately from -1 to +1, with values closer to +1 or -1 indicating stronger positive or negative relationships, respectively [22].

We used the *bootstrapping* procedure in SmartPLS to obtain *T-statistics* and *p-values*. A relationship was considered statistically significant when the *T-statistic* exceeded the relevant critical value or when the *p-value* was lower than the selected significance level [22]. For two-tailed testing, the commonly used critical *t*-values are 1.65 at 10%, 1.96 at 5%, and 2.57 at 1%, while for one-tailed testing they are 1.28, 1.65, and 2.33, respectively [22]. The structural model was used to examine 21 hypothesized relationships, consisting of 12 direct relationships and nine interaction relationships. The direct relationships covered the effects of Poverty Gap, Primary Completion Rate, and Gini Coefficient on Infant Mortality Rate, GDP per Capita, and Trade Openness, as well as the effects of Access to Electricity on the three Economic SDG indicators. The nine interaction relationships examined the moderating effects of Access to Electricity on each relationship between the three Social SDG indicators and the three Economic SDG indicators. Through this procedure, the study evaluates both the direct relationships among the three SDG dimensions and the interaction effect of Environmental SDGs in explaining Economic SDGs in Indonesia.

3. RESULT AND DISCUSSION

3.1. Result

The descriptive statistics for all variables included in the study are shown in Table 2. The analysis was based on 35 observations for each variable. The results show that the mean values varied across the indicators, with the Poverty Gap having a mean of 42.2457, Primary Completion Rate of 99.9618, Gini Coefficient of 33.6829, Infant Mortality Rate of 34.1229, GDP per capita of 8,682.9145, Trade Openness of 52.2083, and Access to Electricity of 84.56. The minimum and maximum values also indicate substantial variation across the observation period, particularly for Poverty Gap, GDP per capita, and Trade Openness.

Table 2. Descriptive Statistics

Statistic	SDG 1 (Poverty Gap)	SDG 4 (Primary Completion Rate)	SDG 10 (Gini Coefficient)	SDG 3 (Infant Mortality Rate)	GDP per capita	SDG 17 (Trade Openness)	Access to Electricity (%)
N	35	35	35	35	35	35	35
Mean	42.2457	99.9618	33.6829	34.1229	8682.9145	52.2083	84.56
Median	41.1000	99.5421	33.2000	30.5000	7802.4641	51.8771	90.60
Mode	41.10[a]	89.09[a]	32.00[a]	16.50[a]	4873.05[a]	32.97[a]	86[a]
Minimum	5.40	89.09	29.30	16.50	4873.05	32.97	41
Maximum	82.80	109.71	38.90	64.30	14470.44	96.19	100

The SEM-PLS analysis was then conducted to evaluate the structural model and the relationships among Social SDGs, Economic SDGs, Environmental SDGs, and their interaction effects. Figure 1 shows the resulting structural model.

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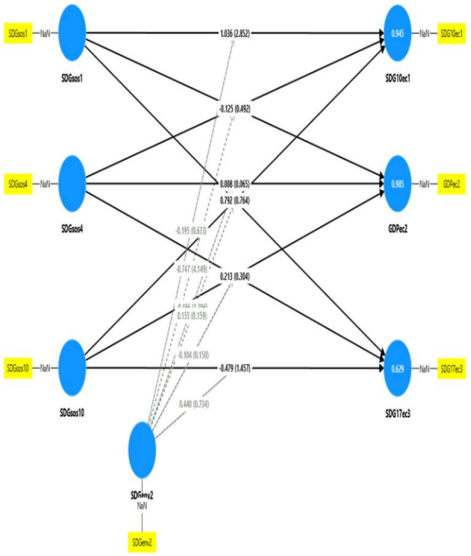


Fig 1. Structural Model

The subsequent analysis evaluates the model through R-Square and Adjusted R-Square, Q-Square, path coefficients, outer loading, and Variance Inflation Factor (VIF), followed by the specific indirect effects, total effects, and outer weights.

Table 3. presents the explanatory power of the endogenous variables. GDP per capita has an R-Square of 0.985 and an Adjusted R-Square of 0.981, indicating that the Social SDGs indicators, Environmental SDGs, and moderation effects explain 98.5% of its variation. This value is categorized as strong based on [22]. The Infant Mortality Rate also shows a strong explanatory power with an R-Square of 0.945 and an Adjusted R-Square of 0.931. Meanwhile, Trade Openness has an R-Square of 0.629 and an Adjusted R-Square of 0.532, indicating moderate explanatory power.The Q-Square results in Table 4. show that all endogenous variables have values above zero, indicating predictive relevance of the structural model. GDP per capita and Infant Mortality Rate have strong predictive relevance with Q-Square values of 0.680 and 0.760, respectively, while Trade Openness has moderate predictive relevance with a value of 0.215. Based on Hair et al. (2019), Q-Square values above 0.35 are considered strong, 0.15-0.35 moderate, and 0-0.15 weak.

Table 3. R-Square and Adjusted R-Square of Endogenous Variables

Endogenous Variable	R-Square	R-Square Adjusted
GDP per capita (GDPec2)	0.985	0.981
Infant Mortality Rate (SDG10ec1)	0.945	0.931
Trade Openness (SDG17ec3)	0.629	0.532

Table 4. Q-Square (Predictive Relevance) of Endogenous Variables

Endogenous Variable	SSO	SSE	Q-Square (1-SSE/SSO)
GDP per capita (GDPec2)	35.000	11.184	0.680
Infant Mortality Rate (SDG10ec1)	35.000	8.390	0.760
Trade Openness (SDG17ec3)	35.000	27.492	0.215

Table 5. presents 21 tested relationships consisting of 12 direct relationships and 9 interaction/moderation relationships. At the 5% significance level, five relationships are statistically significant ($p < 0.05$). Access to Electricity has a positive and significant effect on GDP per capita ($O = 0.581$; $p = 0.004$), while the Gini Coefficient also has a positive and significant effect on GDP per capita ($O = 0.153$; $p = 0.035$). Poverty Gap has a negative and significant effect on GDP per capita ($O = -0.449$; $p = 0.011$) but a positive and significant effect on Infant Mortality Rate ($O = 1.036$; $p = 0.004$). In addition, the interaction between Access to Electricity and Poverty Gap has a negative and significant effect on GDP per capita ($O = -0.747$; $p = 0.001$). This interaction has the highest T-statistic among all tested relationships (4.149), indicating providing the strongest statistical evidence of an interaction effect in the model. The remaining 16 relationships are statistically insignificant ($p > 0.05$).

Table 5. Path Coefficients: Direct and Moderating Effects

Relationship	Original Sample (O)	T-Statistics	P-Values	Conclusion
SDGenv2 to GDPec2	0.581	2.851	0.004	Significant
SDGenv2 to SDG10ec1	0.282	0.702	0.483	Not significant
SDGenv2 to SDG17ec3	0.209	0.204	0.838	Not significant
SDGsos10 to GDPec2	0.153	2.112	0.035	Significant
SDGsos10 to SDG10ec1	0.054	0.398	0.691	Not significant
SDGsos10 to SDG17ec3	-0.479	1.457	0.145	Not significant
SDGsos4 to GDPec2	0.008	0.065	0.948	Not significant
SDGsos4 to SDG10ec1	-0.125	0.492	0.623	Not significant
SDGsos4 to SDG17ec3	0.213	0.304	0.761	Not significant
SDGsos1 to GDPec2	-0.449	2.539	0.011	Significant
SDGsos1 to SDG10ec1	1.036	2.852	0.004	Significant

Relationship	Original Sample (O)	T-Statistics	P-Values	Conclusion
SDGsos1 to SDG17ec3	0.792	0.764	0.445	Not significant
SDGenv2 and SDGsos1 to GDPec2	-0.747	4.149	0.000	Significant
SDGenv2 and SDGsos1 to SDG10ec1	-0.195	0.633	0.527	Not significant
SDGenv2 and SDGsos1 to SDG17ec3	0.155	0.159	0.874	Not significant
SDGenv2 and SDGsos10 to GDPec2	-0.142	1.003	0.316	Not significant
SDGenv2 and SDGsos10 to SDG10ec1	-0.241	1.112	0.266	Not significant
SDGenv2 and SDGsos10 to SDG17ec3	0.440	0.734	0.463	Not significant
SDGenv2 and SDGsos4 to GDPec2	-0.186	1.296	0.195	Not significant
SDGenv2 and SDGsos4 to SDG10ec1	0.143	0.543	0.587	Not significant
SDGenv2 and SDGsos4 to SDG17ec3	-0.104	0.150	0.881	Not significant

The outer loading and VIF results in Table 6. show a value of 1.000 for every construct. Formally, these values exceed the commonly used outer-loading threshold of 0.70 and indicate no multicollinearity concern based on VIF. However, the uniform value of 1.000 should be interpreted cautiously because each construct is reshown by a single indicator. In a single-indicator construct, the outer loading and VIF are mathematically fixed at 1.000, so these values do not indicate perfect measurement quality. Therefore, the outer-model validity and multicollinearity results have limited substantive interpretability and should not be considered independent evidence of optimal measurement quality [22].

Table 6. Outer Loading and Variance Inflation Factor (VIF)

Construct / Interaction	Outer Loading	VIF
GDPec2	1.000	1.000
SDG10ec1	1.000	1.000
SDG17ec3	1.000	1.000
SDGenv2	1.000	1.000
SDGsos10	1.000	1.000
SDGsos4	1.000	1.000
SDGsos1	1.000	1.000
SDGenv2 and SDGsos1	1.000	1.000
SDGenv2 and SDGsos10	1.000	1.000
SDGenv2 and SDGsos4	1.000	1.000

3.2. Discussion

The findings show that relationships among the Social SDGs, Economic SDGs, and Environmental SDGs in Indonesia are heterogeneous rather than uniform across indicators. Of the 21 hypotheses tested, only five relationships were statistically significant at the 5% level: four direct effects and one moderation effect. For the Social SDGs, *Poverty Gap* significantly affected both *Infant Mortality Rate* and GDP per capita, but not Trade Openness. *Primary Completion Rate* did not significantly affect any of the three economic-related outcomes, while the *Gini Coefficient* significantly affected GDP per capita but not Infant Mortality Rate or Trade Openness. These findings indicate that improvements or deterioration in individual social indicators do not automatically produce similar changes across all economic indicators. This pattern is consistent with the broader SDG literature, which emphasizes that interactions among SDGs may be nonlinear and may involve synergies and trade-offs rather than simple one-directional relationships [10]. Therefore, the hypothesis discussion should distinguish between indicators that show direct relationships and those whose effects may depend on other structural conditions.

The first significant relationship is the positive effect of *Poverty Gap* on *Infant Mortality Rate* (H1), with O = 1.036, T = 2.852, and p = 0.004. This result indicates that a larger poverty gap is associated with a higher infant mortality rate, supporting the theoretical argument that poverty limits households' ability to obtain adequate nutrition, healthcare, clean water, sanitation, and healthy living conditions [26]. The relatively large coefficient also indicates that changes in the Poverty Gap are strongly associated with changes in Infant Mortality Rate within the model. This finding is consistent with [27] who found that increased economic support for poor households through cash-transfer programs was associated with reductions in child mortality, and with [28] who reported higher mortality risks among children from lower socioeconomic groups. Study [29] likewise demonstrated that socioeconomic inequality is associated with differences in neonatal mortality among vulnerable populations. The result therefore supports the view that poverty reduction and health improvement are interconnected components of sustainable development, because economic deprivation can increase health vulnerability while poor health can subsequently reinforce socioeconomic disadvantage. In the Indonesian context, reducing poverty should consequently be accompanied by improvements in maternal and child healthcare, nutrition, sanitation, and social protection rather than relying exclusively on reductions in the poverty headcount.

The second significant finding concerns H2, where *Poverty Gap* has a negative and significant effect on GDP per capita (O = -0.449; T = 2.539; p = 0.011). This means that higher poverty is associated with lower income per capita, which is consistent with the concept of a poverty trap in which limited resources constrain human-capital accumulation and productivity, thereby restricting economic advancement (Sachs, 2005). The relationship is also theoretically connected to H1 because higher poverty is associated with higher infant mortality, which can affect the development of human capital across generations and potentially contribute to the persistence of poverty. Study [30] similarly emphasize the close relationship between poverty reduction and economic growth in developing countries, while [31] show that economic growth can contribute to reductions in multidimensional poverty. In contrast, H3 shows that *Poverty Gap* has a positive but insignificant effect on *Trade Openness* (O = 0.792; T = 0.764; p = 0.445), indicating that changes in

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domestic poverty do not systematically determine Indonesia's degree of trade openness. Trade openness is more directly shaped by trade policy, tariffs, international agreements, exchange rates, investment, commodity prices, and global economic conditions than by domestic poverty alone. Thus, H2 is supported while H3 is not, suggesting that poverty relates more clearly to domestic income generation than to a country's integration into international trade.

The remaining Social SDGs relationships demonstrate that the effects of education and inequality are more limited and indicator-specific. H4, which examines the effect of *Primary Completion Rate* on *Infant Mortality Rate*, is not supported because the relationship is negative but insignificant (O = -0.125; T = 0.492; p = 0.623). H5 is also not supported, as *Primary Completion Rate* has an almost zero and insignificant effect on GDP per capita (O = 0.008; T = 0.065; p = 0.948), while H6 is not supported because its positive effect on *Trade Openness* is insignificant (O = 0.213; T = 0.304; p = 0.761). These results suggest that completion of primary education alone may not immediately translate into improvements in health, income, or international trade, because the economic returns to education depend on quality, skills, subsequent educational attainment, and labor-market absorption. This interpretation is consistent with [32], who argue that learning-adjusted schooling provides a more meaningful representation of human capital for economic development than years of schooling alone. H7 also remains unsupported because the *Gini Coefficient* has a positive but insignificant effect on Infant Mortality Rate (O = 0.054; T = 0.398; p = 0.691), even though inequality theoretically can restrict access to healthcare and other basic services. Thus, H4-H7 collectively indicate that aggregate education completion and income inequality do not necessarily generate immediate changes in health, income, or trade indicators, particularly when other structural and institutional factors are present.

The direct effects of the Environmental SDGs further demonstrate that the relationship between environmental-related development and economic outcomes differs across indicators. H8 is supported because the *Gini Coefficient* has a positive and significant effect on GDP per capita (O = 0.153; T = 2.112; p = 0.035), indicating that, within this model and observation period, changes in income inequality are significantly associated with GDP per capita. However, H9 is not supported because the Gini Coefficient has a negative but insignificant effect on Trade Openness (O = -0.479; T = 1.457; p = 0.145). H10 is likewise not supported because *Access to Electricity* has a positive but insignificant effect on Infant Mortality Rate (O = 0.282; T = 0.702; p = 0.483). In contrast, H11 is supported, with Access to Electricity having a positive and significant effect on GDP per capita (O = 0.581; T = 2.851; p = 0.004), indicating that broader electricity access is associated with higher economic output per person. H12 is not supported because Access to Electricity has a positive but insignificant relationship with Trade Openness (O = 0.209; T = 0.204; p = 0.838). The significant H11 finding is consistent with the broader SDG literature showing that infrastructure and resource access can support economic development, while the insignificant H9, H10, and H12 results indicate that the effects of inequality and electricity access do not necessarily extend uniformly across health and international trade outcomes.

The moderation analysis provides the strongest evidence concerning the role of Environmental SDGs in the Social SDGs-Economic SDGs relationship. H13 is not supported because the interaction between *Access to Electricity* and *Poverty Gap* does not significantly affect Infant Mortality Rate (O = -0.195; T = 0.633; p = 0.527). H14, however, is strongly supported because the interaction between Access to Electricity and Poverty Gap has a negative and significant effect on GDP per capita (O = -0.747; T = 4.149; p < 0.001). The T-statistic of 4.149 is the highest among all relationships tested, making H14 the strongest statistical finding in the model. H15 is not supported because the same interaction has no significant effect on Trade Openness (O = 0.155; T = 0.159; p = 0.874). These results indicate that Access to Electricity changes the relationship between Poverty Gap and GDP per capita, but this moderating role does not extend to Infant Mortality Rate or Trade Openness. The finding supports the broader SDG interaction perspective that environmental and infrastructure conditions can alter the strength or direction of relationships between social and economic dimensions rather than simply functioning as independent predictors [2].

The remaining moderation hypotheses involving *Primary Completion Rate* are consistently unsupported. H16 shows that the interaction between Access to Electricity and Primary Completion Rate has no significant effect on Infant Mortality Rate (O = 0.143; T = 0.543; p = 0.587). H17 is also not supported because the interaction has a negative but insignificant effect on GDP per capita (O = -0.186; T = 1.296; p = 0.195), while H18 is not supported because the interaction has a negative and insignificant effect on Trade Openness (O = -0.104; T = 0.150; p = 0.881). These findings suggest that access to electricity does not sufficiently alter the relationship between primary education completion and the three economic-related outcomes examined. One possible explanation is that electricity access provides infrastructure conditions, whereas the economic returns to education depend more strongly on educational quality, advanced skills, employment opportunities, and productivity. Consequently, simply improving electricity access may not be sufficient to convert primary education completion into measurable changes in health, income, or trade outcomes. This finding also reinforces the argument that SDG interactions depend on which indicators are connected, rather than occurring automatically across development dimensions [16].

The final moderation results concerning the *Gini Coefficient* also show no significant interaction effects. H19 is not supported because the interaction between Access to Electricity and Gini Coefficient has an insignificant effect on Infant Mortality Rate (O = -0.241; T = 1.112; p = 0.266). H20 is similarly unsupported because the interaction has a negative but insignificant effect on GDP per capita (O = -0.142; T = 1.003; p = 0.316), while H21 is not supported because the interaction has a positive but insignificant effect on Trade Openness (O = 0.440; T = 0.734; p = 0.463). Taken together, H19-H21 indicate that electricity access does not significantly modify the relationships between income inequality and the three economic-related outcomes. Across H13-H21, therefore, only H14 demonstrates a significant moderation effect, while all other interaction effects remain statistically unsupported. This result is consistent with the argument that SDG relationships can involve selective synergies and trade-offs rather than universal interactions among all indicators [10]. The findings support H1, H2, H8, H11, and H14, while H3-H7, H9-H10, H12-H13, and H15-H21 are not supported, showing that the

contribution of Social and Environmental SDGs to economic development in Indonesia depends heavily on the specific indicator and interaction examined.

4. CONCLUSION

The relationships among Social, Economic, and Environmental SDGs in Indonesia vary across indicators. The PLS-SEM results show that the model has strong explanatory power for GDP per capita ($R^2 = 0.985$) and Infant Mortality Rate ($R^2 = 0.945$), and moderate explanatory power for Trade Openness ($R^2 = 0.629$), with all endogenous variables demonstrating predictive relevance. Of the 21 hypotheses tested, five are supported: Poverty Gap significantly affects Infant Mortality Rate and GDP per capita, Gini Coefficient significantly affects GDP per capita, Access to Electricity significantly affects GDP per capita, and the interaction between Access to Electricity and Poverty Gap significantly affects GDP per capita. The strongest moderation effect is found in the interaction between Access to Electricity and Poverty Gap on GDP per capita ($O = -0.747$; $p < 0.001$), while the other moderation relationships are statistically insignificant.

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