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Green Budgeting and Budget Efficiency Mediated by Eco-Friendly Technology in Public Institutions

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Abstract: This study aims to analyze the implementation of green budgeting in public institutions and to examine the relationship between green budgeting, budget efficiency, and environmentally friendly technology as a mediating variable. The research involved 52 respondents consisting of operational, IT, and financial planning staff across several public institutions. The method employed was a questionnaire survey and observation, while data analysis was carried out descriptively and inferentially using mediation regression tests. Descriptive analysis results indicate a positive trend across all variables. For green budgeting, 13% of respondents strongly agreed, 73% agreed, 12% were neutral, and 2% disagreed. Regarding budget efficiency, 13% strongly agreed, 73% agreed, 12% were neutral, and 2% disagreed. Similarly, for environmentally friendly technology, 13% strongly agreed, 73% agreed, 12% were neutral, and 2% disagreed. These findings consistently show that the majority of respondents perceive their institutions as supporting environmentally oriented budgeting policies, implementing efficient budget use, and adopting environmentally friendly technologies in operational activities. The inferential test results confirmed that green budgeting has a positive effect on budget efficiency ($\beta = 0.550$; $p < 0.05$). However, after including environmentally friendly technology as a mediating variable, the direct effect of green budgeting on efficiency becomes insignificant ($\beta = 0.180$; $p > 0.05$). This indicates full mediation, where green budgeting enhances budget efficiency through the adoption of environmentally friendly technologies. These findings highlight that green budgeting policies in public institutions can foster efficiency, particularly through document digitization, the use of energy-saving equipment, and the implementation of paperless office policies.

Keywords: Efficiency Budget, *Green Budgeting*, Technology Friendly Environment

A. Introduction

Each year, agency the government, especially in Indonesia, allocates very large budget big For activity operations and procurement goods as well as services (Albab & Halim, 2020). Budget This covers various aspect start from infrastructure physical, technological information, up to administration everyday. Not only focused on

sustainability, budgeting model conventional show existence misalignment between objective economy and goals sustainability environment. Phenomenon This is not issue new. (Wardhani et al., 2017) have highlight How agency public often ignore principle friendly environment in cycle budgeting they, who in the end create impact significant negative to ecosystem. This problem is seen in various aspect operational everyday. As example, use device electronics left unattended on non-stop, even though No used, is source waste substantial energy (Gulo et al., 2025). Imagine millions computer, cooler rooms, and lights in buildings government throughout Indonesia which continues operate without efficiency. Procurement paper in a way excessive, which is often become part routine from budget, contributing to deforestation and the burden management large waste. Although digital technology has develop fast, many agency Still trapped in bureaucracy based paper, such as system manual payroll or archives physical consuming source Power natural in a way no necessary (Achmad & Rosariawari, 2023).

Another example that is not lost important is vehicle fleet usage services that do not efficient energy. Vehicle old with emission tall No only pollute air, but also wasteful budget material burnt (Suharizal et al., 2025). Likewise, the journey office and meeting face a face that can replaced with online meetings, often become post a large budget, which should be can saved in a way significant. Issue this no only about efficiency costs, but also about emission carbon produced from transportation. In the sector procurement, use material plastic very use for packaging food and Drink at office events is practice general which adds pile rubbish hard plastic decompose. Even water waste in toilets and facilities general agencies also become proof real from lack of awareness will principle efficiency source power (Rumetna et al., 2022). All example this indicates that the existing budgeting model Still fixated on the approach traditional which only see from side financial, without consider cost external and impact environment term long.

The gap becomes more relevant in the context of the increasingly urgent global climate crisis. Various reports from the Intergovernmental Panel on Climate Change (IPCC) have shown that the public sector holds a crucial role in mitigating the impacts of climate change through fiscal policy and public expenditure (Setyawan, 2025). Government agencies, as community fund managers, bear not only a moral but also a functional responsibility to integrate environmental objectives into every budgeting decision. At the same time, public agencies also face increasingly strict fiscal pressures. Financial resource limitations, especially in the post-pandemic era, demand that every rupiah spent must deliver maximum impact (Fitri & Samputra, 2024). Therefore, instead of viewing budget efficiency and sustainability as two separate issues, it is time to combine them.

Budget efficiency has become a trending topic, as reflected in the growing number of studies focusing on public sector efficiency (Hadiansyah, 2025). This transformation calls for the adoption of a new approach known as green budgeting (Arianto et al.,

2024). This approach does not merely allocate funds for environmental projects but integrates environmental considerations into the entire budgeting process. This means that every budget item from the procurement of stationery to the construction of buildings must be assessed based on its environmental impact. Such an approach offers a dual solution: reducing the environmental footprint of government operations while achieving greater budget efficiency. For example, early investments in LED lighting systems may require upfront costs, but long-term savings in energy use and electricity expenditures will be highly significant. The same applies to efficient waste management systems or transitioning to an electric vehicle fleet. This is the point where environmentally friendly technology plays a crucial role as a mediating variable. This study hypothesizes that green budgeting does not directly increase budget efficiency but rather does so through its role in facilitating the adoption and implementation of environmentally friendly technologies. Green budgeting functions as a mechanism to identify and prioritize investments in technologies that offer dual benefits: reducing the carbon footprint and lowering operational costs (Anwar, 2022).

Without explicit budgeting policies, investments in green technology are often considered additional costs rather than strategic assets for efficiency. However, with green budgeting, such investments become an integral part of an agency's fiscal strategy. A real example is administrative digitalization. The use of cloud computing and e-office technologies for payroll or archiving systems not only reduces paper and ink consumption but also saves time and energy, thereby directly enhancing operational efficiency (Campiglio, 2016). Likewise, the use of smart sensors to manage water and electricity consumption, or the adoption of solar panels as a renewable energy source, directly reduces agencies' routine expenditures. Therefore, this research aims to empirically analyze the extent to which green budgeting influences budget efficiency in public agencies, while considering the mediating role of environmentally friendly technologies. This study will provide solid empirical evidence about the causal relationship among these three variables.

The research results are expected to make theoretical contributions by enriching the literature on public financial governance and sustainability. Practically, the findings can serve as a foundation for central and regional governments to formulate more proactive policies that integrate environmentally friendly principles into their budgeting processes. Thus, this study is not only important in the academic domain but also highly relevant for policy, encouraging public agencies to become drivers of change toward a more efficient and sustainable future. This study also carries urgency in mapping how far green budgeting has been implemented in public agencies in West Java. These agencies were selected because they play a central role in planning budgets with environmental impacts before the model can be adapted to wider society. The study also identifies forms of innovation based on environmentally friendly principles to support budget efficiency. The approach includes analyzing activities that have not yet been digitized and that have not maximized the use of online platforms. Through this study, it is expected that a practical model of green

budgeting will emerge in public agencies one that can be replicated and adapted by other regional public agencies. By identifying these practices, the emerging model of green budgeting will not only be adaptive to technological developments but also aligned with the principles of transparency and accountability in public financial management. The urgency of this study lies in the pressing need for public agencies to respond to policy changes that promote greener and more efficient fiscal management. The results are expected to make real contributions to the formulation of environmentally based budgeting policies that can be replicated across sectors and regions.

B. Methods

This study employs a quantitative approach to examine the relationship between green budgeting, budget efficiency, and environmentally friendly technology in public agencies in West Java. Primary data were collected through an online questionnaire using a Likert scale, which consisted of 13 statements. The instrument was specifically designed to measure each variable using relevant indicators:

a. Green Budgeting is measured through five indicators which include policy budget, special fund allocation, involvement *stakeholders*, integration in document budget and evaluation routine.
b. Efficiency Budget measured with four indicators that focus on usage budget without waste, decline cost operational, program effectiveness, and savings source Power.
c. Environmentally Friendly Technology measured through four indicator related use digital systems, equipment economical energy, application technology green, and internal policies that support it.

The study population covers all public government agencies in the West Java region, with the study subjects being employees directly involved in financial processes, budget planning, and the use of environmentally friendly technology. The researchers selected a sample of 52 respondents from five public agencies that agreed to participate, using a convenience sampling technique due to accessibility and respondent availability. Before the data were analyzed, the questionnaire instrument was tested for validity using Pearson correlation and for reliability using Cronbach's Alpha to ensure data quality. Data analysis began with descriptive analysis to identify respondent response trends and was followed by inferential analysis using step-by-step regression (Baron & Kenny, 1986). This procedure was conducted to test the mediating role of environmentally friendly technology by examining the total effect, the mediation path, and the direct path. The results of each step were then interpreted to draw conclusions about whether the mediating variable played a full or partial role.

C. Results and Discussion

The results of the descriptive analysis show a positive trend, as presented in the bar chart below.

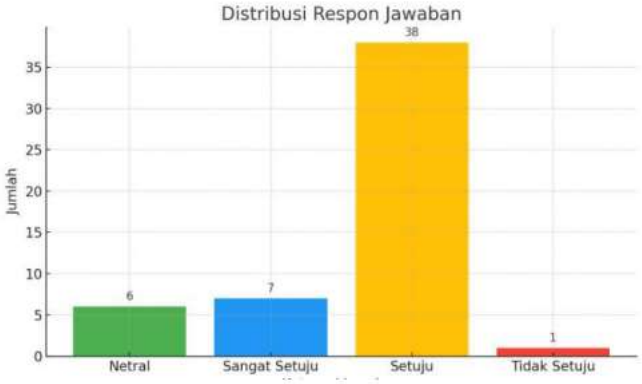

Figure 1. Distribution Response Correspondent

The results of the research conducted in five public agencies in West Java provide a fairly clear picture of the implementation of green budgeting, budget efficiency, and environmentally friendly technology. From a total of 52 respondents who answered 13 questions, the majority gave positive responses to the assessed indicators. The detailed responses for the three variables are presented in Table 1.

Table 1. Details Answer Correspondent on Each Variable

Variables	Very Agree (%)	Agree (%)	Neutral (%)	No Agree (%)	Trends
Green Budgeting	13%	73%	12%	2%	Positive, majority support policy friendly environment
Efficiency Budget	13%	73%	12%	2%	Positive, friendly program environment effective and economical budget
Environmentally Friendly Technology	13%	73%	12%	2%	Positive, technology friendly environment Already implemented in agencies

In the Green Budgeting variable (independent), many respondents stated that their agencies have budget policies that support environmental programs. This phenomenon aligns with the increasing global attention to the role of green budgeting as a fiscal policy instrument for sustainable development (Koç & Çevik, 2023). For example, the annual budget document in one of the public agencies includes a special fund allocation for energy-saving programs in offices, such as upgrading to energy-efficient LED lighting and natural ventilation systems. This practice demonstrates the fiscal commitment required for the transition toward a low-carbon economy (Agrawal et al., 2024).

In addition, the agencies involve stakeholders including operational staff and school committees in budget planning for environmentally friendly programs to ensure the programs are well-targeted. Such a participatory approach is vital to improving accountability and the effectiveness of environmental policy implementation in the public sector (Kabuam, 2024). Routine evaluations of programs based on green budgeting are conducted through quarterly meetings to record progress in energy savings and the use of funds for environmental programs. This shows that such practices are not merely administrative formalities. Evaluations of this kind enable the government to measure fiscal-environmental performance more accurately (Simanullang & Simanullang, 2025).

For the Budget Efficiency variable (dependent), the majority of respondents reported that the budget was used as initially planned, without waste. For instance, one respondent noted a decrease in operational costs following the implementation of waste management programs and the use of renewable energy, where expenditures on environmental programs proved effective and well-targeted. This finding is supported by various studies showing that investments in green initiatives often generate long-term cost savings (Nuryanto et al., 2024).

Agencies also succeeded in saving energy, water, and fuel by replacing old equipment with energy-efficient alternatives, such as Energy Star labeled computers and printers, and by improving water efficiency with automatic tap systems in offices. Efficient resource use is an important indicator of the successful implementation of sustainable public financial management. The use of smart technologies in managing public facilities also plays a crucial role in optimizing energy and water consumption (Pandiyan et al., 2023; Sun et al., 2024). In addition, procurement policies for goods and services contribute significantly by promoting energy-efficient technologies, which directly impact budget efficiency (Ogunsuji et al., 2024). Overall, these steps illustrate how governments can achieve budget efficiency while simultaneously promoting sustainability (Mujiyanto & Tiess, 2013). Such practices also contribute to improved overall public sector performance and demonstrate that green fiscal policies can enhance government effectiveness in managing resources (Schugurensky & Mook, 2024).

Meanwhile, for the Environmentally Friendly Technology variable (intervening), the majority of respondents stated that their agencies had adopted digital systems to save energy and costs. Examples include the use of electronic document management applications to reduce paper and electricity consumption from printers, as well as digital attendance systems to improve work efficiency. Internal policies also support the adoption of environmentally friendly technologies, such as regulations on using energy-efficient lighting, setting optimal air conditioning temperatures, and implementing a "paperless office" policy for all staff. The implementation of green technologies thus supports the effectiveness of green budgeting and budget efficiency in real terms within daily operational activities.

Analysis Results Inferential (Mediation)

Mediation analysis was conducted to test the role of Environmentally Friendly Technology as a mediating variable in the relationship between Green Budgeting and Budget Efficiency. The stepwise regression procedure proposed by (Nurfadila, 2024) Baron and Kenny (1986) was applied to identify the existence and type of mediation effect. This analysis aimed to provide empirical evidence of the causal mechanism underlying the hypothesized relationship.

The results of each analytical step including tests of both direct and indirect paths are presented in detail in the table below and further interpreted in the subsequent narrative.

Table 2. Regression Test

Path	Independent Variable	Dependent Variable	Regression Coefficient (β)	t-statistic	Significance (p)	Remarks
Total Effect (c)	Green Budgeting	Budget Efficiency	0.550	3.25	0.001	Significant
Direct Effect (c')	Green Budgeting	Budget Efficiency	0.180	1.54	0.125	Not Significant
Mediation Path (a)	Green Budgeting	Environmentally Friendly Technology	0.420	2.87	0.003	Significant
Mediation Path (b)	Environmentally Friendly Technology	Budget Efficiency	0.380	2.10	0.005	Significant

Description : df = 49; R^2 for model 1 = 0.302; R^2 for model 2 = 0.285.

Mediation analysis was conducted to test the role of Environmentally Friendly Technology in mediating the connection between Green Budgeting and Budget Efficiency, using the procedure proposed by Baron and Kenny (1986). The results of the regression test are presented in Table 1.

At the first stage, the total effect test shows that Green Budgeting has a significant and positive influence on Budget Efficiency ($\beta = 0.550$, $t = 3.25$, $p < 0.05$). This result indicates the existence of a substantial relationship, thus fulfilling the prerequisite for a mediation test.

At the second stage, the mediation path test also shows significant results. Green Budgeting significantly influences the adoption of Environmentally Friendly Technology ($\beta = 0.420$, $t = 2.87$, $p < 0.05$). Furthermore, Environmentally Friendly Technology significantly influences Budget Efficiency ($\beta = 0.380$, $t = 2.10$, $p < 0.05$). These two paths confirm that a mediation mechanism has occurred.

At the final stage, the direct effect test shows crucial results. When Environmentally Friendly Technology was entered into the model, the effect of Green Budgeting on Budget Efficiency became non-significant ($\beta = 0.180$, $t = 1.54$, $p > 0.05$). Based on Baron

and Kenny's mediation criteria, these findings confirm that Environmentally Friendly Technology fully mediates the connection between Green Budgeting and Budget Efficiency. The impact of Green Budgeting on efficiency is no longer direct but fully occurs through the mediating variable.

These findings provide empirical evidence that green budgeting policies in public agencies in West Java can enhance budget efficiency, particularly through the adoption and implementation of environmentally friendly technological practices. In the Green Budgeting variable (independent), many respondents stated that their agencies have budget policies that support environmental programs. In addition, agencies involve stakeholders, including operational staff and school committees, in budget planning for environmentally friendly programs to ensure appropriate targeting. Routine evaluations of green budgeting-based programs are carried out through quarterly meetings to record progress in energy savings and the use of environmental program funds, ensuring that these practices are not merely administrative formalities.

D. Conclusions

The results of the study indicate that green budgeting has a positive influence on the budget efficiency of public institutions. However, when environmentally friendly technology variables are included in the analysis model, the direct effect of green budgeting on budget efficiency becomes insignificant. This result proves that the relationship is fully mediated; budget efficiency does not increase directly due to environmentally friendly budgeting policies, but through the implementation of environmentally friendly technologies. Environmentally friendly technologies are the main link between green budget policies and increased efficiency. The adoption of technologies such as document digitization, the use of energy-efficient equipment, automated air management systems, and paperless office policies have significantly contributed to operational cost savings and resource efficiency. The implementation of green budgeting has been shown to boost fiscal efficiency when accompanied by environmentally friendly technological innovations.

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