

How Green Accounting Drives Corporate Sustainability: A Mediated Moderated Model of MFCA and Resource Efficiency

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ABSTRACT

Corporate sustainability has become a primary focus in the global business agenda, with an increasing number of companies seeking ways to integrate environmentally responsible business practices. In this context, this study aims to investigate the influence of green accounting implementation on corporate sustainability by considering the material flow cost accounting approach, while also examining the moderating effect of resource efficiency. The sample of this study consists of manufacturing companies listed on the Indonesia Stock Exchange (IDX) for the period 2022–2024. Data were collected by reviewing the financial reports and sustainability reports of the selected sample companies. The data analysis technique employed was path analysis using Smart Partial Least Square (SmartPLS) software. The hypothesis testing results indicate that green accounting has a positive influence on corporate sustainability. Green accounting has a positive influence on material flow cost accounting. Material flow cost accounting has a positive influence on corporate sustainability. Green accounting has a positive influence on corporate sustainability through material flow cost accounting. Furthermore, resource efficiency was found to be unable to moderate the positive influence of green accounting on corporate sustainability.

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1. INTRODUCTION

Sustainability has become a global strategic agenda, driven by the growing awareness of the importance of maintaining a balance between economic growth, social welfare, and environmental preservation. Since the United Nations (UN) adopted the Sustainable Development Goals (SDGs) in 2015, they have served as a shared reference framework for all nations in addressing multidimensional challenges, including poverty, inequality, climate change, and

environmental degradation [1,2]. As one of the signatory countries, Indonesia has adopted the SDGs as a framework for its national development agenda, in which the private sector is expected to actively participate in their implementation through sustainable business practices.

The manufacturing sector remains a primary driver of the national economy, with the non oil and gas processing industry contributing 16.30% to the national GDP in the second quarter of 2023 [3]. This sector is also strategically important as it supplies

tradable goods and absorbs a substantial portion of the labor force [4]. However, manufacturing growth is correlated with environmental degradation, particularly through liquid waste, emissions, and resource consumption [5]. Moreover, the resource and energy intensive production characteristics of the manufacturing sector have the potential to generate significant environmental impacts, including water pollution, air pollution, and the generation of hazardous and toxic waste (B3) [6]. In response to these challenges, modern companies are expected not only to generate profits but also to assume responsibility for the social and environmental consequences of their operational activities. The Financial Services Authority (OJK), through its regulations, mandates that companies prepare sustainability reports encompassing economic, social, and environmental aspects, indicating that sustainability has now become an essential element that cannot be overlooked in business strategy [7].

Green accounting, or environmental accounting, has emerged as a new paradigm that emphasizes transparency in environmental cost reporting, assisting companies in internalizing environmental impacts into their decision making processes [8,9]. The implementation of green accounting focuses on the concept of resource conservation, including land, materials, and energy, which is grounded in the ecosystem concept. The objective of its application is to enhance environmental management efficiency by evaluating environmental activities from both a cost perspective (environmental costs) and the sustainability benefits for the company across economic, social, environmental, and technological aspects [10]. Through this practice, companies can provide more accountable and transparent data to stakeholders regarding the environmental consequences of their production operations, which in turn contributes to increased public trust and strengthened corporate reputation.

Material Flow Cost Accounting (MFCA) is an environmental accounting approach oriented toward identifying

inefficiencies in the use of materials, energy, and waste within production processes [8]. MFCA provides quantitative information regarding material flows, encompassing both those utilized as main products and those discarded as waste, thereby assisting companies in reducing waste, lowering production costs, and improving operational efficiency [11]. MFCA enables companies to identify potential waste, optimize production processes, and minimize resource consumption. The advantage of the MFCA model lies in its capacity to enhance profits and productivity (internal benefits) while simultaneously reducing negative environmental impacts (external benefits), ultimately contributing to corporate sustainable development [12].

Resource efficiency refers to the management of raw materials, energy, and water, as well as the values associated with waste reduction and the mitigation of harmful impacts on ecosystems throughout the production cycle [13]. The efficient use of resources can serve as a relatively low cost and rapid means of reducing waste and subsequent processing and disposal costs [14]. The discourse on resource efficiency, particularly concerning waste reduction and management, is not only a concern for scientists and environmental activists but also for corporate management. The production process of a product, from raw material extraction to post consumer disposal, should not harm the environment, particularly if companies are able to specify these environmental costs in detail.

Empirical studies examining the relationship between green accounting, MFCA, and corporate sustainability have yielded mixed results. Sartika et al. [8] found that both MFCA and green accounting have a significant influence on sustainable development, and that resource efficiency strengthens this relationship. Nurkholisah & Nurcholisah [6] reported that green accounting has a positive impact on sustainable development, while MFCA has no significant effect. Said et al. [15] found that green accounting and MFCA positively influence corporate sustainability, with

MFCA mediating the relationship between green accounting and sustainability. Sari Rakhmawati [10] found that green accounting does not have a significant effect on corporate sustainability, whereas MFCA does, and that resource efficiency only moderates the relationship involving MFCA, not green accounting.

These discrepant findings indicate a research gap that necessitates further investigation into the role of MFCA as a mediating variable and resource efficiency as a moderating variable in the relationship between green accounting and corporate sustainability. This study aims to address this gap by examining the influence of green accounting on corporate sustainability through MFCA, while also considering the moderating effect of resource efficiency, within the context of manufacturing companies in Indonesia.

2. LITERATURE REVIEW

2.1 *Legitimacy Theory*

Legitimacy theory, as proposed by Dowling dan Pfeffer [16], explains that companies have a reciprocal relationship with society and strive to obtain, maintain, and expand their social legitimacy through business practices that align with societal norms and values. The implementation of green accounting, MFCA, and the disclosure of environmental performance serve as means for companies to demonstrate compliance with regulations and commitment to sustainable development [17]. By attaining legitimacy, companies can maintain operational stability, secure access to resources, and sustain competitive advantage. Voluntary disclosure of environmental activities is undertaken by companies as a strategy to build and maintain

legitimacy in the eyes of the public.

2.2 *Stakeholder Theory*

Stakeholder theory, as proposed by Freeman [18], asserts that corporate responsibility extends beyond shareholders to encompass all relevant parties, including consumers, employees, government, the community, and the environment. Within this framework, the implementation of green accounting and MFCA can be viewed as a manifestation of corporate accountability in presenting transparent information regarding environmental impacts, thereby fulfilling the information needs of stakeholders [19]. Companies that attend to stakeholder interests are more likely to gain support and legitimacy, which ultimately supports the achievement of sustainability objectives.

2.3 *Corporate Sustainability*

Corporate sustainability usually builds on the triple bottom line of environmental, social, and economic performance [20]. This concept emphasizes that companies are not only responsible for generating financial profits but must also consider the social and environmental impacts of their operations. Corporate sustainability is measured using a disclosure index based on the Global Reporting Initiative (GRI) guidelines, which encompass three dimensions: the economic dimension (economic performance, market presence, indirect economic impacts), the environmental dimension (materials, energy, water, biodiversity, emissions, waste, environmental compliance), and

the social dimension (employment, human rights, community, product responsibility) [21].

2.4 Green Accounting

Green accounting, or environmental accounting, is an accounting system that integrates environmental costs into conventional accounting practices to measure, record, and report the environmental impacts of business activities [22]. This concept emerged as a response to the limitations of traditional accounting, which focuses solely on financial performance without considering environmental and social consequences. Green accounting enables companies to identify, measure, and allocate environmental costs arising from their operational activities, such as waste management costs, pollution prevention costs, and environmental compliance costs [23]. The implementation of green accounting aims to enhance environmental management efficiency by evaluating environmental activities from both a cost perspective and the sustainability benefits for the company across economic, social, and environmental aspects. Through this practice, companies can provide more accountable and transparent data to stakeholders regarding the environmental consequences of their production operations [24].

2.5 MFCA

Material Flow Cost Accounting (MFCA) is an environmental accounting approach oriented toward identifying inefficiencies in the use of materials, energy, and

waste within production processes [25]. MFCA, which is recognized under ISO 14051, provides quantitative information regarding material flows, encompassing both those utilized as main products and those discarded as waste, thereby assisting companies in reducing waste, lowering production costs, and improving operational efficiency. The advantage of the MFCA model lies in its capacity to enhance profits and productivity (internal benefits) while simultaneously reducing negative environmental impacts (external benefits), ultimately contributing to corporate sustainable development. MFCA enables companies to identify potential waste, optimize production processes, and minimize resource consumption by measuring material flows and the costs associated with the use of natural resources and waste throughout the production process.

2.6 Resource Efficiency

Resource efficiency is defined as the management of raw materials, energy, and water, as well as the values associated with waste reduction and the mitigation of harmful impacts on ecosystems throughout the production cycle. The efficient use of resources can serve as a relatively low cost and rapid means of reducing waste and subsequent processing and disposal costs [14]. The discourse on resource efficiency, particularly concerning waste reduction and management, is not only a concern for scientists and environmental activists but also for corporate management. The production process of a

product, from raw material extraction to post consumer disposal, should not harm the environment, particularly if companies are able to specify these environmental costs in detail [15]. Resource efficiency is measured through various indicators, including energy intensity ratio, water intensity ratio, raw material efficiency ratio, and carbon emission intensity [11].

3. METHODS

This study employs a quantitative causal approach to examine the influence of green accounting on corporate sustainability, with Material Flow Cost Accounting (MFCA) as a mediating variable and resource efficiency as a moderating variable. The population of this study comprises manufacturing companies listed on the Indonesia Stock Exchange (IDX) for the period 2022–2024, with the sample determined using purposive sampling technique based on the following criteria: companies published complete financial reports and sustainability reports, and disclosed information related to environmental costs and environmental accounting practices. Secondary data were collected through documentation techniques by reviewing annual reports and sustainability reports downloaded from the official IDX website (www.idx.co.id) and the respective companies' websites. The green accounting variable was measured using environmental cost proxies, MFCA was measured through indicators of material flow and production costs, resource efficiency was measured using energy, water, and raw material intensity ratios, while corporate sustainability was measured using a disclosure index based on GRI guidelines. The data analysis technique employed Partial

Least Square Structural Equation Model (PLS-SEM) using SmartPLS software, which includes the evaluation of the measurement model (outer model) through convergent validity, discriminant validity, and reliability tests, as well as the evaluation of the structural model (inner model) through R-square, Q-square, and path coefficient tests. Hypothesis testing was conducted using the bootstrap resampling approach, wherein a hypothesis is accepted if the t-statistic value > 1.96 ($p\text{-value} < 0.05$), while mediation and moderation tests were performed by analyzing direct, indirect, and interaction effects to examine the role of MFCA as a mediating variable and resource efficiency as a moderating variable in the relationships among the variables.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

The descriptive analysis results indicate that the green accounting variable has a mean value of 21.385 with a standard deviation of 2.244, MFCA has a mean of 25.384 with a standard deviation of 1.226, and resource efficiency has a mean of 0.747 with a standard deviation of 0.287, while corporate sustainability has a mean of 6,515,255,923.063 with a very large standard deviation of 30,923,228,261.313, indicating high data variability across sample companies.

4.2 Inner Model Analysis

Standardized Root Mean Square Residual (SRMR) is a measure of model fit, namely the difference between the data correlation matrix and the estimated correlation matrix. Thus, it allows assessing the average magnitude of the difference between observed and expected correlations as an absolute measure of the goodness-of-fit criterion (model). SRMR values below 0.08 indicate a fit model. The model estimation results for the SRMR value are $0.026 < 0.08$, which means that the model fit is acceptable.

Table 1. SRMR Test Result

	Estimated Model
SRMR	0.026

Source: Processed Primary Data (2026)

Based on Table 4.2, it shows that the corporate sustainability variable (Y) has an R-Square value of 0.298. This value shows that the influence of the strength of exogenous variables on endogenous variables is categorized as weak, or in other words the influence of green accounting variables on corporate sustainability is 29.8% and 70.2% is influenced by other variables outside the variables in the research.

The MFCA variable has an R-Square value of 0.310. This value explains that the influence of the predictive power of green accounting variables on MFCA is categorized

as weak ($0.31 < 0.50$) or in other words, exogenous variables influence endogenous variables only 31% and 69% are influenced by other variables outside the variables in this study.

Based on Table 4.3, the lower RMSE and MAE values, the PLS (Partial Least Squares) model appears to be more effective and accurate in predicting corporate sustainability variables compared to the LM (Linear Model). Although the difference is not very large, the superiority of the PLS model in both metrics (RMSE and MAE) shows that this model has good predictive power.

Table 2. R-square Test Result

	R Square	R Square Adjusted
Corporate Sustainability (Y)	0.298	0.256
MFCA (M)	0.310	0.300

Source: Processed Primary Data (2026)

Table 3. PLS Prediction Test Result

	PLS		L.M	
	RMSE	MAE	RMSE	MAE
Corporate sustainability(Y)	29157714524.139	16157359478.785	29643829008.308	16189427765.073
MFCA (M)	1,046	0.848	1,061	0.849

Source: Processed Primary Data (2026)

4.3 Hypothesis Testing

The Inner Model (Structural Model) obtained from research data analysis can be seen in the image below:

4.3.1 Green Accounting Positive Influence on Corporate Sustainability

The first hypothesis states that green accounting has a positive effect on corporate sustainability. The test results show that the green accounting variable with a path coefficient value (Original Sample column) = 0.330 and the significant level with the T Statistics value = $2,333 > 1.96$, and P-Value = $0.020 < 0.05$. Based on these results, it can be concluded that the green accounting variable has a positive effect on corporate sustainability (Hypothesis Accepted).

4.3.2 Green Accounting Positive influence on Material Flow Cost Accounting

The second hypothesis states that green accounting has a positive effect on MFCA. The test results show that the green accounting variable with a path coefficient value (Original Sample column) = 0.557 and the significant level with the T Statistics value = $6,218 > 1.96$, and P-Value = $0.000 < 0.05$. Based on these results, it can be concluded that the green accounting variable has a positive and significant effect on MFCA (Hypothesis Accepted).

4.3.3 Material Flow Cost Accounting influence on Corporate Sustainability

The third hypothesis states that MFCA has a positive effect on corporate sustainability. The test results show that the

MFCA variable with a path coefficient value (Original Sample column) = 0.207 and the significant level with the T Statistics value = 2,237 > 1.96, and P-Value = 0.025 < 0.05. Based on these results, it can be concluded that the MFCA variable has a positive and significant effect on corporate sustainability (Hypothesis Accepted).

4.3.4 Green Accounting has a positive effect on Corporate Sustainability through Material Flow Cost Accounting

The fifth hypothesis states that MFCA mediates the effect of green accounting on corporate sustainability. The test results show that the coefficient value (Original Sample column) = 0.115 and the significant level with the T Statistics value = 2,187 > 1.96, and P-Value = 0.029 < 0.05. Based on these results, it can be concluded that the MFCA variable is able to positively and significantly mediate the influence of green accounting on corporate sustainability (Hypothesis Accepted).

4.3.5 Resource Efficiency moderates the negative effects of Green Accounting on Corporate Sustainability.

The fourth hypothesis states that resource efficiency negatively moderates green accounting on corporate sustainability. The test results show that the green accounting variable and the moderation variable are resource efficiency with a path coefficient value (Original Sample column) = -0.285 and the significant level with the T Statistics value = 2,553 < 1.96, and P-Value = 0.011 < 0.05. Based on these results, it can be concluded that resource efficiency negatively moderates the relationship between green accounting and corporate sustainability. This means that when resource efficiency increases, the positive effect of green accounting on corporate sustainability decreases (Hypothesis Rejected).

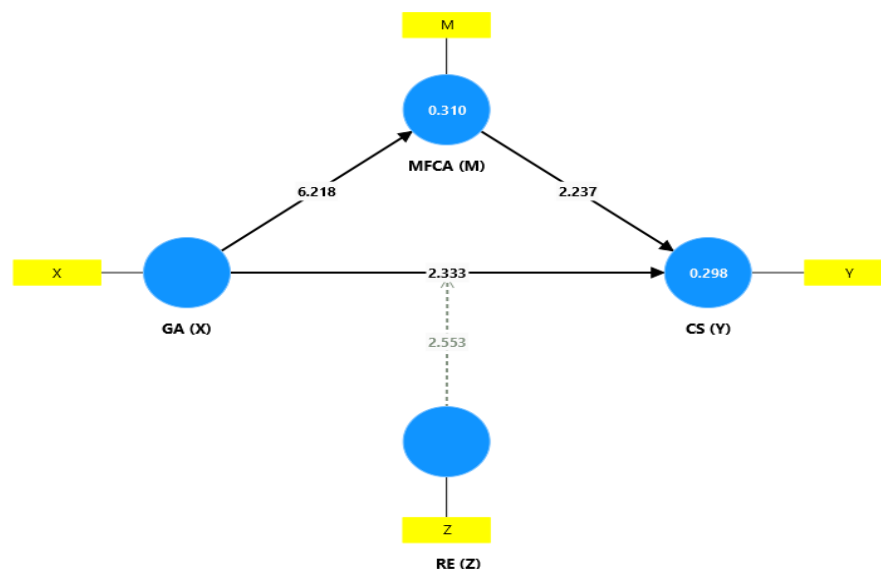


Figure 1. SmartPLS Bootstrapping Output

Table 4. Path coefficient test and significance of influence

	OriginalSample (O)	T Statistics	P Values
Green accounting(X) -> Corporate sustainability (Y)	0.330	2,333	0.020
Green accounting(X) -> MFCA (M)	0.557	6,218	0,000
MFCA (M) -> Corporate sustainability (Y)	0.207	2,237	0.025

Source: Processed Primary Data (2026)

Table 4.5 Mediation testing

	Original Sample(O)	T Statistics	P Values
Green accounting(X) -> MFCA (M) -> Corporate sustainability (Y)	0.115	2,187	0.029

Source: Processed primary data (2026)

Table 4.6 Moderation Testing

	OriginalSample (O)	T Statistics	P Values
Z*X -> Corporate sustainability (Y)	-0.285	2,553	0.011

Source: Processed primary data (2026)

4.4 Discussion

Based on the results of hypothesis testing and discussion regarding the influence of green accounting on corporate sustainability using a material flow cost accounting approach and moderated by resource efficiency, the following conclusions can be drawn:

- 1) Green accounting has a positive and significant effect on company sustainability. By implementing green accounting, companies can increase efficiency and reduce operational costs through wiser use of resources [26]. Overall, green accounting not only preserves the environment but also supports the company's long-term profitability and sustainability [27,6]. This is in accordance with legitimacy theory and stakeholder theory, green accounting allows companies to be transparent in their environmental impacts and proactive in managing this responsibility, which can maintain legitimacy and increase trust and support from stakeholders.
- 2) Green accounting positive and significant effect on MFCA. Implementing green accounting through MFCA helps companies track material flows more accurately, identify and minimize waste of resources which will increase the efficiency of material use. This is in

accordance with legitimacy theory and stakeholder theory, by implementing green accounting and MFCA, companies demonstrate their commitment to resource efficiency and environmental impact reduction, increasing transparency and accountability in the use of materials and cost management, which in turn supports long-term sustainability and relationships. positive with all stakeholders [19,28].

- 3) MFCA has a positive and significant effect on company sustainability. This shows that MFCA can help companies map the flow of materials in the production process and identify points where waste or inefficiency occurs. Overall, MFCA provides companies with a powerful tool to increase operational efficiency, reduce environmental impact, and improve financial sustainability and reputation [17,29,26]. By implementing MFCA, companies can be more proactive in managing their resources and environmental impacts, ultimately contributing to long-term sustainability and certainly strengthening legitimacy and relationships with stakeholders. This is in accordance with legitimacy

theory and stakeholder theory [30].

- 4) Green accounting has a positive effect on company sustainability through MFCA. In other words, the use of MFCA in green accounting practices can effectively increase company sustainability. This shows that the integration of accounting systems that consider material flows with green accounting principles can provide significant benefits for companies in achieving their sustainability goals. The implementation of MFCA increases the company's legitimacy by demonstrating commitment to green accounting practices and reflects the company's response to the needs and interests of stakeholders regarding environmental sustainability, strengthening the relationship between the company and stakeholders [31].
- 5) Resource efficiency significantly but negatively moderates the relationship between green accounting and corporate sustainability. This means that when companies increase the efficiency of resource use, the positive effect of green accounting on company sustainability actually decreases. When companies focus too much on resource efficiency, they tend to allocate more budget and resources in that direction, thereby reducing investment in

green accounting initiatives. As a result, wider environmental impacts are not monitored. Therefore, companies must balance resource efficiency with green accounting practices to achieve optimal sustainability [8,10,13].

5. CONCLUSION

Based on the results of hypothesis testing and discussion, this study concludes that green accounting has a positive and significant influence on corporate sustainability, both directly and indirectly through MFCA as a mediating variable, indicating that the integration of green accounting with MFCA enhances environmental transparency, resource efficiency, and corporate accountability, thereby strengthening legitimacy and stakeholder relationships. Furthermore, MFCA is proven to have a positive and significant influence on corporate sustainability by assisting companies in identifying waste and inefficiencies in production material flows. However, resource efficiency was found to negatively moderate the relationship between green accounting and corporate sustainability, implying that increased resource efficiency may reduce the positive influence of green accounting if companies focus excessively on operational efficiency while neglecting investments in more comprehensive environmental accounting practices. Accordingly, companies need to strike a balance between resource efficiency and the integrated implementation of green accounting to achieve optimal sustainability.

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