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Emission Reduction and Socio-Economic Indicators as Driving Factors of West Sulawesi Economic Growth

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ABSTRACT

This study investigates the impact of implementing a green economy on the economic growth of West Sulawesi. A green economic system offers a pathway to achieving sustainable development goals by balancing economic, social, and environmental resilience in regional development strategies. By integrating sustainability principles, green economy policies aim to enhance growth while addressing environmental challenges. The research employs a mixed-methods approach, combining descriptive and inferential analysis. Data from 2012–2022 were analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS). The findings demonstrate a significant positive relationship between green economic indicators and economic growth ($p = 0.000$), with an influence value of 0.88. This indicates that the adoption of green economic policies contributes substantially to economic development in West Sulawesi, reflecting the potential of such initiatives to drive sustainable progress. The study highlights the necessity of implementing well-designed green economy policies tailored to local challenges and opportunities. These policies should promote economic growth while safeguarding environmental conditions, ensuring alignment with the principles of sustainable development. Policymakers are encouraged to leverage these findings to enhance the region's economic growth through a green economy framework that fosters long-term resilience and sustainability.

1. INTRODUCTION

Climate change poses a significant threat to human life and has been exacerbated by unsustainable economic practices, including industrialization and rapid economic development [1-3]. While industrialization has improved living conditions in some cases, it has also contributed to environmental degradation and climate change. Addressing these challenges requires integrating ecological considerations into economic development strategies, particularly in regions vulnerable to environmental and socio-economic pressures [4-6].

The concept of a green economy offers a framework for harmonizing economic growth with environmental protection and sustainable resource management [7-9]. This paradigm emphasizes innovative technologies and strategies to conserve resources, improve environmental conditions, and manage waste effectively [10, 11]. As part of sustainable development, the green economy aims to alleviate poverty while enhancing economic resilience [12, 13].

In the context of West Sulawesi, implementing green economic policies is critical to balancing economic growth with environmental sustainability. By aligning regional development strategies with the principles of a green economy, policymakers can address local challenges, reduce emissions, and promote socio-economic well-being. This study examines the impact of green economic indicators on the economic growth of West Sulawesi, providing insights into how tailored policies can foster sustainable development in the region.

There are 15 indicators that will be used to measure the implementation of the green economy. These indicators are classified into three pillars, namely economic, social and environmental which are determined by Bappenas in the Green Economy Index (GEI) to measure the effectiveness of economic transformation in Indonesia towards sustainable development [14, 15]. As the youngest province in Indonesia, West Sulawesi stimulates the economy of its people as GRDP continues to increase. Over the last three years, the West Sulawesi economy has experienced extraordinary growth. Increased production in all areas of the economy is the source of this extraordinary growth. In the process of making sustainable economic policies, the West Sulawesi GRDP indicator can be used as a consideration, especially the green economy paradigm in economic growth policies.

Table 1 shows the GRDP per capita for West Sulawesi and its regencies from 2020 to 2022, with figures ranging from 18,343 thousand rupiah in Mamasa to 66,388 thousand rupiah in Pasangkayu in 2022. This data highlights regional economic disparities, with Pasangkayu and Mamuju showing consistent growth. The overall increase in GRDP per capita, from 32,837 thousand rupiah in 2020 to 37,070 thousand rupiah in West

Sulawesi by 2022, suggests a positive trend in economic development. These figures support the study's objectives by providing a foundation to assess how green economic policies may influence economic growth across regions.

Table 1. GRDP per capita based on current prices (thousand rupiah)

Regency	2020	2021	2022
Majene	28,633	29,605	31,212
Polewali Mandar	27,807	28,524	30,261
Mamasa	18,343	18,992	19,790
Mamuju	42,076	44,118	46,848
Pasangkayu	54,821	64,167	66,388
Central Mamuju	23,849	25,939	27,236
West Sulawesi	32,837	35,192	37,070

Source: BPS West Sulawesi 2024

Overall, Sulawesi's economic growth generally shows an increase in West Sulawesi's GRDP from year to year [16]. However, the value of natural resources lost in West Sulawesi due to exploitation (depletion) and environmental damage (degradation) has not been calculated or deducted as the value of loss and damage that should be paid. As a result, the values stated in GRDP do not reflect the true values of community welfare. The calculation is carried out so that the value reflects the actual welfare of society by taking into account natural resource and environmental factors [17]. This research aims to integrate the green economy into government policy. It is important to examine the economic development of West Sulawesi regarding the implementation of policies from economic, social and environmental aspects in line with the vision of Supporting Sustainable Economic Development with an Environmental Sense in West Sulawesi.

2. METHODOLOGY

This research is quantitative to assess the impact of green economic policies on economic growth, social development, and environmental sustainability in West Sulawesi. The data for this study was in the range of 2020-2022. The study analyzes data from 2012 to 2022 to examine the impact of green economic policies on economic growth in West Sulawesi. The 2012–2022 period was chosen because it represents a decade of significant economic development in the region, including the implementation of various green economy initiatives. This timeframe allows for a thorough assessment of the evolving effects of these policies on regional growth. The data obtained from information related to the research variables tested comes from data from BPS (Central Statistics Agency), West Sulawesi Bapedati, West Sulawesi Environmental Service Annual Report, and West Sulawesi Provincial Forestry Service.

The model analysis built in this research is a multivariate analysis of structural equation models (SEM-PLS) with a tolerance level of 5%. The SEM-PLS method can be used in this research because it provides information regarding indicators that are able to explain the influence of green economic variables on sustainable economic growth. PLS (Partial Least Square) analysis is an alternative approach that shifts from the SEM (Structural Equation Model) approach from covariance becomes variance-based. The research hypothesis that will be tested using SEM-PLS analysis is that there is a positive and significant influence between the green economy indicator variables on economic growth in West Sulawesi.

Testing the structural model is between research variables and testing the measurement model is between indicators and the variables themselves to find out how much the indicators of each variable explain that variable. In this research, the environmental pillar is measured by data on forest area and emission reduction from Baseline/BAU. The economic pillar is measured by the value of the agriculture, fisheries and forestry sectors and the social pillar is measured by data on life expectancy, average length of schooling of more than 15 years, and open unemployment rate. The economic growth variable is measured by regional revenue and per capita income in West Sulawesi Province. As for the structural equation model:

$$Y=\alpha+\beta X+\varepsilon \quad (1)$$

where, Y=Economic Growth Variable, $X1$=Green Economy, ϵ=error term.

3. RESULTS

The results provide descriptive statistics for key study indicators (Table 2). Standard deviations offer insights into data consistency: "Forest Area" exhibits high variability (173,819.93), contrasting with stable "Life Expectancy" (0.743). "Emission Reduction" shows significant fluctuations (1,260.29), while "Agriculture Sector" varies notably (1,547,683.63). In economic and social development, "Forest Area" averages 1,144,004.5 with wide deviation. "Emissions Reduction" trends negatively (-816.6) with volatile performance. "Agriculture Sector" averages 11,272,469.8 with considerable variation. "Life Expectancy" and "Years of Schooling" maintain stability (0.743 and 0.464). "Open Unemployment Rate" and "Income Per Capita" show minimal variability (2.838, 0.484, and 0.475).

However, the results indicate that the mean value of forest area is relatively high (1,144,004.545), but the standard deviation (173,819.926) suggests considerable variability in this indicator. This variability implies that the performance of "forest area" in the model may be influenced by factors such as land use changes, deforestation rates, or inconsistent reporting across different regions. For instance, certain areas might experience significant deforestation due to illegal logging or agricultural expansion, which can lower the effectiveness of forest conservation initiatives. The underperformance of "forest area" in the model could be due to its complex relationship with economic growth. While forest conservation contributes to long-term sustainability, its short-term impact on economic growth may not be as immediately visible as sectors like agriculture or infrastructure. Additionally, forest-related activities such as timber extraction or land conversion may directly conflict with green economy goals, making it harder to quantify the positive influence of forest area on economic growth.

Reducing Emissions from Baseline as an Environmental Pillar and mitigating climate change is a control effort to reduce risks due to climate change through activities that can reduce emissions/increase absorption of Green House Gases from various sources. West Sulawesi Province's CHG emissions come from 3 (three) areas, namely land (66%), energy (32%), and waste management (2%), where in 2010 Green House Gas (GHG) emissions reached around 6.9

million tonnes CO_2-eq. Emission inventory indicators are used because they show efforts to reduce emissions and regional economic growth. Lower emission intensity indicates economic growth without sacrificing GHG emissions, thus implying sustainable development and implementation of a green economy.

The agriculture, fisheries, and forestry sectors have significantly contributed to West Sulawesi's economic growth over the past decade. Green economy policies promote sustainable practices like organic farming, agroforestry, and efficient technology, reducing greenhouse gas emissions and enhancing resilience to climate change. Life expectancy, reflecting overall societal well-being, serves as an indicator for sustainable development and public policy. Education, measured by average years of schooling, is crucial for advancing green development. The open unemployment rate ties green economy implementation to community welfare, with green sector growth creating jobs and reducing unemployment.

Figure 1 presents the results of the PLS algorithm test on the two research variables. It shows that the Green Economy variable has three indicators whose outer loading or loading factor values do not meet the required threshold, whereas the Economic Growth variable meets all criteria. Table 3 displays the outer loading values for each indicator. For example, the Open Unemployment indicator has a loading factor of 0.624, and the Emission Reduction indicator has a value of -0.616, both failing to meet the 0.70 requirement. The low standard deviation in the Emission Reduction indicator (1,260.29), as shown in Table 2, reflects considerable variation, which could be linked to inconsistent policy implementation or external factors, potentially impacting the predicted relationship between green economy initiatives and economic growth.

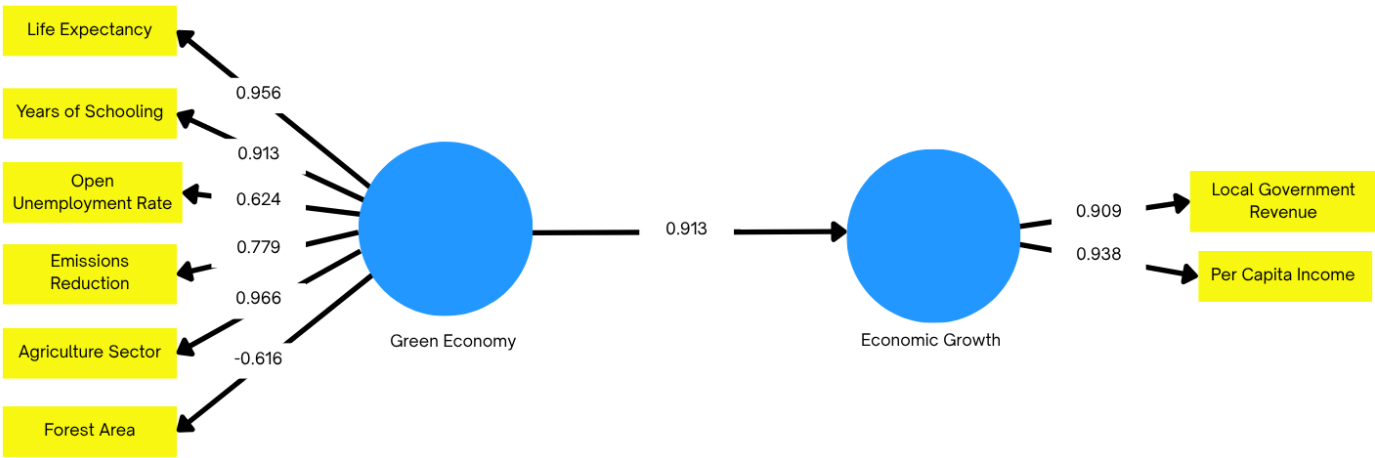

Figure 1. Initial model test results with path analysis (SEM-PLS)

Table 2. Descriptive statistics

Indicator	Mean	Median	Min	Max	Std Dev
Forest Area	1144004.545	1092376	1069989	1691410	173819.926
Emissions Reduction	-816.586	-674.09	-2963.79	545.19	1260.287
Agriculture Sector	11272469.8	11433154.57	8709502.43	13349365.6	1547683.632
Life Expectancy	64.419	64.34	63.04	65.63	0.743
Years of Schooling	7.369	7.31	6.76	8.08	0.464
Open Unemployment Rate	2.838	3.01	2.08	3.35	0.484
Local Government Revenue	335.015	296.94	140.4	807.73	174.964
Income Per Capita	8.711	8.736	8.091	9.358	0.475

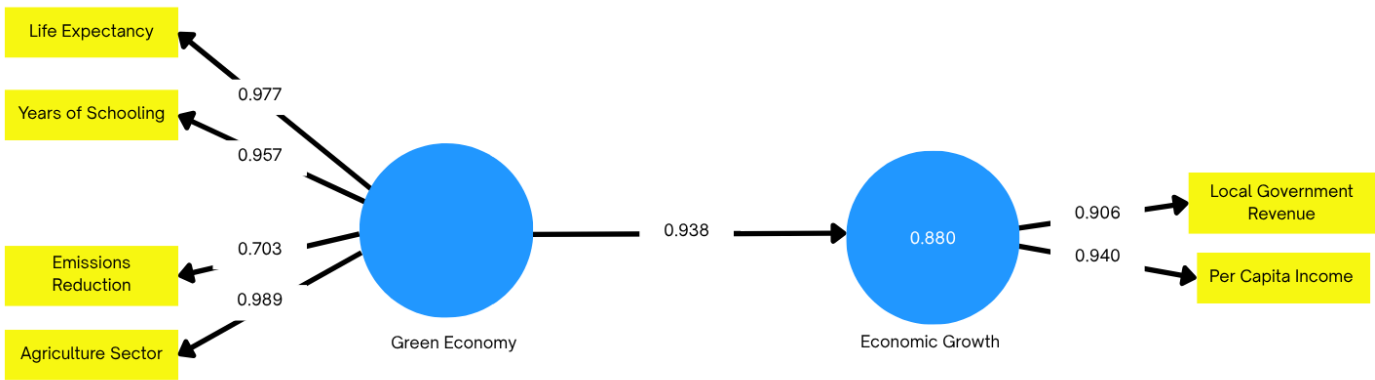

Figure 2. Modified model test results with path analysis

Table 3. Descriptive statistics

Indicator	Economic Growth	Green Economy
Life Expectancy		0.956
Years of Schooling		0.913
Open Unemployment Rate		0.624
Emissions Reduction		0.779
Agriculture Sector		0.966
Forest Area		-0.616
Local Government Revenue	0.909	
Income Per Capita	0.938	

Figure 2 shows the results of the modified model test, with path analysis conducted after eliminating the indicators that did not meet the 0.70 threshold for outer loading. Specifically, the indicators for Open Unemployment and Forest Area were removed due to their low loading factor values (0.624 and 0.278, respectively). As a result, the modified model now includes only the indicators that meet the convergent validity requirement of 0.70. Table 4 presents the outer loading values for each remaining indicator in the modified model. As seen, all indicators, including Economic Growth and Green Economy variables, now satisfy the condition for convergent validity, with values ranging from 0.703 (Emission Reduction) to 0.989 (Agriculture Sector). These modifications improve the model's overall robustness and ensure that only the most reliable and relevant indicators are included in the analysis, enhancing the validity of the study's results based on the Fornell-Larcker and cross loading criteria.

Moreover, Table 4 presents the outer loading values for the measurement model after modifications. The high outer loading values for "Life Expectancy" (0.977) and "Agriculture Sector" (0.989) are particularly significant within the context of this study, which aims to explore the relationship between green economy initiatives and economic growth in West Sulawesi. These high values suggest that both indicators are highly reliable and strongly represent their respective constructs, making them key variables for assessing the effectiveness of green economy policies.

Table 4. Outer loading values of the measurement model

Indicator	Economic Growth	Green Economy
Life Expectancy		0.977
Years of Schooling		0.957
Agriculture Sector		0.989
Emissions Reduction		0.703
Local Government Revenue	0.906	
Income Per Capita	0.943	

Table 5 shows that each indicator has a cross loading value that meets the provisions. This means that the cross-loading value obtained shows higher results between indicators in the construct compared to indicators in other constructs.

Table 5. Discriminant validity values (cross loading)

Information	Economic Growth	Green Economy
Life Expectancy	0.893	0.977
Years of Schooling	0.952	0.957
Agriculture Sector	0.942	0.989
Emissions Reduction	0.584	0.703
Local Government Revenue	0.906	0.767
Income Per Capita	0.943	0.949

Source: Processed Data (2024)

Based on Table 6, all the roots of the AVE (Fornell-Larcker Criterion) for each construct are greater than the correlation with other variables. Where the Green Economy has an AVE value of 0.835, the AVE root is 0.93. Economic growth has an AVE value (Table 7) of 0.852, so the root of the AVE is 0.923. The value of 0.93 is greater than the correlation with other constructs, namely the Green Economy of 0.914. Composite reliability testing uses two methods, namely Cronbach's Alpha and Composite Reliability (CR). Both are used to measure the reliability (accuracy, consistency and precision of the instrument) of a construct. The difference is that Cronbach's Alpha measures the lower limit while Composite Reliability measures the true value of constant reliability.

Table 6. Discriminant validity values (cross loading)

Information	Economic Growth	Green Economy
Economic Growth	0.923	
Green Economy	0.938	0.914

Table 7 explains that all constructs have reliability values that comply with the provisions. All constructs can be declared reliable because the Cronbach's Alpha value is greater than 0.70 and the CR value is greater than 0.70.

Table 7. Cronbach's Alpha, CR and AVE values

Information	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Economic Growth	0.829	0.855	0.92	0.852
Green Economy	0.93	0.965	0.952	0.835

Figure 3 shows the results of the influence of the research model that has been tested. It can be seen that between constructs have a significant influence and between indicators and constructs also have significant value.

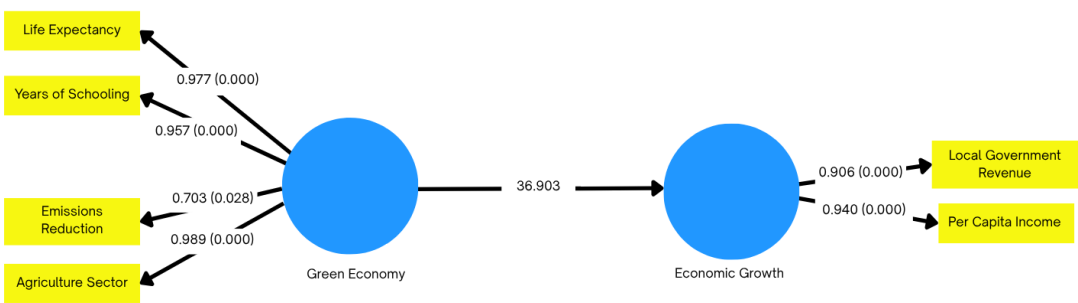

Figure 3. Structural model of path analysis with SEM-PLS

Table 8 shows the magnitude of the influence of the green economy variable on West Sulawesi's economic growth, giving a coefficient of 0.938 or p (0.000) < 0.05. This explains that the alternative hypothesis is accepted (the null hypothesis is rejected), namely that there is a positive and significant influence of the green economy on economic growth in West Sulawesi. This shows the importance of transportation and green economy regulations in West Sulawesi because they have an increasing effect on sustainable economic growth.

Table 8. Discriminant validity values

Hypothesis	Original Sample (O)	Sample Mean (M)	Std Dev (STDEV)	T Statistics (|O/STDEV|)	*p*
Green Economy -> Economic Growth	0.938	0.958	0.025	37.385	0.000

Table 9 shows that the R-Square value for the West Sulawesi Economic Growth variable is 0.88 and the Adjusted R-Square value is 0.86. This means that 88 percent of the variable value of West Sulawesi's economic growth is explained by green economy indicators and variables and the remaining 12 percent is explained by other variables not determined in this research.

Table 9. R-Square

Indicator	R Square	R Square Adjusted
Economic Growth	0.88	0.867

4. DISCUSSION

The results indicate that the green economy has a “positive and significant influence” on economic growth in West Sulawesi. However, while this finding is noteworthy, it is important to delve deeper into the underlying mechanisms that drive this relationship. The green economy, which integrates environmental sustainability into economic policies, contributes to economic growth by promoting sectors like agriculture, renewable energy, and eco-tourism. These sectors can create jobs, increase local revenues, and enhance regional development. However, it is essential to explore how these mechanisms unfold over time and how they interact with other factors such as government policies, market conditions, and regional infrastructure. Moreover, while the green economy's positive influence is clear, several potential confounding factors may affect this relationship. For example, external factors such as global economic trends, climate events, or policy changes at the national level may also influence economic growth in the region. It is crucial to consider these factors to fully understand the extent to which the green economy drives sustainable development and economic growth in West Sulawesi. Further research should explore these underlying dynamics to clarify the specific pathways through which green economy policies contribute to long-term economic growth.

The results underscore the significance of “green agricultural practices” in driving the green economy in West Sulawesi. These practices, which emphasize sustainable and environmentally-friendly methods, include crop rotation, integrated pest management, and the use of organic fertilizers. In the region, green agriculture is implemented through local government initiatives that promote sustainable farming techniques, supported by both policy measures and financial incentives. These initiatives are monitored through key performance indicators such as reductions in pesticide use, increases in organic farm acreage, and improvements in soil quality.

The green economy focuses on improving the quality of life and social justice while reducing environmental risks. Transitioning to a green economy requires long-term political commitment and public involvement, promoting policies like energy efficiency, renewable energy, and low-emission technologies [18]. However, conflicting green economy discourses and differing definitions complicate its implementation. Green economic growth, as emphasized by Dogaru [13], aims to achieve sustainable development by preserving natural resources while driving economic progress. Global initiatives to reduce waste and pollution are key, but GDP-driven green stimulus alone is insufficient to reverse environmental degradation [19].

Developing countries face significant environmental challenges due to high consumption and pollution. As labor and natural resource dividends decline, these countries are adopting sustainable green economic development through science and technology improvements. The positive impact of renewable energy on economic growth in Europe. Renewable energy consumption reduces emissions and supports a sustainable green economy. Bina [20] argues that scarcity in a green economy drives both growth and constraints. A green economy focuses on resource efficiency, emission reductions, and social justice, promoting sustainable consumption and production while ensuring environmental sustainability.

The green economy is crucial for enhancing human welfare and social justice while reducing environmental risks and scarcity. It emphasizes developing systems that generate profit without harming the environment. Barbier [21] argues that the separation between economic development and environmental policy is artificial. In West Sulawesi, sectors like agriculture, fisheries, and forestry contribute significantly to economic growth. Green economy policies, such as organic farming and agroforestry, promote sustainable practices. Kasayanond et al. [22] find that green economy awareness improves environmental sustainability. Jänicke [23] highlights the green economy's role in adopting efficient, resource-saving technologies to reduce emissions and mitigate climate change, addressing environmental degradation. This paradigm will unfold if economic growth is consistent and sustainable, positively impacting employment levels and helping reduce unemployment, a major challenge for local governments [24]. Implementing green economic policies requires a clear understanding of their structures, practices, and the discourses shaping their identity and trajectory. Zhang et al. [25] emphasize that the green economy is a strategy for growth, improving lives, and long-term welfare, promoting sustainable technologies. Technological transformation impacts society, making it crucial to maximize new technologies' performance and address their distributional effects. Guo et al. [26] argue that a green economy ensures environmental sustainability and climate adaptation, recognizing that long-term growth depends on conserving natural ecosystems for future prosperity.

5. CONCLUSIONS

The analysis reveals that four research indicators effectively explain green economic variables: Emission Reduction from Baseline, Agriculture, Fisheries and Forestry Sectors, Life Expectancy, and Average Length of Schools. Two indicators—Regional Original Income and Per Capita Income—explain West Sulawesi's economic growth. However, Forest Area and Open Unemployment Rate did not meet the outer loading value requirements. The study shows a positive and significant impact of green economic indicators on economic growth in West Sulawesi, explaining 88% of economic growth, while 12% is influenced by other factors.

It is recommended that the government enhance support for green economy policies by prioritizing specific actions such as introducing targeted incentives for emissions reduction, implementing clear guidelines for sustainable resource management, and promoting eco-friendly agricultural practices through financial and technical assistance. Public awareness can be raised by launching targeted campaigns and incorporating sustainability education into school curricula and community workshops focused on sustainable agricultural and fisheries practices. Regional governments should focus on fostering green industries by offering tax breaks and grants for startups in clean technology and renewable energy. Encouraging private-public partnerships for the development of green technologies will also create new job opportunities. Regular monitoring and evaluation, supported by a robust data collection framework, will help assess policy effectiveness and make data-driven adjustments. These tailored actions will support economic diversification, boost regional income, and ensure the growth of a sustainable green economy in West Sulawesi.

There are several limitations that need to be acknowledged. First, the study excludes certain variables that could influence the results, such as the role of renewable energy adoption and industrial sustainability practices, which may provide a more comprehensive view of the green economy's impact. Additionally, potential biases in data collection, particularly regarding regional discrepancies in reporting and variations in the implementation of green practices, could affect the accuracy of the findings. The study also relies on data from government sources, which may not fully capture informal sector activities or local variations in policy enforcement. Future research should address these limitations by incorporating a broader range of variables, improving data collection methods, and exploring other regional dynamics that could influence the outcomes of green economy policies.

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