

Green Accounting and Environmental Performance Through Material Flow Cost Accounting

Retnaningtyas Widuri¹, Jesselyn Adi Nugraha², Josselyn Valentina Wijaya³
^{1,2,3}School of Business and Management, Petra Christian University, Indonesia
Email: widuri@petra.ac.id

DOI: <https://doi.org/10.33005/baj.v9i1.459>

Received: May 2026

Revised: June 2026

Published: June 2026

ABSTRACT

This study examines the effect of green accounting on the environmental performance of Indonesian manufacturing companies, with Material Flow Cost Accounting (MFCA) as a mediating variable. Previous studies have reported inconsistent findings and have rarely examined MFCA as a mediator in emerging-market manufacturing contexts. Using secondary data from 28 manufacturing companies listed on the Indonesia Stock Exchange during 2021–2024 (112 firm-year observations), this study employs Partial Least Squares Structural Equation Modeling (PLS-SEM) with WarpPLS. The results indicate that green accounting has a positive and significant effect on environmental performance, both directly and indirectly through MFCA, confirming MFCA's mediating role. These findings suggest that integrating green accounting with MFCA can strengthen corporate environmental performance and sustainability practices. This study contributes by providing empirical evidence from Indonesian manufacturing firms and integrating Legitimacy Theory and Stakeholder Theory to explain the mediating role of MFCA in enhancing the relationship between green accounting and environmental performance.

Keywords: Environmental Performance; Green Accounting; Material Flow Cost Accounting

ABSTRAK

Penelitian ini mengkaji pengaruh akuntansi hijau terhadap kinerja lingkungan perusahaan manufaktur di Indonesia dengan Material Flow Cost Accounting (MFCA) sebagai variabel mediasi. Penelitian ini dilakukan karena hasil studi sebelumnya masih menunjukkan inkonsistensi dan jarang menguji peran MFCA sebagai mediator pada sektor manufaktur di negara berkembang. Penelitian kuantitatif ini menggunakan data sekunder dari 28 perusahaan manufaktur yang terdaftar di Bursa Efek Indonesia selama periode 2021–2024 (112 pengamatan perusahaan-tahun). Data dianalisis menggunakan Partial Least Squares Structural Equation Modeling (PLS-SEM) dengan WarpPLS. Hasil penelitian menunjukkan bahwa akuntansi hijau berpengaruh positif dan signifikan terhadap kinerja lingkungan, baik secara langsung maupun tidak langsung melalui MFCA. Temuan ini menegaskan bahwa MFCA berperan sebagai mediator yang memperkuat pengaruh akuntansi hijau terhadap kinerja lingkungan. Penelitian ini memberikan implikasi bagi manajer dan regulator untuk mengintegrasikan akuntansi hijau dengan MFCA dalam meningkatkan keberlanjutan perusahaan. Kontribusi utama penelitian ini adalah memberikan bukti empiris mengenai peran mediasi MFCA pada perusahaan manufaktur Indonesia dengan mengintegrasikan Teori Legitimasi dan Teori Pemangku Kepentingan.

Kata kunci: Akuntansi Hijau; Kinerja Lingkungan; MFCA; Pelaporan Keberlanjutan; PROPER

Widuri, R., Nugraha, J.A., & Wijaya, J. V. (2026). *Green Accounting and Environmental Performance Through Material Flow Cost Accounting*. BAJ: Behavioral Accounting Journal, 9(1), 61-81. <https://doi.org/10.33005/baj.v9i1.459>

INTRODUCTION

Indonesia is at a turning point right now. It has to deal with the pressures of both economic growth and environmental duties at the same time. In order to combat climate change, the international community must act swiftly. According to the European Commission, Indonesia's emissions of greenhouse gases (GHG) reached 1.8 Gt CO₂e in 2023, an increase of 2.4% from the previous year. There are serious environmental challenges, and Indonesia is one of the world's fastest-growing polluters, as this illustrates. Because of the potential significance and longevity of these changes, the Indonesian government has responded by enacting stricter laws. Businesses are facing growing public pressure to prioritize social and environmental responsibility over profit maximization, and the Financial Services Authority (OJK) has responded with a regulation (No. 51/POJK.03/2017) that requires organizations to create and share sustainability reports. This regulation also highlights the importance of environmental issues to corporate strategy and stability (Setiawan et al., 2024).

The present financial accounting system in Indonesia is a significant barrier to the transition to real business sustainability. This old approach is not suitable for measuring or disclosing a company's environmental performance since it is meant to record previous financial transactions (Selpiyanti & Fakhroni, 2020). The system also ignores the non-financial aspects and influence on society and environment. These constraints may limit the ability to assess the intrinsic value and risk of a company. This requires a more detailed accounting. This lays the onus on management to promote the development of green accounting (Bebbington & Unerman, 2018). There is a rising awareness of sustainable business practices in Indonesia, resulting in an increased appreciation for green accounting. Green accounting presents a paradigm that prioritizes long-term efficiency in the use of industrial resources, aiming to decouple firm development from environmental harm and relate it to environmental conservation (Christian et al., 2023). The implementation of green accounting allows organizations to track their environmental performance and discover solutions to increase efficiency. The strategic value of green accounting is not limited to operational monitoring as actual data shows its multidimensional influence on business performance. Recent research demonstrate that green accounting adoption has an effect on several elements of organizational performance such as market value and financial stability. In the Indonesian energy industry, (Al Gamar & Widoretno, 2024) research reveals that green accounting methods have a considerable positive impact on business value via enhanced perception of stakeholders and investor trust. Moreover, (Bresciani et al., 2023)

shown that green accounting approaches minimize stock volatility, therefore stabilizing market positioning and reinforcing investor trust in business sustainability aims. The findings emphasize the strategic relevance of environmental accounting systems for the establishment of competitive advantages and for the attainment of long-term organizational legitimacy.

Practical approaches such as Material Flow Cost Accounting (MFCA) may deepen principles of green accounting. MFCA (ISO 2011) is a systematic approach to tracking and analyzing material flows in physical and monetary terms. The aim is to help companies to determine where they are squandering energy and commodities. This approach is important for management to uncover ways of saving money and to find out what types of trash may be reduced, reused or recycled (Widyawati et al., 2025). In making items, companies could look at the resources they use and the waste they produce and discover where they are squandering time and money . They are useful for improved resource management and in lowering the impact on the environment. MFCA also illustrates the monetary worth of waste items. Linking prices to material efficiency helps improve decision-making, which encourages sustainable behaviors. Green accounting and MFCA complement each other to enhance the company's environmental performance efficiently. Green accounting defines the general approach and outlines the firm policies and sustainability objectives. It encourages the development of environmentally friendly companies by providing measurements that promote investment in green technology and by establishing a strong brand reputation (Amanda Safitri et al., 2025; Khan & Gupta, 2024a). MFCA is a practical instrument that at the same time leads to actual changes. This provides managers with the data they need to make choices on process improvement and waste reduction (D.B. & J.P., 2024; Panggabean et al., 2024). The display of the cost of waste encourages firms to utilize MFCA to see environmental management as a source of value and competitive advantage. This combination enables firms to go beyond compliance with the requirements to active environmental management.

Environmental performance refers to the amount of corporate operations that affect the environment: the less harm produced, the better the environmental performance, and vice versa (Habib et al., 2020; Melenia et al., 2023). The indicator covers energy efficiency, emission reduction, waste management and compliance with environmental requirements. Good environmental performance is a kind of corporate responsibility to the expectations of many stakeholders in the context of stakeholder theory. Stakeholders include shareholders, workers, local communities, consumers, and non-governmental groups that carefully monitor and analyze

the environmental effect of company operations. In this study, environmental performance is operationalized through the PROPER rating issued by the Ministry of Environment and Forestry, which captures both regulatory compliance and beyond-compliance performance. This indicator is appropriate in the Indonesian context because it reflects not only adherence to environmental regulations but also proactive environmental initiatives that go beyond minimum legal requirements (Dura & Suharsono, 2022). Thus, green accounting provides the strategic information base, MFCA translates that information into process-level efficiency improvements, and environmental performance reflects the observable sustainability outcome of those efforts.

Previous empirical studies generally suggest that green accounting and related environmental management accounting practices are associated with stronger environmental outcomes, although the strength of the relationship varies across settings. For example, Melenia et al. (2023) report that the implementation of green accounting improves environmental performance in Indonesian cement, energy, and mining companies, while Trisnaningsih et al. (2024) show that the application of green accounting and MFCA supports sustainable development outcomes. Ulupui et al. (2020) provide evidence that green accounting, MFCA, and environmental performance are positively linked, and Bresciani et al. (2023) demonstrate that environmental management accounting practices contribute to environmental performance through knowledge-based organizational mechanisms. Nevertheless, prior findings are not entirely uniform. Some studies report weaker, context-dependent, or non-significant effects, particularly when environmental accounting practices are examined across different industries, organizational scales, and research designs. For instance, Soewarno et al. (2023) did not find a significant role for MFCA in their model of Indonesian MSMEs, suggesting that the effectiveness of MFCA may depend on firm size, reporting maturity, and operational complexity. Selpiyanti & Fakhroni (2020) also discuss the implementation of green accounting and MFCA in relation to sustainable development, but their evidence implies that the translation of accounting practices into broader environmental outcomes is not always direct and may depend on how the constructs are measured and operationalized. These divergent findings may be explained by several factors, including differences in industrial context, country setting, period of observation, sample size, and the proxies used to measure both environmental accounting and environmental performance. Studies focusing on heavily regulated or environmentally sensitive sectors often report stronger positive effects, whereas studies using broader samples or alternative performance indicators may produce weaker or inconsistent results. Differences in model specification, including the

treatment of mediating or moderating variables, may also explain why prior studies have not reached a fully consistent conclusion regarding how green accounting contributes to environmental performance.

However, there is still a huge gap in the preceding studies, the combination of environmental accounting techniques with sustainability appears promising. There is a lot of research on the direct link between green accounting and environmental performance but more research is necessary to uncover the techniques to strengthen this relationship. The prior studies have a main shortcoming in that they do not pay enough attention to how resource-efficiency accounting systems may combine green accounting with the achievement of sustainability objectives. In addition, the research on the topic has primarily concentrated on the internal cost saving benefits of MFCA rather than the broader implications for environmental performance. The present research attempts to bridge this gap by studying the impact of green accounting on environmental performance and the potential mediating role of MFCA in the link between the two variables.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Legitimacy Theory

Legitimacy theory suggests that a corporation's long-term prosperity depends on its acceptability by society at large. The basic idea is that a firm can only be sustainable if its activities and objectives are consistent with its values and beliefs. Legitimacy is the generic notion that the acts of a corporate organization are desirable, suitable, or acceptable within some socially built system of norms, values, beliefs, and definitions (Bilal et al., 2024).

Gaining legitimacy does not ensure an organization will always be safe and secure. The word legitimacy is a dynamic phrase that needs organizations to constantly assess and adjust their policies and operations to public expectations that are always changing (Irene Kurnianingtyas & Luh Putu Puji Trisnawati, 2024). Organizations that fail to change their environmental reporting and procedures risk losing their social license to operate in the face of changing cultural norms and increasing environmental awareness.

Stakeholder Theory

Stakeholder theory is a significant departure from the traditional shareholder theory, which claims that the fundamental duty of a firm is to maximize wealth for its owners. This theory offers a more holistic and ethical vision suggesting that a corporation has duties not just to its

shareholders but also to a wider group of people called stakeholders (Awa et al., 2024). This includes workers, customers, suppliers, local communities and regulators, all of whom are impacted by or potentially impact the company's activities.

Otoritas Jasa Keuangan (2017) states that stakeholders can be divided into two primary groups, internal and external. Internal stakeholders are those who work for the company, like owners, managers, and employees. Their main priorities may be making money, setting strategic goals, and treating employees fairly. External stakeholders, such as customers, creditors, competitors, government, and society, have an interest in the company's social and environmental impacts.

The two theories play distinct but complementary roles in the present conceptual model. Legitimacy Theory clarifies the organizational motivation behind the adoption of green accounting and the improvement of environmental performance, because firms need credible environmental actions and disclosures to remain acceptable within prevailing social norms. Stakeholder Theory, by contrast, clarifies the specific incentives and pressures that push firms to implement Green Accounting and MFCA, since these practices respond to demands for transparency, accountability, efficiency, and environmental responsibility from internal and external stakeholders. Taken together, the two theories support the model path Green Accounting, MFCA, and Environmental Performance: green accounting enhances the visibility of environmental costs, MFCA embeds that information into operational decision-making, and improved environmental performance helps firms satisfy stakeholder expectations while reinforcing legitimacy. For this reason, the combined use of Legitimacy Theory and Stakeholder Theory provides a stronger basis for interpreting the hypothesized direct and mediated relationships than either theory alone

Green Accounting

Green accounting, also known as environmental accounting, was developed directly because conventional accounting methods failed to properly address the natural environment. Traditional financial reporting has historically provided a dangerously incomplete picture of true corporate performance, as it has largely omitted the quantification of environmental costs and impacts (Khan & Gupta, 2025). Green accounting extends the conventional accounting framework to include these environmental externalities. Green accounting offers a more holistic view that is profoundly useful for all stakeholders in their decision-making processes, as it presents both financial and non-financial information ((Khan & Gupta, 2024; Ulupui et al., 2020). Including non-

financial indicators such as tons of carbon dioxide emitted or litres of water utilized, provides a far more full picture of company performance and long term viability.

In the framework of stakeholder theory, green accounting is the responsibility of a firm to serve the needs of the wide range of stakeholders with respect to more environmentally friendly and sustainable business operations. It offers the language and data needed to convey performance to investors, consumers, regulators and communities, therefore addressing the informational demands of a wide range of stakeholders. Prior studies generally agree that green accounting improves organizational transparency and supports better environmental and sustainability outcomes, yet the literature is not entirely consistent regarding the magnitude and pathway of this effect. Several studies report favorable impacts of green accounting on environmental or sustainability-related outcomes, but other studies suggest that the effect may vary across sectors, institutional settings, and measurement approaches. This inconsistency indicates that green accounting should not only be viewed as a disclosure practice, but also as an information system whose effectiveness depends on whether reported environmental costs are translated into operational actions. In this respect, the present study responds to the literature gap by examining whether MFCA functions as the mechanism through which green accounting leads to measurable environmental improvement.

Material Flow Cost Accounting (MFCA)

Green accounting offers the strategic foundation for environmental reporting. Material Flow Cost Accounting (MFCA) is a comprehensive operational level instrument that puts these concepts into practice. MFCA is a specific environmental management accounting methodology for measuring and improving production efficiency through the explicit monitoring and quantification of all material inputs and the costs of the final product and of the material losses (waste) generated during the production process. This deep knowledge leads to a considerably better understanding of the possible financial losses due to poor material use, which in turn gives a strong data-driven foundation for management decision making in the pursuit of waste reduction (Ratmono et al., 2024). Businesses have a better chance of making manufacturing process changes when they know the real cost of waste. This might result in victories for the environment and the bottom line.

Theoretically, MFCA enables the business to meet the demands of many stakeholders in terms of operational efficiency and environmental responsibility, which is in line with stakeholder theory. The data that results gives investors a signal that resources are being managed

effectively, ensures regulators that environmental rules are being followed and shows local communities that there is a real commitment to reduce industrial pollution.

MFCA has an important functional role in managerial processes because it measures material flows in both physical and monetary terms and assigns costs not only to outputs, but also to losses, waste, and inefficiencies. As a result, MFCA does more than provide descriptive cost information; it reveals where production processes consume excessive materials or energy and where hidden environmental costs are generated. This information leads managers to identify high-loss production stages, redesign inefficient processes, substitute materials, and reduce waste, which in turn results in better environmental performance

Environmental Performance

Environmental performance is the amount of corporate operations that affect the environment, the less harm produced, the better the environmental performance, and vice versa (Habib et al., 2020; Melenia et al., 2023). The indicator covers energy efficiency, emission reduction, waste management and compliance with environmental requirements. Good environmental performance is a kind of corporate responsibility to the expectations of many stakeholders in the context of stakeholder theory. Stakeholders include shareholders, workers, local communities, consumers and non-governmental groups that carefully monitor and analyze the environmental effect of company operations. Environmental performance is a particularly suitable dependent variable under both Legitimacy Theory and Stakeholder Theory. Under Legitimacy Theory, environmental performance represents visible evidence that a firm's environmental reporting is supported by actual operational outcomes, thereby helping preserve legitimacy. Under Stakeholder Theory, environmental performance reflects the extent to which a firm responds to the demands of regulators, communities, customers, and investors for environmentally responsible conduct.

In the literature, environmental performance is measured using both objective and subjective indicators. Objective measures commonly include emissions, energy use, waste generation, material efficiency, and environmental ratings, whereas subjective measures often rely on self-reported assessments or perception-based scores. Objective indicators are generally stronger for comparability and accountability, but they may depend on the availability and consistency of disclosed data. In this study, environmental performance is represented by the PROPER rating, which is appropriate because it captures both compliance and beyond

compliance dimensions of environmental achievement in the Indonesian context, and therefore offers a relevant proxy for firm-level environmental outcomes.

The Influence of Green Accounting on Environmental Performance

Green accounting has a large and favorable impact on improving the environmental performance of companies (Fadjarenie et al., 2024). This strategy urges corporations to include environmental expenses in their financial statements (Dura & Suharsono, 2022). This offers a framework for management to identify, quantify and control the environmental costs associated with their company operations and in turn offers an incentive for those costs to be reduced via improved environmental practices. Although several studies indicate a positive relationship between the implementation of green accounting and environmental performance, this connection requires further examination in various contexts, given the variation in findings across different industrial sectors. Causally, green accounting leads to improved environmental performance because it makes environmental costs more visible to management and external stakeholders. When firms identify and disclose environmental costs systematically, managers are more likely to allocate resources toward cleaner processes, better waste treatment, and preventive environmental actions. This process also strengthens accountability, because stakeholders can more easily assess whether environmental commitments are being translated into actual environmental improvement. Therefore, based on prior theoretical and empirical considerations, this study posits:

H1: Green Accounting positively influences Environmental Performance

The Role of Material Flow Cost Accounting (MFCA) as a Mediating Variable

Through the implementation of MFCA, companies can simultaneously lower costs whilst also reducing the environmental damage caused by their production activities. Based on research by (Crippa et al., 2021) a positive and significant relationship was found between green accounting and MFCA, particularly within the context of manufacturing companies that are required to report their environmental performance. MFCA provides the operational mechanism through which the strategies of green accounting are executed. However, not all research provides consistent results. Soewarno et al., (2023) for instance, tested MFCA as a mediating variable but did not find a significant influence. Such discrepancy in approach implies that the place of MFCA in the theoretical frameworks is still an unresolved question. In the current investigation, MFCA is proposed as a mediating variable assuming that the favorable influence of

green accounting on environmental performance is transmitted via the operational efficiencies that MFCA permits.

The mediating role of MFCA can be explained through a clear causal sequence. Green accounting generates information on environmental expenditures and environmental responsibility, but this information does not automatically change production behavior. MFCA mediates this relationship because it translates environmental cost information into process-level signals about material losses, waste costs, and inefficient resource use. Once these signals become visible, managers can take corrective actions such as redesigning production flows, reducing material leakage, substituting inputs, or improving recycling practices, which then lead to better environmental performance. In this sense, MFCA is not only an accounting technique but also a decision-enabling mechanism that connects strategic environmental reporting with operational environmental improvement. This reasoning helps explain why the effect of green accounting on environmental performance is expected to become stronger when firms also apply MFCA, especially in manufacturing settings where material flows and waste generation are central to production efficiency. So, then, by this reasoning:

H2: Material Flow Cost Accounting mediates the relationship between Green Accounting and Environmental Performance.

RESEARCH METHOD

The research is designed as a quantitative study. It is based on a methodological framework which is aimed at the statistical analysis of the numerical data for rigorous testing of the proposed research hypotheses. This study is based only on the empirical evidence of secondary data obtained from publicly accessible sustainability reports and annual reports of the sampled businesses. The research used PLS-SEM (Partial Least Squares-Structured Equation Modelling) to analyse the data. The approach is ideal for the purposes of the study, since it may be used to test predictive correlations between latent variables and to evaluate complicated research models. All the analyses were performed using WarpPLS 8.0 software.

Population and Sampling Procedure

The population of this research was the manufacturing companies listed on the Indonesia Stock Exchange (IDX) and involved in the PROPER program from the Ministry of Environment and Forestry in the 2021-2024 timeframe. The sample was obtained using purposive sampling approach to guarantee that the businesses fit the parameters of the study design. The admission

requirements require that the company: (1) be listed on IDX for the whole term; (2) publish annual reports and sustainability reports each year; (3) disclose environmental costs; and (4) engage in the PROPER program. This resulted in a final sample of 28 businesses, and hence 112 firm-year observations across the four-year duration of the research.

Operational Definition of Variables

Accounting Green. In this study green accounting is operationalised by measuring the environmental expenses indicated in companies' sustainability or annual reports. Environmental costs are the expenses borne by enterprises to avoid, limit or mitigate the environmental impacts of their activities. The metric was determined as Ln (Total Environmental Cost) by using a natural logarithm transformation, similar to the operationalization proposed by Abdullah and Amiruddin (2020).

Table 1. Operational Variable

No.	Construct	Indicators	Sources
1.	Green Accounting	Environmental Cost	(Abdullah & Amiruddin, 2020)
2.	Material Flow Cost Accounting	Production Cost	(Abdullah & Amiruddin, 2020)
3.	Environmental Performance	PROPER Rating	(Dura & Suharsono, 2022)

Source: Processed by the authors (2025)

Material Flow Cost Accounting The Material Flow Cost Accounting (MFCA) is defined as the sum of the production cost of the company's annual report. Cost of production is the sum of all costs incurred in the process of manufacturing. It comprises raw materials, direct labor and factory overheads. This indicator is in line with the methodology of Abdullah and Amiruddin (2020) and also given as a natural logarithm, Ln (Total Production Cost). **Environmental Performance.** Environmental performance is the degree to which corporations satisfy their environmental commitments. That is measured by the PROPER rating set by the Ministry of Environment and Forestry (KLHK) . The PROPER framework measures the environmental performance of corporations on two aspects, namely compliance with environmental rules and beyond-compliance performance. The ratings are converted into the following numerical scale:

Table 2. PROPER Score Rating

Colour	Description	Score
Gold	Very good	5
Green	Good	4
Blue	Enough	3
Red	Bad	2
Black	Very bad	1

Source: Ministry of Environment and Forestry (KLHK)

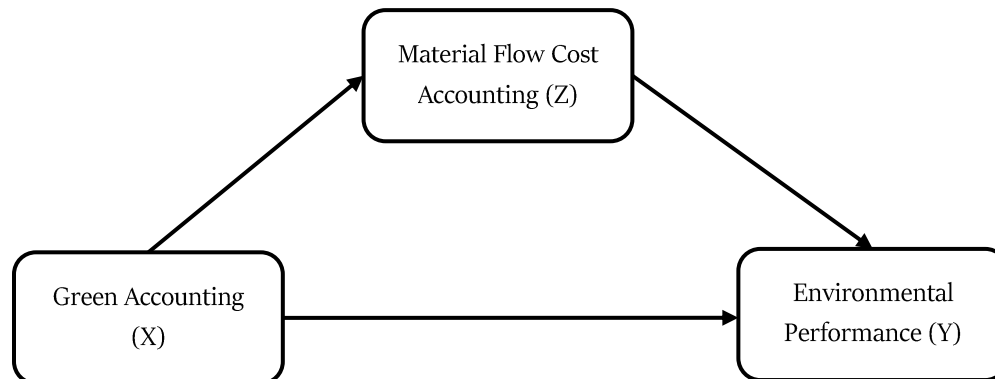


Figure 1. Analysis Model

RESULTS AND DISCUSSION

The suggested model was tested using PLS-SEM in a two step assessment. The investigation started with the examination of the outer model to check the validity of the measurement constructs. The initial assessment consisted of the major criteria of convergent validity, discriminant validity, and internal consistency reliability .

Outer Model Evaluation

Table 3. Convergent Validity Test

Variables	Indicator	Loading Factor	Description
Green Accounting	X	1.000	Valid
Environmental Performance	Y	1.000	Valid
Material Flow Cost Accounting	Z	1.000	Valid

Source: Data processed by the authors (2025)

Based on table 3, the examination of the measurement model presents an interesting finding, each indicator used in this analysis has an amazing loading factor of 1.000. This number is the maximum value, i.e. each indication exactly corresponds to its latent construct. This result indicates that each indicator is a perfect and only representation of their corresponding concept and meets the criteria of convergent validity (Hair et al., 2019).

Table 4. Discriminant Validity Test

Variables	AVE	Description
Green Accounting	1.000	Valid
Environmental Performance	1.000	Valid
Material Flow Cost Accounting	1.000	Valid

Source: Data processed by the authors (2025)

Table 4 shows that all structures have an Average Variance Extracted (AVE) value of 1.000. AVE is an important statistic because it indicates the amount of variation that a construct explains from its indicators in proportion to the measurement error. A result of 1.000 suggests each construct fully captures the variance of its single indication, demonstrating discriminant validity.

Table 5. Reliability Test

Variables	Composite Reliability	Cronbach's Alpha	Description
Green Accounting	1.000	1.000	Reliable
Environmental Performance	1.000	1.000	Reliable
Material Flow Cost Accounting	1.000	1.000	Reliable

Source: Data processed by the authors (2025)

The findings of reliability evaluation, together with the extensive data shown in Table 5, provide strong confirmation of the internal consistency of the measurement model constructs. The composite reliability and Cronbach alpha for all three study variables are all flawless, 1.000. These metrics together quantify the extent to which a set of indicators effectively measures a single latent idea. The theoretical maximum value is 1.000, which shows that the internal consistency is outstanding. It means that all measurement items of each variable are entirely correlated and free from measurement error.

Inner Model Evaluation

The analysis of the explanatory capacity of the model, shown in Table 6, is focused on the coefficient of determination R^2 . The R^2 value of the main endogenous construct, environmental performance, is 0.252. This statistical result indicates that the predictor variables, namely green accounting and MFCA, together explain 25.2% of the overall variation in environmental performance.

Table 6. R-Square Value

Endogen Variable	R-Square
Environmental Performance	0.252
Material Flow Cost Accounting	0.038

Source: Data processed by the authors (2025)

Based on table 6, for the model's second endogenous variable, material flow cost accounting (MFCA), the analysis demonstrates a substantially lower coefficient of determination, with an R^2 value of just 0.038. This statistic implies that its sole predictor, green accounting, accounts for just 3.8% of the variation seen in MFCA.

Table 7. Predictive Relevance (Q^2)

Endogen Variable	Q-Square
Environmental Performance	0.296
Material Flow Cost Accounting	0.097

Source: Data processed by the authors (2025)

Based on table 7, the structural model's predictive validity was assessed using the Q-Square (Q^2) statistic. To get a feel for how well the model works in practice, this crucial statistic looks at how well it can forecast the values of the endogenous constructs. The results are shown in Table 7. Both environmental performance and MFCA had Q^2 values of 0.296 and 0.097, respectively. According to Hair et al. (2019), one of the test conditions is that the model must have predictive relevance if the Q^2 value is greater than zero. The structural model satisfies the bare minimum for predictive validity since both computed values of Q^2 are bigger than zero. The investigation concluded with an assessment of the overall model fit. Regarding the empirical data, this is a crucial stage in validating the whole theoretical framework. The model is satisfactorily and well-fitted, as shown by the primary goodness-of-fit values in Table 8. The explanatory power of the model is confirmed by a substantial Average Path Coefficient (APC) and a significant Average R-Squared (ARS), both with p-values below the 0.05 cut-off.

Table 8. Model Fit Test

Model Fit Index	Value	P-Value	Description
Average Path Coefficient (APC)	0.270	<0.001	Accepted
Average R-Squared (ARS)	0.145	0.029	Accepted
Average block Variance Inflation Factor (AVIF)	1.092	-	Accepted

Source: Data processed by the authors (2025)

The findings in Table 8 show that the model has an Average Path Coefficient (APC) of 0.270 and a p-value of <0.001. The result is statistically significant and the model is accepted. This score shows that, on average, the route coefficients are of a relatively decent strength. Based on Table 8, the ARS and AVIF values met the criteria with a significance level of less than 0.05. The Average R-Squared (ARS) is 0.145, which is likewise statistically significant (p-value = 0.029), supporting the predictive ability of the model. Furthermore, the AVIF is 1.092. This is far lower than the suggested general threshold of <5.0 and also fulfills the ideal criteria of <3.3 (Trisnaningsih et al., 2024), showing that there is no substantial multicollinearity among the constructs.

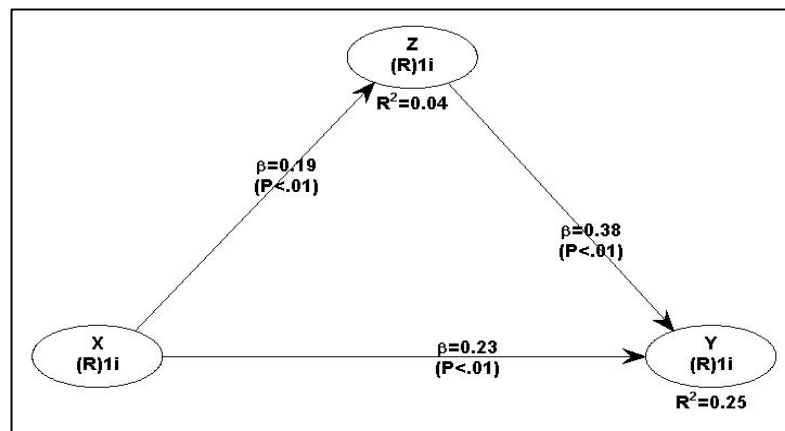


Figure 2. Results of Hypothesis Testing

The first hypothesis of this study is that green accounting has a positive effect on environmental performance. As shown in Table 9, the hypothesis test gave a regression coefficient of 0.232 and a p-value of 0.005. H1 is approved since the value is less than the 0.05 significance level, indicating that green accounting has a significant positive influence on environmental performance.

Table 9. Hypothesis Testing

Hypothesis	Relationship	Path Coefficient	P-Value	Decision
H1	Green Accounting → Environmental Performance	0.232	0.005	Accepted
H2	Green Accounting → MFCA → Environmental Performance	0.074 (indirect)	0.003	Accepted

Source: Data processed by the authors (2025)

Referring to Table 9 regarding the results of the hypothesis test, the result aligns with the findings of Trisnaningsih et al. (2024), which shows that green accounting enhances environmental performance. This illustrates that green accounting helps companies be more responsible for how they affect the environment, which is in line with the evaluation standards of the PROPER programme. By formally accounting for environmental costs, companies are incentivized to reduce those costs through improved environmental management.

The other findings demonstrate a significant indirect effect with a coefficient of 0.074 and a p-value of 0.003 (which is <0.05). Therefore, H2 is accepted. This statistically proves that MFCA mediates the relationship between green accounting and environmental performance. This gives a different view compared to the study by (Soewarno et al., 2023), which placed MFCA in a moderating role. The current finding implies that MFCA serves as the operational conduit through which the strategic environmental commitments encoded in green accounting are translated into measurable environmental performance improvements.

Green accounting is a method of obtaining measurable information about the environment. At the same time, MFCA uses the information to make decisions that are beneficial for the environment. As a result, companies that use green accounting can improve their environmental performance more effectively when they also apply MFCA, as the latter provides the concrete operational mechanism for achieving the strategic sustainability goals set by the former. The application of green accounting is not only a compliance with the environmental rules but also a part of the company duty towards the sustainability. The purpose of this research was to experimentally investigate the effect of green accounting on environmental performance and the mediating effect of MFCA based on legitimacy theory and stakeholder theory. The study result on the mediating function of material flow cost accounting (MFCA) provides a fresh viewpoint to comprehend the mechanism between green accounting and environmental performance. The findings of this research confirm that MFCA acts as a partial mediator in transmitting the effect of green accounting from operational efficiency to environmental performance. For company managers, green accounting integrated with MFCA is a strategic decision-making instrument that provides visibility and accountability for people's environmental effect. This strategy is in accordance with the performance of social responsibilities as stated in Stakeholder Theory (Ninčević Pašalić & Ćukušić, 2024) and ensures that corporations stay aware of the environmental demands of all their stakeholder groups.

CONCLUSION, IMPLICATIONS, LIMITATIONS, AND RECOMMENDATIONS

The findings show that green accounting has a positive and significant effect on environmental performance, with a path coefficient of 0.232 and a p-value of 0.005, indicating that firms that recognize and report environmental costs more transparently tend to achieve better environmental performance. This study also demonstrates that MFCA significantly mediates the relationship between green accounting and environmental performance, as reflected in the indirect effect of 0.074 with a p-value of 0.003, confirming that green accounting improves environmental performance not only directly but also through operational cost-and-material efficiency. Taken together, these results suggest that green accounting is most effective when it is translated into concrete production-level practices, because the identification of environmental costs encourages firms to reduce waste, improve resource efficiency, and strengthen environmental outcomes.

MFCA plays a central mediating role in this model because it converts the strategic intent of green accounting into measurable operational action. The significant indirect effect indicates that the influence of green accounting on environmental performance is partially carried through MFCA, while the direct effect remains significant, showing that MFCA complements rather than replaces the direct contribution of green accounting. This mediation is the core contribution of the study because it clarifies how environmental accounting moves from disclosure to performance improvement in manufacturing settings. In practice, manufacturing firms should adopt MFCA as a routine managerial tool to identify waste, lower material losses, and strengthen both environmental disclosure and production efficiency.

From a theoretical perspective, the findings extend Legitimacy Theory by showing that green accounting and MFCA operate as legitimacy-enhancing mechanisms through which firms demonstrate responsiveness to societal expectations for environmental responsibility. The results indicate that legitimacy is strengthened not merely by symbolic disclosure, but by the operational evidence of cost and material control embedded in MFCA, which makes environmental reporting more credible and verifiable. For Stakeholder Theory, the study shows that transparency over environmental costs and material flows responds to stakeholder demands for accountable, resource-efficient, and environmentally responsible conduct. This enriches the theory by clarifying when MFCA functions as a stakeholder-response mechanism, namely when firms convert environmental information into visible process improvements; future studies should therefore

examine boundary conditions such as organizational culture, regulatory pressure, and stakeholder salience.

The practical implications are direct and actionable:

- For manufacturing managers, the evidence suggests that MFCA should be integrated into environmental accounting systems because it supports cost efficiency and improves environmental performance; since MFCA mediates the effect of green accounting on performance, managers should treat it as an operational bridge rather than a stand-alone reporting tool.
- For policymakers and regulators, the findings support stronger sustainability-reporting guidance and clearer MFCA-oriented standards or incentives, because firms are more likely to improve environmental performance when environmental accounting is linked to measurable production efficiency.
- For auditors and consultants, the study indicates a need to evaluate not only whether environmental costs are disclosed, but also whether the reported information is traceable to material-flow controls and waste-reduction actions, since the empirical results show that MFCA strengthens the accounting-performance link.
- Regulators may also consider fiscal incentives or disclosure requirements that encourage firms to report environmental cost data more consistently, especially in manufacturing sectors with high material intensity.

This study has several limitations:

- Methodologically, it uses a cross-sectional PLS-SEM design, which limits causal inference and leaves potential endogeneity unresolved; future studies should employ panel data, longitudinal designs, or quasi-experimental approaches to strengthen causal claims.
- In terms of data, the analysis relies on secondary disclosures from annual and sustainability reports, and the short observation window may not fully capture changes in MFCA practice or disclosure quality over time; future research should combine archival data with surveys, interviews, or mixed-methods evidence to assess disclosure quality and implementation depth more accurately.
- Regarding the sample, the study is limited to Indonesian manufacturing firms participating in PROPER, so generalizability remains restricted; future studies should expand to other sectors, regions, or countries to test external validity.

- Future research should also include additional moderators or mediators, such as organizational culture, environmental regulation intensity, or digital accounting capability, and may explore broader evidence through panel models, field experiments, and cross-country comparisons.

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