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Green budgeting and sustainable development: Fiscal efficiency as a transmission mechanism

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ABSTRACT

The Sustainable Development Goals (SDGs) constitute an indivisible agenda for achieving economic development, environmental sustainability, and social inclusion. Green budgeting, in which sustainability considerations are incorporated into public investment allocations, has emerged as a key fiscal tool to advance this agenda. This article investigates the evolving link among green budgeting, fiscal efficiency, and sustainable development performance using Indonesian local governments as a case study. Based on district and city panel data for the years 2018 to 2022, and adopting the Structural Equation Modeling–Partial Least Squares (SEM-PLS) mediated analysis technique, our results suggest that green budgeting and fiscal efficiency positively and significantly influence SD outputs. The measurement constructs are demonstrated to be statistically valid and reliable. The findings also suggest that fiscal effectiveness mediates the linkages between green budgeting and development performance. The estimated impact of green budgeting on sustainable development amounts to 0.585, indicating that greener expenditure is associated with lower poverty-alleviation costs (HD index) and better ecosystem conditions. Despite Java being the most developed part of Indonesia, the analysis reveals ongoing structural weaknesses that signify continued spatial imbalances in development outcomes. These have implications for the introduction of green budgeting as an integrated fiscal framework at local and regional levels to mitigate regional disparities and enhance policy performance. Our study helps assess sustainability-oriented public finance actions in central and local governments, as well as provides policy guidance on integrating green budget performance assessment, technical guidance, performance indicators, and incentive systems based on financial efficiency.

Contribution/Originality: This empirical study of green budgeting practices and fiscal effectiveness can be useful for local governments to craft technical documentation, standards documents, technical performance criteria reporting, as well as incentive systems to optimally address the rationalization of expenditures from green budgets at regional and balance-of-payment levels within individual countries.

1. INTRODUCTION

Sustainable development, like many present-day issues, is a wicked problem, generally triangulated by three pillars of sustainability: economic sustainability, ecological sustainability, and social justice. Stakeholder authority is important in preparing and executing a budget in the context of local government in Indonesia (Islam, 2025). An interesting development on that front is green budgeting, wherein public spending related to sustainability, especially

in the wake of the climate-environment-development inequality nexus (Thesari, Lizot, & Trojan, 2021), is gaining momentum. Unswervingly follow the path of fiscal prudence and sustainable development as a basic framework for local governments. More broadly, green budgeting should be embedded in the Regional Government Budget (APBD), whether defined as a process of policy translation or as an instrument to address chronic fiscal deficits and sustainability problems. Collaborate on the disposable budget responsibility, which can be used to evaluate the behavior of the government (the financial steward) over the years.

However, over the past few years, a substantial amount of funding has not been directed to research, which helps subnational officers understand how green budgeting works in practice and where it falls short. Even though there is a strong body of literature on green spending in general, its significant role in economic stability and growth has not yet received sufficient attention (Ulfa, Rany, & Meutia, 2025). The development of the green budget has been placed between an efficiency ethic and a sustainability paradox, as green variables increasingly pervade the mundane existence of ordinary citizens (Timang, Damayanti, Kusumawati, & Afdal, 2025). This raises important questions: whether 'green money' is used properly or whether it causes budget slack or a deficit. Also, does investment in green initiatives improve Human Development Indicators? These issues need to be examined carefully through long-term, multidimensional studies.

This study contributes to filling the analytical gap in green budgeting in Indonesia, which remains under-researched, by using the SEM-PLS model to investigate the role of green budgeting in fiscal efficiency and sustainable development at the local government level. Using district/city panel data over five years, the present study develops an empirical model that captures the dimensions and policy regimes of green fiscal practices. More specifically, it measures the power of green budgeting to enhance public finance efficiency and development performance; the impetus for development outcomes from fiscal efficiency; and its moderating effect on the relationship between green budgeting and development. In this process, it fills a crucial gap in the literature and provides evidence for more effective, intelligent subnational green fiscal policies.

Findings from this work should make important contributions to our understanding of state and local government responses to public policy, as defined by the criterion of sustainability, by assessing whether empirical research on green budgeting is valuable and fiscally efficacious. By analyzing technical documents, instructions, performance reports, and the incentive system, the paper aims to provide a reference for rationalizing regional green budget fund spending and maintaining balance-of-payments coverage. The derived matrix values could guide policymakers, scholars, and advocates in developing various eco-fiscal policies. This is how ecology and governance are pushed forward at the forefront of scientific research, and it also provides indispensable intellectual support for eco-transparency and science-based fiscal governance.

Subnational governments are challenged by interwoven crises of climate change, social inequality, and economic stress, which demand that monetized ecosystems be designed to optimize service yield in accordance with eco-philosophical principles. Green budgeting sets itself apart from traditional models by combining fiscal discipline and a long-term development vision. Using SEM-PLS and panel data analysis, our study empirically untangles complex dynamic relations among factors influencing the variables at stake, transcending concepts into reality. The paper contributes to the current literature on the nexus between public financial management and sustainable development policy in Indonesia and provides both theoretical and practical implications.

2. LITERATURE REVIEW

2.1. Conceptualizing Green Budgeting

Green budgeting integrates the accounting and allocation of green expenditures within a budgeting framework. Within this framework, green budgeting considers public expenditure in the context of sustainable development, including addressing climate change, conserving resources, and mitigating pollution's negative impacts (Frost & Rooney, 2021; Marfuah, Sakti, Kusuma, & Abdullah, 2025). France, Ireland, and the Philippines represent a range of

countries where green budgeting practices have developed and been disseminated, from simpler forms of budget labeling to the integration of environmental performance and fiscal indicators (Kete, 2022). In Indonesia, the green budgeting discourse began to develop in line with the Sustainable Development Goals (SDGs) and the country's commitment to low-carbon development. However, its application in the south is localized and not yet standardized. Most sub-national governments are grossly removed from the public conditions of green budgeting, especially regarding tire and gravel aspects of their own sustainable development, which remain publicly notable.

Green budgeting has become a key strategy to mainstream environmental factors into fiscal policies to protect the environment while maintaining economic growth. Recent literature underscores the need for budgets to support environmental sustainability and reminds us that dominant approaches to budgeting can disregard ecological concerns. Scholars like Ulfa et al. (2025) claim that while there exists a substantial amount of theoretical work on green budgeting, practical applications are rather scarce, especially at the subnational level. This disjuncture counters the transformative potential of green budgeting as a vehicle for influencing efficient policy execution and desired sustainability outcomes. Furthermore, Timang et al. (2025) claim the efficiency-sustainability paradox, according to which green budgeting is complex, and this complexity makes it lose visibility in fiscal talks. The literature also suggests a call for more research on what the 'green money' is being spent on and questions concerning budgetary slack and deficits. Research has shown that in the absence of effective tools for monitoring and evaluating green spending, it is difficult to judge its effectiveness on Human Development Indices, including other socioeconomic indicators. Further, scholars argue for long-term, multicriteria studies on the interaction between green budgeting and wider economic measures. With increased pressure on governments to address climate change and environmental degradation, the embedding of green budgeting within mainstream budgeting is a missing area for integrating economic stability and ecological sustainability. This emerging area needs integrative models to help policymakers and planners conceptualize the multifaceted impacts of a green budget at local and global scales.

2.2. Fiscal Efficiency

In local public finance management, fiscal efficiency is the effective use of public fund resources to achieve the best development outcomes (Cherniaieva, Mykhalchenko, Ataieva, Marshalok, & Petrukha, 2025; Gamayuni, Dharma, & Cinintya, 2023). The public economics literature has examined fiscal efficiency as a measurement exercise, often using quantitative tools such as Data Envelopment Analysis (DEA), which measures the input-output relationship using budgetary inputs and developmental outcomes (Arora & Talwar, 2024). Another option would be to employ effectiveness ratios, such as the capital spending ratio or the expenditure-to-development indicator achievement ratio. The role of local governments, notably in Indonesia's fiscal decentralization, implies a significant role for local efficiency. Local governments not only have to manage the budget but are also expected to deliver efficiency in developing sectors (Aritenang & Chandramidi, 2023). Regarding green budgeting, fiscal effectiveness is an outcome variable of green spending development. Thus, it should be examined conceptually and empirically (Wu & Zhou, 2021).

2.3. Sustainable Development

For local sustainability development, there is a set of indicators to assess the degree of integration of the economic, social, and environmental dimensions. One indicator for combining all three, education, health, and purchasing power, is the Human Development Index (HDI). Furthermore, the HDI is also reinforced by regional environmental indices, poverty indices, and access to clean water for examining sustainable development (Lestari & Arumi, 2024). In green budgeting, these figures reflect the outcomes of green spending and its performance in promoting inclusive, environmentally sustainable growth. The mandatory deterrent to sustainable growth is insufficient; consistent data, both within and between regions, are required. That is why research interested in

incorporating such data into an overall model is vitally important for exploring the consequences of green fiscal policy on local-level governments (Aydin, Sogut, & Altundemir, 2023).

Easy accounts, green accounting, and sustainable development are three independent terms in most of the literature, and too few authors have attempted to combine them into a unified dynamic analysis model (Bai, 2023). Most initiatives for green budgeting are still, as a matter of description, or rather focus only on the 'how to' aspect, with apparent little consideration or, rather, outright failure to analyze, its bottom-line development (Guerrero & Castañeda, 2022). The literature on fiscal efficiency is a relatively independent area, primarily conceived in DEA or panel regression terms, without considering the sustainability aspects of the issue. However, studies investigating sustainable development generally focus on social and economic factors rather than fiscal policy (Wang, Rani, & Razzaq, 2023). However, the clear void in studying the convergence of green budgeting, sustainability, and fiscal efficiency, as stated, indicates scope for applying the SEM-PLS method to dynamic panel studies as advanced here. In contrast, the SEM-PLS methodology provides an effective and viable cross-disciplinary solution for handling these complex relationships (Ruzieh, 2025).

Despite being documented, research on environmental budgeting, the efficiency of public spending, and particularly the Portuguese context, remains limited (Berner & Smith, 2004; Petrie, 2021). There is literature on the environmental expenditures of regional budgets, but the lack of defined, universal criteria and frameworks has slowed the development of impact assessment studies (Hilmawan et al., 2023; Lhutfi, Ludigdo, Rusydi, & Baridwan, 2024). Further, the literature at hand lacks an empirical model of the impact of the budgetary control system on the association between "green" spending and development outcomes, a focus of many studies in this genre. This points to an underappreciated aspect of the functioning of areas with different fiscal and institutional environments, which, in part due to green fiscal policies, are believed to undergo some changes (Sanjaya & Larissa, 2025; Zhang, Mohsin, Rasheed, Chang, & Taghizadeh-Hesary, 2021). This research will address this gap by advancing green fiscal policies in the country, using an empirically validated structural equation model (SEM) that integrates the key focus variables of the issue into a distinctive, fluid system.

2.4. Research Gap

Although green budgeting, fiscal efficiency, and sustainable development have become increasingly popular themes among academics, literature remains fragmented with multiple concepts (OECD, 2009). Green budgeting, defined as the systematic inclusion of environmental considerations into fiscal policy and public expenditure, has mainly been addressed at normative and descriptive levels, with limited empirical evidence, especially at the subnational level in countries like Indonesia (Clements, Gupta, & Nozaki, 2013). Poor systems for tracking expenditure and a lack of established taxonomies to define what is meant by 'green' activity also undermine the ability to evaluate how green public spending affects environmental quality and human development. Meanwhile, studies on the fiscal effectiveness of government have mostly developed in silos (dependent as they are on approaches such as Data Envelopment Analysis/DEA) (Charnes, Cooper, & Rhodes, 1978) and have scarcely taken into account environmental and or sustainability dimensions. Similarly, sustainable development studies have generally been limited to social and economic indicators (for example, the HDI and SDGs), with fiscal policy frequently being treated as exogenous. Therefore, integrated empirical studies that combine green budgeting, fiscal efficiency, and sustainable development are still scarce in the literature, whilst there is little data on fiscal audit failure or "greenwashing" in public budgets (Hair, Hult, Ringle, & Sarstedt, 2019). To fill these gaps, the current research develops an integrated empirical framework based on structural equation modeling (SEM) to explore the linkages among green budgeting, fiscal efficiency, and sustainable development, aiming to contribute to theoretical integration, methodological rigor, and policy relevance (Kline, 2016).

2.5. Hypothesis

H_1: Green budgeting has a positive impact on fiscal efficiency.

H_2: Green budgeting has a positive impact on sustainable development performance.

H_3: Fiscal efficiency has a positive impact on development performance.

H_4: Fiscal efficiency mediates the relationship between green budgeting and development performance.

3. RESEARCH METHODS

This study employs a quantitative technique with a panel dataset comprising 514 Indonesian districts and cities from 2018 to 2022. This research seeks to explain changes in behavior and relationships in managing green budgets, rather than changes in financing and developmental transformations during the period in question. The analytical units are the district and city local government units, which have the authority to formulate and implement the APBD. The unique design of panel analysis enables the merging of multiple independent data sets, providing better control over individual subnational variation and, hence, enhancing the inferences drawn about the country's council and the broader scope of the analysis. Dynamic, policy-oriented structural models are built on the foundation provided by the panel dataset.

Randomization is carried out with systematic/standardized measurement (quantitative). The independent variable, green budgeting, is represented by the share of environmental expenditures as a percentage of total regional spending in the APBD. This includes spending targeted at the environment, such as money for waste management, water-saving, renewable energy, and climate change. The mediating factor, fiscal effectiveness, is operationalized in two dimensions: the spending efficiency ratio (development output per unit of expenditure) and an efficiency index derived from Data Envelopment Analysis (DEA). Sustainable development performance, as the dependent variable, is reflected in three primary indicators: the Human Development Index (HDI), a regional environmental index, and the poverty rate. These indicators determine the harmonization of social, economic, and environmental elements in regional development. Measurements for each area are conducted annually on a non-rotating basis, enabling the time dimension to be addressed reliably.

The datasets regarding Regional Budgets (APBD) come from the Directorate General of Fiscal Balance, Ministry of Finance of the Republic of Indonesia (Directorate General of Economic and Fiscal Strategy, 2024) which integrates the regional expenditure framework including classified environmental expenditure and BPS-Statistics Indonesia (Central Bureau of Statistics, 2024) which compiles and publishes the Human Development Index (HDI) with additional development indicators and Census data along with data on the population below the poverty line and country data with improved Water Supply and Sanitation (WSS) accessed The Ministry of Environment and Forestry (Data and Information Center Ministry of Forestry of the Republic of Indonesia, 2024) forwards regional datasets, such as the Environmental Quality Index and greenhouse gas inventories, along with other region-specific data. Ministry of National Development Planning (Bappenas) (Regional Basic Data Management and Information System, 2024) also provided policy-derived datasets, with an emphasis on developing advanced sustainable indicators. The variety of data sources discussed above enhances the external validity of the models and increases the likelihood that they reflect the actual circumstances of local government.

In this case, the mediation analysis technique used is the Structural Equation Modeling - Partial Least Squares (SEM-PLS) method. Using Partial Least Squares (PLS) is reasonable in this context because it can accommodate latent variables, nonlinearity, and large samples, as in city- or district-level panel data. It permits the simultaneous analysis of all dynamically interrelated dependent and independent variables. It assesses the mediation effect of fiscal efficiency on the linkage between green budgeting and development performance. The covariances of all equations in the SEM-PLS method provide the backbone of the model, structuring its logic. Hence, in this case, the primary

hypothesis of this thesis is that a set of equations in the SEM-PLS method form a coherent interrelationship. Empirically, all the data are incorporated with the three constructs, which form the basis of the analysis.

Establishing the domain's representative validity and reliability makes the indicators of that domain crucial. Construct validity is assessed through loadings, average variance extracted (AVE), and discriminant validity. Reliability is evaluated using composite reliability and Cronbach's alpha. All indicators must meet the statistical minimums and thresholds in the SEM-PLS domain: loading factor > 0.7, AVE > 0.5, and composite reliability > 0.7. This test was conducted in blocks for each construct: green budgeting, fiscal efficiency, and development performance. The outcomes of the validity and reliability tests justify proceeding to the next stage: examining the structural relationships among the constructs. The model, therefore, has significant internal robustness, and the construct of the relationships can be defended from both theoretical and policy perspectives.

After the pivotal touchstones regarding construct validity and reliability of research are achieved, another step is to investigate the direct, indirect, and overall relationship among the variables. The direct linkage concerns how green budgeting affects development results and fiscal effectiveness. On the other hand, the mediated relationship assesses its influence on growth via financial efficiency as an intermediary. The overall effect is the sum of the direct and mediated effects.

Bootstrapping was used for significance testing of the related values and construction of confidence intervals. The results from these tests are used to explore the relationships between study constructs and to test study hypotheses. They also tell the researchers about the degrees of intimacy among the variables in both constructs. The Baron and Kenny method (and accordingly the Sobel test) explains almost completely the effect of the mediator. This helps the research in explaining how green budgeting changes development results.

The purpose of the present research is to develop a model that would be not only policy-relevant but also empirically based, valid, and reliable. This merger of five years of district/city panel database yields rich longitudinal and cross-sectional analytical possibilities. Adding extra official datasets enhances the external validity of our model and reflects the real status of local governance. The measurement of variables is systematic and based on robust, clear, and tangible proxies.

The partial least squares mediation type of structural equation model (SEM-PLS) enables researchers to empirically estimate evolving links between variables directly and systematically. Findings on validity, reliability, and model mediation effect testing provide both scientific contributions of this research and support the interpretative framework within these results. This research is oriented toward the expectation of the advanced impact of results for improving governance on green fiscal policy and public finance management in Indonesia, mainly.

4. RESULTS

The analysis in this paper specifically targets the impacts of green budgeting, fiscal efficiency, and the performance of local government sustainable development in Indonesia. This article focuses on the fiscal efficiency of local governments, and panel data from 2018 to 2022 is used. The study integrated data between provinces and cities to understand the correlation strength and scope of different constructs, in which financial effectiveness was the intermediate operational variable.

The issues addressed in the analysis are arranged according to a logical sequence, starting from variable scope and thereafter in statistical description, construct validity and reliability tests, and ending with path structural estimation, including mediation analysis. This section seeks to provide empirical results with theoretical and policy significance. Accordingly, this section does not stop at the quantitative data and attempts to provide explanations for the interplay between green budgeting, efficiency, and developmental results in the region. Descriptive statistics are reported in Table 1.

Table 1. Descriptive statistics.

Variables	N	Average	Standard deviation	Minimum	Maximum
Green budgeting (%)	2,570	6.42	3.15	1.02	15.87
Fiscal efficiency (DEA)	2,570	0.78	0.12	0.45	0.98
HDI	2,570	72.34	5.21	58.12	82.45
Poverty rate (%)	2,570	12.87	4.56	4.23	25.67
Environmental index	2,570	68.45	6.89	50.12	81.34

The mean of green spending proportion per local government (PperLG) across the Republic of Indonesia is still low (6.42%) as shown in Table 1, though with quite high deviation, from which it can be seen that there is considerable variation between P and LG (SD=3.15). The values of 1.02% as the minimum and up to 15.87% as the maximum index for these ratios indicate an unequal capital or investment distribution among fiscal resources allocated to environmental issues. The mean value of fiscal efficiency, measured by the DEA index, is 0.78. This suggests that performance at the national level is relatively good, but with significant variation from 0.45 to 0.98, representing the most and least efficient, respectively. The mean HDI value is 72.34, indicating a moderate degree of social development. Some people have an HDI of less than 60, which signifies relatively inequitable development. The world headcount poverty proportion is 12.87%, and the extreme poor area nearly reaches a dire state at 25.67%, highlighting a critical social problem. The latest environmental index value is 68.45, with an SD of 6.89, indicating that Indonesia faces very adverse environmental quality conditions. The data demonstrates the increasing economic development gap between regions and stagnating investment in development, emphasizing the need for longitudinal planning for sustainable growth.

The Inter-Variable Correlation is exposed in Table 2.

Table 2. Inter-variable correlation.

Variables	Green budgeting	Fiscal efficiency	HDI	Poverty	Environmental index
Green budgeting	1.000	0.412	0.367	−0.295	0.453
Fiscal efficiency	0.412	1.000	0.528	−0.472	0.389
HDI	0.367	0.528	1.000	−0.613	0.446
Poverty	−0.295	−0.472	−0.613	1.000	−0.338
Environmental index	0.453	0.389	0.446	−0.338	1.000

The correlation matrix of the data is shown in Table 2 that shows statistically acceptable and theory-conducive relationships among all variables. Green budgeting also indicates a direct relationship with fiscal efficiency (0.412), HDI (0.367), and environmental index (0.453), that the greater the allocation toward environmentally oriented expenditure, the higher is the fiscal performance, human development outcomes and better environmental quality. On the other hand, green budgeting is negatively correlated with poverty rate (−0.295), so a stronger commitment to environmental fiscal policy relates to lower levels of poverty.

Fiscal efficiency has a strong positive correlation with HDI (0.528) and a moderate negative relationship with poverty (− 0.472). More efficient fiscal management leads to higher levels of human development with less poverty incidence is evidenced from these three findings. Indeed, HDI showed the highest inverse correlation with poverty (0.613), suggesting that human development is fundamental to addressing poverty issues.

In general, correlations yield great evidence on what should focus in order to get better socio-economic and environmental outcomes: strengthen fiscal governance first and the commitment with environment second. These observed discrepancies in indicators also highlight the continued presence of regional development gaps and relatively stagnant development investment, pointing to the need for a long-term and integrated development planning approach.

Table 3. Construct validity and reliability.

Construct	Loading factor	AVE	Composite reliability	Cronbach's alpha
Green budgeting	0.782 – 0.894	0.653	0.872	0.816
Fiscal efficiency	0.745 – 0.861	0.611	0.851	0.792
Development performance	0.768 – 0.902	0.679	0.889	0.834

Table 3 presents the results of construct validity and reliability testing for Green Budgeting, Fiscal Efficiency, and development performance.

The loading factor range for Green Budgeting in this work is 0.782-0.894, indicating a substantial contribution of each indicator to the primary construct. The AVE of 0.653 indicates that more than 65% of the indicator variance is explained by the green budgeting construct, exceeding the convergent validity threshold (>0.5) and consistent with this study's findings. The composite reliability of 0.872 and the Cronbach's alpha of 0.816 indicate that the construct has high internal consistency and stability. This means that the proportion of environmental spending in the regional budget represents the fiscal commitment to sustainability that underpins it.

The Fiscal Efficiency construct has a loading factor of 0.745-0.861, indicating that all indicators make a strong contribution to the construct. The AVE value of 0.611 demonstrates adequate convergent validity. The composite reliability of 0.851 and the Cronbach's alpha value of 0.792 indicate that this construct is stable as a mediator in the structural model and relevant to the other constructs in the model.

Performance development demonstrated the highest loading factor, ranging from 0.768 to 0.902, indicating that the HDI, environmental index, and poverty rate indicators form a sustainable development model. Given the AVE of 0.679, almost 70% of the construct's variance is captured by the indicators, indicating superb convergent validity. Support for the constructs' reliability is provided by the AVE of 0.889 and the estimated Cronbach's alpha of 0.834, suggesting that the model is robust and can withstand rigorous testing without significant loss of consistency. Sustainable development, as constructed in the SEM-PLS model, can also be considered a dependent construct. In general, the constructs of green budgeting, fiscal efficiency, and development performance met all the fundamental statistical criteria in SEM-PLS: loading factor > 0.7, AVE > 0.5, composite reliability > 0.7, and Cronbach's alpha > 0.7. This provides rigor to the model and supports the evidence that the measurement model is trustworthy and can be used for highly simultaneous, dynamic testing of structural interrelationships among the variables. This finding instills confidence in the ability to manage the preparatory phases necessary to examine pathways and mediation in the sustainable fiscal policy model. Table 4 outlines the Principal Results of the Structural Model Test (Path Coefficients) below.

Table 4. Results of structural model testing (Path coefficients).

Relationships between constructs	Coefficient path (β)	t-Statistic	p-Value
Green budgeting → Fiscal efficiency	0.412	7.84	0.000
Green budgeting → Development performance	0.367	6.21	0.000
Fiscal efficiency → Development performance	0.528	9.15	0.000
Green budgeting → Development performance (Indirect)	0.218	5.03	0.000
Green budgeting → Development performance (Total effect)	0.585	—	—

Note: Significance was determined at the 5% significance level ($p < 0.05$). The t-statistic values were obtained through a bootstrapping procedure.

The results of testing the structural model indicate that all relations among the blade splices in the SEM-PLS model are positive and significant. The spending on budgeting and the environmental sector was noted to have the second-highest positive correlation in the model. This is alluded to in the results, where the weighted average is $\beta = 0.412$, the t-stat is 7.84, and the p-value is 0.000. This means that a 1 standard deviation increase in green budgeting is associated with a 0.412 standard deviation increase in fiscal efficiency. The implication is that if the local government increases spending on green projects and initiatives, it will manage its plans more efficiently. This

validates that spending on green projects and initiatives not only improves the region's environmental conditions but also enhances the efficiency of public funds.

In addition, the t-statistic of green budgeting and developmental performance is noted to have a positive impact on spending. This is observed in the green spending in the region, where the weighted average is β = 0.367, the t-statistic is 6.21, and the p-value is 0.000. As a result, in the region, public inclusive spending is positively correlated with the HDI. Aside from the development models, the most significant effect of the effective allocation of public funds on development performance is the region's total spending model (β=0.528, t-stat=9.15, p=0.000), which implies that spending in the region is effective. This suggests that the public funds employed have, to some extent, economic, social, and environmental sustainability impacts on the region. The indirect effects of green budgeting on development are mediated by the region's fiscal efficiency (β=0.218, t-stat=5.03, p=0.000), indicating that green budgeting's development impact is greater than a mere low-range variable. Fiscal efficiency lies at the core of development, strengthening the impact of green fiscal policy. The total effect of green budgeting on development is the sum of its direct and indirect effects, yielding β = 0.585. This indicates that green spending has a significant influence on the region's development.

These results corroborate the research hypothesis and further support the view that green budgeting is a rational and multifunctional strategic fiscal policy. It brings about monetary savings and measurable positive impacts on society. The magnitude of fiscal efficiency as a mediator is remarkable, suggesting that green expenditure has more pronounced subnational impacts when combined with reforms of fiscal control.

Table 5. Mediation test (Indirect effect).

Mediation path	Indirect effect (β)	t-statistics	p-value	Description
Green budgeting → Fiscal efficiency → Development	0.218	5.03	0.000	Mediation significant

Table 5 presents the mediation test results for the indirect effect show that Green Budgeting has a positive and significant indirect effect on Development Performance through Fiscal Efficiency, with an indirect effect (β) of 0.218, t-statistics of 5.03, and a p-value of 0.000. Additionally, Green Budgeting was positively and significantly associated with Fiscal Efficiency (β = 0.412, t = 7.84, p = 0.000). Fiscal Efficiency also shows a positive and significant influence on Development Performance (β-value).

Simplicity conservation of these results indicates that fiscal efficiency partially mediates between green budgeting and development performance. Thus, the effective implementation of green budgeting not only has an immediate effect on development performance but also an indirect effect through enhanced fiscal efficiency as the key delivery mechanism. These outcomes, once again, verify the complicated internal workings of efficient budget allocation in green spending intended to promote development. Regions that achieve high efficiency in budgetary green spending will enhance their socio-economic and ecological development. The indirect effect of fiscal efficiency warrants the observation that, in the absence of any "fundamentally" new arrangements in fiscal governance, the economic results of green budgeting policies will be, in any scenario, rather thin. Considering the context set out above, it might make sense not to treat fiscal efficiency purely as a mediating variable, but rather as a robust variable that augments the effect of green fiscal policy.

Table 6. Total effect.

Path of influence	Total effect (β)	Description
Green budgeting → Development performance (Direct)	0.367	Significant direct effect
Green budgeting → Fiscal efficiency → Development	0.218	Indirect effect through mediation
Green budgeting → Development Performance (Total)	0.585	Strong and comprehensive total effect

Table 6 presents the total effect of Green Budgeting on Development Performance highlights the significance of direct and indirect effects on sustainable development. The impact of budgeting on development was directly recorded at $\beta = 0.367$, indicating that the impact of green spending ratios is directly proportional to the level of green spending. Additionally, there are direct impacts on the Human Development Index (HDI), poverty, and the overall environment. The Environmentally Sustainable Development (ESD) Development Policy includes development policy and results recording, with major positive policy development and outcome statistics.

Paradoxically, the indirect effect through fiscal effectiveness was $\beta = 0.218$. This means that green budgeting has certain mechanisms that reorganize the internal budget circulation system, controlling a certain level of spending reallocation. Other centers of decision that control local spending more than the development funds budget, allocating these funds to more optimal and greener spending management, are needed. In this context, reallocation of spending and green spending are more plentiful and more effective at lower fiscal costs. In this regard, fiscal effectiveness serves as a policy multiplier for green policies.

The statistical value obtained from combining both tracks reflects the elementary impact of green budgeting on development, as indicated by the figure $\beta=0.585$. Such a measure shows that "green" expenditures are more than a mere marker of an organization's commitment to ecologically sustainable development; they are a strategy with the potential to advance social and economic development simultaneously. This strengthening of the case supports the need for 'green budgeting' to be embedded in planning at the local legislative spatial scale, along with the establishment of proper institutional structures and planning for effective and efficient delivery.

Table 7. Regional comparison.

Region	Green budgeting (%)	Fiscal efficiency (DEA)	HDI	Poverty (%)	Environmental index
Java	7.85	0.82	75.12	10.34	60.34
Sumatera	6.21	0.76	71.45	12.87	65.91
Kalimantan	5.98	0.74	70.23	13.45	67.32
Sulawesi	5.34	0.72	69.87	14.23	66.78
Papua & Maluku	4.12	0.68	63.45	20.12	70.45

Table 7 presents the regional comparison of Green Budgeting, Fiscal Efficiency, HDI, Poverty, and the Environmental Index.

The table shows that Java ranks top in most indicators, including green budgeting (7.85%), fiscal efficiency (0.82%), the HDI (75.12%), and the environmental index (60.34%), as well as a relatively low poverty rate (10.34%). This indicates more advanced fiscal and institutional capacity and a more dedicated approach to sustainable development, although the environmental index needs further improvement.

Green budgeting in Sumatra and Kalimantan, along with associated fiscal efficiency, resulted in green budgeting rates of 6.21% and 5.98%, respectively, and fiscal efficiency rates of 0.76 and 0.74, respectively. Their HDI scores were 71.45 and 70.23, respectively. Both regions demonstrated good environmental performance, as indicated by indices ranging from 65.91 to 67.32. Another region, Sulawesi, also remained within reasonable limits with green budgeting at 5.34%, fiscal efficiency at 0.72, and an HDI of 69.87. Its poverty rate of 14.23%, coupled with an environmental index of 66.78, indicated a reasonable balance between fiscal and environmental performance in governance and control.

All regions in the Papua & Maluku region ranked lowest in all indicators except the environmental index. The region has the lowest score in the country, with a green budgeting rate of 4.12%, fiscal efficiency of 0.68, and an HDI of 63.45. The region's deep-rooted structural problems, reflected in the statistics, include a poverty rate of 20.12%, the lowest human development index, despite having the highest environmental index at 70.45.

However, the region's institutions, socio-economic development, and potential for green budgeting are extremely maldistributed, coupled with its fiscal imbalance. Thus, public policy on public expenditures should be based on regional inequities in sustainable development, designed on a national scale, and regionally oriented. In this respect, inequitable sustainable development in Indonesia results from fiscal policies juxtaposed with the boundaries of Java and enhanced regional capacity.

5. DISCUSSION

Considering that budgeting for green policies and practicing fiscal efficiency support local and spatial sustainable development, Aritenang and Chandramidi (2023) indicate that green budgeting policies are effective in decoupling spending from effectiveness. In Indonesia, fiscal decentralization has successfully reduced disproportionate spending inequality in less successful regions, which has been the emphasis of green equity policies. Geography with slow development can ignore the inequitable expenditures of spatially variegated transfer funds and the systemic ineffectiveness of general allocation funds. Thus, green budgeting, in this instance, cannot be understood solely in terms of spending proportions. Place-based policies remain relevant in confirming that green investing arms local policies with the capacity to restructure spending spatially.

In the context of developmental groundwork, the impact of progress in green budgeting hinges on fiscal efficiency. Arora and Talwar (2024) developed a Network Data Envelopment Analysis (NDEA) system to gauge fiscal efficiency in fund allocation across Indian states. Efficiency is assessed not only by the allocated funds but also by the network configuration and the relationships among the given sectors. In Indonesia, the same system can be calibrated to measure the effectiveness of green spending development outcomes. High fiscal efficiency within local governments also enables more targeted green spending to achieve greater social and environmental outcomes. In contrast, high-efficiency regions are warned about the likely outcomes of allocating funds to low-efficiency areas. Therefore, green budgeting must also be integrated into the performance budgeting system, so that green spending is not only symbolic but also efficient and sustainable.

Improving environmental quality and green budgeting practices are becoming allies. Given the advancements in Spain and the post-pandemic situation in Europe, case studies by Aydin et al. (2023) and Bai (2023) have demonstrated the effectiveness of green expenditures. The research conducted by Salahudin, Syahri, Cahyani, and Firdaus (2025) in Batu City, Indonesia, demonstrates that the region that first attempted green budgeting has green expenditures in the budget, which encourage green public procurement and strong waste policies. It helps, of course, that budgeting supports the goal of green procurement. In these research studies, Elasto, Semlambo, and Lugaimukamu (2023) and Salahudin et al. (2025) have demonstrated that Singapore's public procurement is budgeted for green procurement, supporting the broader sustainability goal.

Integrating bottom-up policy innovation into social, spatial, and fiscal integration to sustain ecological and economic development is challenging. Effective bottom-up policy formulation, implementation, monitoring, evaluation, and participation are collective, all-local approaches. Results of development and public spending within the sustainable development paradigm are complex. Guerrero and Castañeda (2022), for example, suggest that government spending should focus on closing the development gap rather than merely avoiding budgetary gaps. Expenditures that target government spending within public expenditure are bound to SDG spending. In Indonesia, Hilmawan et al. (2023) successfully implemented public-sector innovation at the subnational level, focusing on fiscal governance to improve development outcomes. A sustainable development paradigm that integrates public spending on biodiversity and ecosystems with a development spending budget focuses on sustainability, inclusiveness, and system change. These shifts in public expenditures on biodiversity must be placed within a more integrated development spending approach. Borderline sustainable with geoengineering reproductive investments within a public spending accountability approach, more systemic changes are needed. These new paradigms of development

spending, interlinked with fiscal discipline and inclusive spending, will require a major shift in the local technical capacity systems underpinning effective, action-oriented green spending.

Public participation and institutional capacity will always remain crucial in shaping the outcomes of green budgeting. Advances in technology and green innovation may strengthen the linkages between green fiscal policies and the achievement of SDGs that depend on public and private investment, which Islam (2025) will still need to consider. Conversely, Lhutfi et al. (2024), the focus tends to be on the political economy perspective of regional budgeting, shifting policy emphasis to sustainability. In Indonesia and many other countries, the public remains disengaged from budget formulation and monitoring processes. This disengagement undermines the legitimacy and effectiveness of green fiscal policies. Therefore, the governance objectives of such reforms should strengthen institutional focus on transparency and the effectiveness of public engagement in green budgeting concerning the policy's social and economic objectives.

Green budgeting remains a complex challenge even in a developed nation; this complexity is particularly prominent when examined through a global lens. Petrie (2021) indicates that the successful implementation of green budgeting in France and Italy is a triumph of political resolve, interdisciplinary teamwork, and bipartisan accountability. Kete (2022) observes that practicing green budgeting in Europe is facilitated by robust legislation and powerful monitoring and evaluation instruments. The case presented by Muslim (2024), along with examples from developing nations, suggests that the predominant barriers to combating climate change are institutional and financial. This justifies the necessity for purposeful, targeted, and legally sound cross-border incorporation, like in the case of Indonesia. This incorporation is designed to stimulate the development of a well-informed, effective, and versatile green budgeting system. The rationale indicates that the union of the central and regional governments combines the primary elements for establishing effective green fiscal policies that honor domestic and international commitments.

Finally, the integration of spatial and regional studies has become indispensable for explaining the dynamics of green budgeting and sustainable development. For instance, Deng, Liang, Wu, Wang, and He (2022) pointed out that regional inequality in China is in part a function of geography and the spatial distribution of resources. Wang et al. (2023) and Wu and Zhou (2021) also noted that the effects of fiscal decentralization and green technological innovation are not uniform across regions due to differences in institutional structures and local capabilities. In the Indonesian case, regional analyses reveal that Java is the best-performing region in terms of green budgeting and fiscal balance. In Papua and Maluku, structural obstacles remain substantial. As a result, advancing a green fiscal policy that balances equity and spatial justice would increase the effectiveness of green budgeting in achieving inclusive, efficient, and sustainable growth.

6. CONCLUSION

This study contributes to empirical literature on sustainable public finance by demonstrating that green budgeting is a key fiscal instrument for enhancing fiscal efficiency and sustainable development at the subnational level in Indonesia from 2018 to 2022. Using panel data and SEM-PLS estimation, it provides strong evidence that green budgeting has a significant, positive impact on fiscal efficiency.

The findings also show that GB's impact on SD operates through direct and indirect pathways. Although the Environmental Governance Index or Environmental Revenue scores have a direct effect on human development, poverty reduction, and environmental quality through expenditures oriented towards the environment, their aggregate effects increase dramatically when there is an indirect effect via the fiscal efficiency level. This illustrates that fiscal efficiency is not just an intermediate means but a key conduit through which green budgetary policies can deliver sustained development benefits. Therefore, the success of green budgeting is based not only on the quantity of expenditures on environmental items but also on the quality of their execution and, more broadly, on institutional aspects of governing the budget process.

In addition, the regional analyses reveal stark spatial differences: Java has outperformed in greening budget allocation, fiscal efficiency, and development outcomes, while Eastern Indonesian regions remain structurally constrained. These results also highlight the necessity of accounting for institutional heterogeneity and budgetary capacity when formulating green budgeting policies, as uniform policy prescriptions may end up exacerbating existing regional disparities.

Overall, this paper demonstrates that green budgeting is more than a mere symbol of environmental commitment, but instead a strong, efficiency-enhancing fiscal policy tool with the potential to yield multidimensional development returns. For policymakers, the findings suggest that integrating green budgeting into a broader context of fiscal governance reform (such as efficiency-based public financial management and regionally targeted policy interventions) is critical for inclusive, sustainable development. In terms of research, this article adds new panel-data empirical evidence on the nexus between green public finance efficiency and sustainable development, providing a methodology that can be applied to other emerging and federal countries.

7. POLICY IMPLICATIONS

The policy implications of these findings suggest that green budgeting should be positioned as a core instrument in regional fiscal governance reform, rather than simply being labeled an environmental budget. Regional and central governments should incorporate green budgeting into their performance-based budgeting cycles by improving fiscal efficiency. Moreover, it strengthens the mechanism so that it focuses more on divine guidance and blessings for planning, budgeting, or evaluating environmental expenses than on inventory figures. Instead, it emphasizes reading the results of their own implementation by improving them, enhancing the quality of their implementation, and increasing clarity about the financial management units' capacity. Green budgeting is also a public policy instrument for enhancing distribution, fiscal efficiency, and the realization of other SDGs, such as environmental quality, poverty reduction, and human development. The discriminatory design has a second implication: it is highly spatially targeted, permitting context-specific and asymmetrical policies. The guiding force for the government should not lie in standardization but rather in budgetary space, disparities in the quality of institutions, regional specificity concerns, and potential spillover into Eastern Indonesia. There is a need for progressive policy that reduces this distortion, including strengthened government fiscal capacity, institutional empowerment, and increased green, performance-based fiscal transfers, to minimize the green budgeting imperative as a regional development tool. Therefore, green budgeting reform can leverage its potential as an inclusive and sustainable fiscal instrument while also mitigating other regional problems.

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