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Green Accounting and Material Flow Cost Accounting as Determinants of Sustainable Development: Evidence from Indonesian Mining Companies

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ABSTRACT
This study aims to analyze the effect of Green Accounting and Material Flow Cost Accounting on Sustainable Development in mining companies listed on the Indonesia Stock Exchange from 2022-2024. The population used in this study was 63 mining companies listed on the Indonesia Stock Exchange. Based on sample selection using purposive sampling, 15 company samples were obtained with 3 research periods, resulting in a total of 45 samples. This research method uses a quantitative approach with multiple linear regression analysis using software SPSS. This study uses secondary data in the form of financial reports and sustainability reports of companies. The data analysis technique used is multiple linear regression analysis. The results of the analysis show that Green Accounting has a positive effect on Sustainable Development, indicating that improvements in environmental cost management and disclosure contribute to improvements in corporate sustainability performance. Material Flow Cost Accounting has a positive effect on Sustainable Development, and is even the most dominant variable in explaining variations in Sustainable Development because it promotes resource efficiency and waste reduction in the production process. Simultaneously, Green Accounting and Material Flow Cost Accounting are proven to have a significant effect on Sustainable Development with a high coefficient of determination, so that the model is considered capable of explaining most of the sustainability variation in the mining companies studied. Research implication is that green accounting significantly promotes sustainable development through improved transparency and environmental accountability, while material flow cost accounting contributes to sustainability mainly when integrated into broader strategic and environmental management practices.

Keywords: *Green Accounting, Material Flow Cost Accounting, Sustainable Development.*

INTRODUCTION
The rapid development of globalization and industrialization has had a serious impact on the environment. Various environmental problems such as global warming, pollution, and scarcity of natural resources have become major challenges faced by almost all countries. The mining sector is one of the most complex industrial sectors because its operational activities are directly related to the exploitation of natural resources. Economic development that depends on natural resources without considering the carrying capacity and capacity of the environment has the potential to cause sustainable environmental degradation, thereby threatening the sustainability of development in the future. This is in line with the view that natural resources and the environment have limited capacity, so their use must be managed wisely so as not to hinder the welfare of future generations.

The mining industry is one of the industries that has the potential to have a negative impact on the surrounding community and environment. Some of the negative impacts that often arise include water and air pollution, forest and land damage, disputes with local communities, and a decline in quality of life. During the 2022-2024 period, the mining sector was the highest amount of waste compared to other sectors, namely 60,133,158 tons, thus putting great pressure on environmental sustainability. Hazardous waste from mining activities generally consists of tailings containing heavy metals, used lubricant waste from coal, and wastewater from the mining process (KLHK, 2023).

According to WCED (1987), sustainable development is a concept of development that meets current needs without compromising the ability of future generations to meet their needs. Sustainable development has become a concept that is inseparable from global development goals. The Sustainable Development Goals (SDGs) agenda adopted by the United Nations (UN) on September 25, 2015, emphasizes the importance of integrating economic growth with environmental protection. There are three important aspects of sustainable development, namely economic, social, and environmental aspects. Environmental

degradation is one of the biggest threats to sustainable development and can hinder the achievement of SDGs. Therefore, the environmental aspect is one of the crucial pillars for achieving sustainable development. Companies need to implement accounting support tools that can integrate environmental aspects to support companies in aligning with sustainable development.

An adaptation of business activities that take environmental issues into account is environmental accounting or green accounting. Currently, many financial reports still do not provide information on reporting and activities related to environmental sustainability. Green accounting is an effort to connect economic interests that can help companies understand the natural and environmental aspects that effect the economy (May, 2023). Green accounting plays a crucial role for companies prioritizing efficiency and effectiveness in their production processes while emphasizing the sustainable use of natural resources. This helps align corporate development with environmental functions and benefits satiety. The implementation of green accounting greatly assists companies in compiling internal reports and making management decisions (M. Wahyudin Abdullah, 2020). Green accounting management uses the environmental costs borne by the company as well as company performance data, which can assist companies in making business decisions.

In line with green accounting, material flow cost accounting also provides a concrete approach to tracking and managing environmental costs, so that the two complement each other in supporting the company's sustainability goals. Material flow cost accounting helps companies understand the environmental and economic impacts of the raw materials and labor they use. Material flow cost accounting focuses on measuring and analyzing material and energy flows and related costs in the production process. The goal is to improve resource efficiency while reducing waste and emissions that can damage the environment. The benefits of implementing material flow cost accounting are that it helps increase profits and productivity (internal), and can help companies reduce their negative impact on the environment (external), which in turn contributes to the sustainable development of the company (Selpiyanti, 2020).

Green accounting and material flow cost accounting are important instruments in sustainable business practices that can help companies achieve the Triple Bottom Line (economic, social, and environmental). Green accounting focuses on accurate and transparent reporting of environmental impacts, while material flow cost accounting optimizes production processes to be more efficient and environmentally friendly. Material flow cost accounting theoretically supports sustainable development by providing cost information that encourages waste reduction and optimal use of raw materials, thereby making company activities more environmentally friendly. The implementation of both is expected to have a synergistic impact in promoting sustainable development by preserving the environment while increasing the economic and social value of the company (victor santoso, 2023).

This research took two theories to elaborate the result, Stakeholder theory and Legitimacy Theory. Legitimacy Theory states that companies or organizations must obtain and maintain legitimacy from the social environment in which they operate to ensure their continued existence (Hindriani, Siregar, Idayu, & Husni, 2024). Legitimacy is the public perception that an organization's activities align with prevailing social norms, values, and expectations. In the context of environmental accounting, this theory is used to explain the importance of companies disclosing information about environmental activities as an effort to maintain a positive image and gain public support. Through the application of legitimacy theory, companies can not only meet their social and environmental needs but also open up opportunities for increased transparency and accountability. By disclosing relevant financial and non-financial information, companies can provide a more complete picture of the social and environmental conditions related to their business strategies. This will improve the company's relationships with stakeholders, including investors, customers, employees, and the community. Legitimacy theory provides guidance for companies to build a positive reputation, increase public trust, and achieve long-term sustainability. Legitimacy theory is highly relevant to this research, as it emphasizes the importance of companies gaining and maintaining social legitimacy by aligning with societal values, norms, and expectations. In this regard, mining companies that adopt Green Accounting and Material Flow Cost Accounting strive to demonstrate their commitment to environmental management and responsible resource use as part of a strategy to gain public recognition and support (Abdullah & Amiruddin, 2020). Green Accounting, as a method for recording and reporting environmental costs, supports legitimacy theory by providing clarity regarding the company's environmental impact. This can enhance trust and the company's image among the public and stakeholders. In this way, companies can gain social legitimacy and play a role in implementing Sustainable Development (Medianawati & Cahyonowati, 2025). Material Flow Cost Accounting also contributes by encouraging companies to be more efficient in material use and reduce waste, which will help mining companies

optimize production processes in a more environmentally friendly manner. This practice can strengthen a company's efforts to maintain social legitimacy by conducting operations that prioritize sustainability, thereby better achieving sustainable development. Therefore, legitimacy theory serves as a framework that explains the motivation of companies to implement Green Accounting and Material Flow Cost Accounting as a tool to gain social acceptance and achieve sustainable development through their environmental and social responsibilities (Rahmatika, 2025).

Stakeholder theory first emerged at the Stanford Research Institute in 1963. According to R. Edward Freeman (1983), stakeholder theory is a theory often used as a basis for research related to Sustainable Development. Stakeholder theory is divided into two categories: internal stakeholders, consisting of owners, management, and employees, and external stakeholders, consisting of government, society, and the environment. Stakeholder theory in a company emphasizes that organizations not only work for individual interests but also provide benefits to stakeholders. Therefore, companies need support from the surrounding community, where the community is a stakeholder. This support can significantly impact a company's sustainability (Selpiyanti & Fakhroni, 2020). Stakeholders are not only focused on achieving profits but also on providing benefits to stakeholders. Companies that apply stakeholder theory will build close relationships with their stakeholders. One step company can take to maintain this relationship is by publishing sustainability reports. This report provides transparent information on the company's activities across economic, social, and environmental aspects. The application of Green Accounting in sustainability reporting within company management will foster corporate social responsibility towards the surrounding community (Razak & Wahyuni, 2023). In implementing Green Accounting, the stakeholder concept encourages companies to consider all parties involved by providing information regarding the environmental impact of their activities. In this way, the implementation of Green Accounting can increase transparency and stakeholder trust in the company's intentions, ultimately supporting efforts towards Sustainable Development (Tuti & Sisdianto, 2024). Similarly, Material Flow Cost Accounting (MFCA), which focuses on efficient material management and waste reduction, demonstrates the company's commitment to stakeholders, particularly regarding environmental and social issues. By considering stakeholders' perspectives, companies can accommodate the needs and expectations of all parties, ensuring that the use of MFCA not only provides economic benefits but also contributes to social and environmental aspects (Selpiyanti & Fakhroni, 2020). In general, the Stakeholder concept provides a basis that helps companies integrate Green Accounting and MFCA as an approach to meet stakeholder expectations, improve reputation and social relations, and encourage sustainable development that balances economic, social, and environmental aspects.

There are inconsistencies in previous research results that prompted the author to re-examine these variables. Research conducted by Irene & Luh (2024) states that green accounting and material flow cost accounting have an effect on improving sustainable development in companies in the energy sector, specifically the oil, gas, coal, and palm oil subsectors listed on the Indonesia Stock Exchange (IDX). Widya & Mulia (2022) also stated the same thing, namely that green accounting and material flow cost accounting have a positive and significant effect on sustainable development in agricultural sector companies listed on the Indonesia Stock Exchange (IDX). This differs from the research conducted by Siska & Irfan et al. (2023) and Nurul & Hilmi et al. (2024), which states that green accounting does not influence the improvement of sustainable development, and material flow cost accounting has a significant positive effect on improving sustainable development. Meanwhile, research conducted by Elsa & Kania (2025) and Millenia & jesica (2025) states that green accounting has a significant positive effect on sustainable development, while material flow cost accounting has no effect on sustainable development. The author chose the mining industry as the object of research because there are only a few research on mining industry taken into consideration to analyse the effect of Green Accouting and Material Flow Cost Accounting on Sustainability Develepmont using the recent data (2022-2024).

METHOD

This study is quantitative in nature with a causal-explanatory design to analyze the the effect of green accounting and material flow cost accounting on sustainable development in mining companies listed on the Indonesia Stock Exchange (IDX) for the period 2022-2024. The research population includes all mining companies on the IDX that published annual report and complete sustainability reports during that period. The sampling technique used is purposive sampling with criteria: (1) mining companies listed on the IDX during the 2022-2024 period, (2) companies that publish complete annual reports and sustainability reports, (3) mining companies that report their annual reports and sustainability reports using the rupiah currency.

Based on these criteria, a sample of 15 companies with a total of 45 observations was obtained. The data used was secondary data in the form of annual reports and sustainability reports obtained from the companies' official websites and the Indonesia Stock Exchange (www.idx.co.id).

Sustainable development measurements are conducted by totaling scores across four main dimensions, namely economic aspects (net profit, investment, and sales), social Aspects (CSR, employee salaries, and severance pay), environmental aspects (waste utility costs and occupational health and safety costs), and technological aspects (development and research costs), which are disclosed in the company's annual report and sustainability report. Green accounting measurement refers to Selpiyanti (2020), who state that green accounting disclosure consists of three dimensions with a total of 14 indicators. The measurement was carried out using the Global Reporting Initiative (GRI) index through content analysis by assessing the information presented in the annual report and sustainability report.

MFCA is measured based on cost components that reflect the efficiency of a company's resource utilization, namely material costs (raw materials, transportation, and storage costs), system costs (depreciation and maintenance costs), and energy costs (electricity and fuel consumption). The MFCA value is obtained from the sum of these three cost components. The Material Flow Cost Accounting measurement used is based on ISO 14051 and refers to research conducted by City (2025) on the MFCA measurement as follows:

MFCA = Material Cost + System Cost + Energy Cost

Description: Material Cost = Raw Material, Transportation, and Storage Costs
System Cost = Depreciation and Maintenance Costs
Energy Cost = Electricity and Fuel Consumption

Material Flow Cost Accounting are presented in millions of rupiah.

Data collection techniques were carried out using documentation methods by identifying, and processing quantitative information contained in the annual reports and sustainability reports of the sample companies. Data analysis was performed using multiple linier regression to examine the effect of green accounting and material flow cost accounting on sustainable development. Data processing and analysis were performed using software SPSS 22 version, which included descriptive statistical analysis, classical assumption testing, and hypothesis testing to obtain valid and scientifically accountable empirical evidence. The result will be elaborated using Legitimacy Theory and Stakeholders Theory.

RESULT AND DISCUSSION

Result

- Descriptive statistical analysis

  Based on table 1, the green accounting variable has a minimum value of 1.43 and maximum value of 3.29. the mean value of 2.53 with a standard deviation of 0.44, indicating that the application of green accounting in the sample companies is in the moderate category and the level of data dispersion is relatively low. This can be interpreted as meaning that perceptions or practices of green accounting among companies tend to be homogeneous, with no extreme differences within the research sample.

  For the material flow cost accounting variable, the minimum value is 63,676 (Rp63,676,000,000), while the maximum value is 14,627,002 (Rp 14,627,002,000,000). The average value of 2,368,673.36 and standard deviation of 3,728,980.73 indicate that the costs or economic value associated with material flow coat accounting implementation vary greatly between companies. The standard deviation value, which is greater than the average value, illustrates a wider distribution of data, indicating that there are companies with very low material flow cost accounting implementation and others with very high implementation, which statistically indicates the heterogeneity financial variables due to differences in business scale, production capacity, and resource usage intensity between companies.

Table 1. Result of descriptive statistical analysis

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
GA	45	1,43	3,29	2,5016	0,467
MFCA	45	63676	14627002	2134000	3608868,39444
SD	45	117401	80224933	9872848	20188065
Valid N (listwise)	45				

Meanwhile, sustainable development has a minimum value of 117,401 (Rp 117,401,000,000) and a maximum value of 80,224,933 (Rp 80,224,933,000,000). The mean sustainable development value is 9,872,630.13 with a standard deviation of 20,188,094.37, which is also much greater than the mean value. These values indicate that the level of corporate sustainability information to a limited extent and other companies that disclose extensively. Overall, these descriptive statistical results provide an initial overview of the distribution and level of dispersion of each variable's data before further hypothesis testing is conducted, as is function of descriptive analysis in quantitative research.

- Normality test

  Based on figure 1, it can be seen that the points are scattered around the diagonal line and mostly follow the direction of the line, although there are slight deviations at some points at the beginning and end of the curve. This distribution pattern indicates that the regression residual model tends to be normally distributed, so the assumption of normality in this study is fulfilled and the model is suitable for further hypothesis testing.
- Multicollinearity test

  Based on the results of the multicollinearity test in table 2, the tolerance values for the Green Accounting and Material Flow Cost Accounting variables are 0,947, while the VIF values for both variables are 1.056. a tolerance value greater than 1,10 and a VIF value below 10 indicate that there is no multicollinearity between the independent variables in the regression model used. Thus, both variables can be declared free from high correlation between variables. These results confirm that the research model has good stability and accuracy in explaining the relationship between independent and dependent variables.
- Heteroscedasticity test

  Based on figure 2, it can be seen that the plots or points are scattered randomly above and below the number 0, so it can be concluded that there is no heteroscedasticity in the regression model.
- Autocorrelation test

  Table 3 shows that the Durbin-Watson value is 1.868, which is close to 2, generally interpreted as no autocorrelation in the residuals, especially if the value is bet ween the lower and upper limits in the Durbin-Watson table (around 1.5-2.5). thus, it can be concluded that the regression model used has fulfilled the assumption of no autocorrelation.

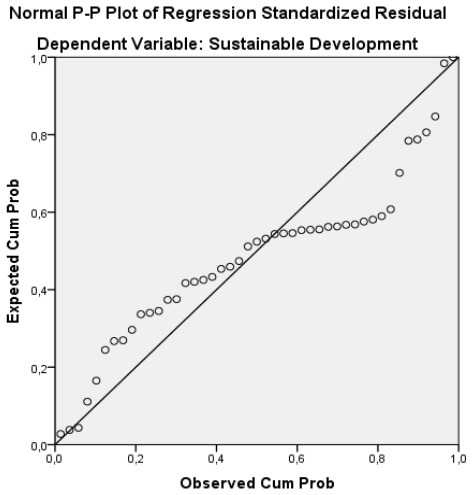

Figure 1. Normality test results

Table 2. Multicollinearity test result

Coefficients			
Model		Collinearity Statistics	
		Tolerance	VIF
1	MFCA	0,947	1,056
	GA	0,947	1,056

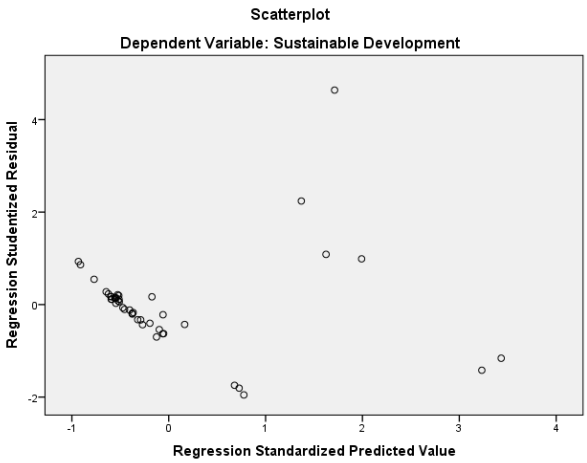

Figure 2. Heteroscedasticity test result

Table 3. Autocorrelation test result

Model Summary					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.856[a]	0.732	0.720	10689394.70795	1.868

- Multiple linier regression analysis

Table 4. Multiple linier regression analysis result

Coefficients						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-17232152,040	7443629,113		-2,315	,026
	MFCA	4,761	,386	,851	12,326	,000
	GA	6773498,254	2985054,846	,157	2,269	,028

The constant α has a negative value of -17232152.040. This indicates that if the green accounting and material flow cost accounting variables are considered to be zero, then the sustainable development value will be at that negative number. In practical terms, this negative constant indicates that without the implementation pf green accounting and material flow cost accounting, the company's sustainability level tends to be very low. The green accounting variable has regression coefficient of 6773498.254, which indicates that every one-unit increase in green accounting will increase sustainable development by that amount. However, the beta coefficient value of 0.157 shows that the influence of green accounting is relatively smaller than that of material flow cost accounting. Thus, although green accounting contributes significantly, its role in improving corporate sustainability is still supportive compared to material flow cost accounting, which has a stronger influence in the regression model. The material flow cost accounting variable has a regression coefficient of 4.761, indicating that every one-unit increase in material flow cost accounting will increase sustainable development by 4.761 units. In addition, the beta coefficient value of 0.851 shows that material flow cost accounting is the most dominant variable in this model, so it can be concluded that the application of material flow cost accounting has a strong role in supporting the achievement of corporate sustainability goals.

- Coefficient of determination test (R^2)

Based on the results of the coefficient of determination (R^2) tests in table 5, an R value of 0.856 was obtained, indicating that the relationship between the Green Accounting and Material Flow Cost Accounting variables and Sustainable Development is very strong. The Adjusted R Square value of 0.720 indicates that the two independent variables are able to explain 72% of the variation in Sustainable Development, while the remaining 28 % is influenced by other factors outside the research model.

Table 5. Coefficient of determination result

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.856[a]	0.732	0.720	10689394.70795

- Simultaneous coefficient test (F test)

Table 6. Simultaneous coefficient test result

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.133.550.105.285.600.000	2	6.566.775.052.642.780.000	57.471	<.001[b]
	Residual	4.799.052.687.338.660.000	42	114.263.159.222.349.000		
	Total	17.932.602.792.624.200.000	44			

Based on the results of the simultaneous regression coefficient test (F test) in table 6, an F value of 57.471 was obtained with a significance level of <0.001. a significance value far below the 0.05 limit indicates that the multiple linier regression model used in this study is statistically significant. Thus, it can be concluded that the Green Accounting and Material Flow Cost Accounting variables together have a significant effect on Sustainable Development. This means that the two independent variables have the ability to simultaneously explain the variation in the dependent variable. These results also reinforce the validity of the research model, as all variables included in the model are proven to collectively contribute significantly to the improvement of Sustainable Development.

- Partial coefficient test (t-test)

Based on the results of Multiple linier regression analysis result in table 4, the Green Accounting variable shows a t-value of 2.269 with a significance level of 0.028, which is less than 0.05. thus, it can be concluded that green accounting has a positive and significant effect on sustainable development. The green accounting regression coefficient value of 6773498.254 shows that increasing the implementation of green accounting contributes to improving corporate sustainability. Meanwhile, the Material Flow Cost Accounting variable obtained a t-value of 12.326 with a significance level of 0.000, which is less than 0.05. This result shows that material flow cost accounting has a positive and significant effect on sustainable development. The material flow cost accounting regression coefficient of 4.761 indicates that an increase in the application of material flow cost accounting contributes significantly to improving coefficient test (t-test) show that both independent variables partially have a significant effect on sustainable development, although material flow cost accounting is the variable that has a more dominant effect based on the larger beta coefficient value.

Discussion

The Influence of Green Accounting on Sustainable Development

The results of this study indicate that Green Accounting (GA) has a positive influence on Sustainable Development. This finding indicates that increased implementation of Green Accounting tends to be followed by an increase in a company's Sustainable Development. However, GA's contribution to the variation in Sustainable Development is relatively smaller compared to other variables, so its role is more of a supporting factor than a primary determinant in the model.

In the context of legitimacy theory, Green Accounting serves as a key tool for companies to demonstrate that their operational activities align with societal values, norms, and expectations. Mining companies frequently face scrutiny for environmental damage and social conflict, making the need to maintain social legitimacy crucial. When companies publicly disclose environmental costs, waste management policies, and ecological impact monitoring results, they build a narrative that their natural resource exploitation activities are conducted responsibly. Thus, consistent implementation of GA helps companies obtain and maintain a social license to operate, reflected in improvements in SD indicators, such as improved environmental quality, more harmonious community relations, and business sustainability.

From a stakeholder theory perspective, Green Accounting (GA) can be understood as a company's response to information demands from diverse stakeholders. Investors require evidence that environmental risks have been accounted for so as not to threaten long-term financial performance. Governments and regulators require environmental costs as a basis for compliance evaluation and policy formulation. The public wants to ensure that environmental damage is properly managed and restored. By providing comprehensive environmental information through GA, companies demonstrate concern for the interests of all these stakeholders. Consequently, stakeholder trust will increase, environmental resistance will decrease, and support for company projects will grow, ultimately strengthening the achievement of Sustainable Development.

The finding that GA has a positive impact on Sustainable Development indicates that disclosing and managing environmental costs is not merely a symbolic activity but has real implications for sustainability performance. When environmental costs are accurately recorded, management can identify areas of waste and then design energy efficiency programs, waste reduction programs, and improvements in production

technology. These programs not only reduce long-term costs but also improve environmental quality and the social conditions of surrounding communities. Therefore, the positive relationship between GA and Sustainable Development demonstrates that integrating environmental aspects into accounting systems can lead companies toward more sustainable operating patterns.

However, GA's contribution to Sustainable Development remains smaller than other managerial instruments that directly impact the production process, such as Material Flow Cost Accounting. This situation can be explained in practice: in many companies, GA still focuses on reporting (disclosure) rather than internal control. This means that environmental information is disclosed but not fully utilized as a basis for strategic planning and investment decision-making. From a legitimacy theory perspective, this illustrates a situation where some companies still use GA reactively to external pressures, rather than proactively reformulating their business models. As a result, despite its positive influence, GA's driving force for improving Sustainable Development is not yet optimal.

Stakeholder theory also helps explain why the strength of GA's influence can vary across companies. In companies with active and critical stakeholders, for example, institutional shareholders concerned with ESG (Environmental Social Governance), the impetus for using GA as a tool for monitoring and measuring sustainability performance tends to be stronger.

Conversely, in environments with weak stakeholder pressure, GA can potentially cease to be an administrative process. Therefore, to maximize GA's contribution to Sustainable Development, companies need not only to improve their environmental cost recording capabilities but also to establish sustainability dialogue with stakeholders so that the resulting information is truly used for joint evaluation and improvement.

Overall, Green Accounting can be viewed as a bridge between the demands of social legitimacy and stakeholder expectations and the day-to-day business practices of mining companies. When GA is integrated not only into reporting but also into budget planning, investment appraisals, and manager performance evaluations, environmental costs are no longer seen as mere expenses but as long-term investments to maintain resource sustainability, stable social relationships, and sustained profitability. Under these conditions, GA's contribution to Sustainable Development will be stronger and consistent with predictions from both legitimacy and stakeholder theories.

The results of this study align with previous research conducted by (Elsa Nurkholisoh, 2025), (Hindriani, Siregar, Idayu, & Husni, 2024), (Kurnianingtyas & Trisnawati, 2024), and (Widya Lestari, 2022) that found Green Accounting has a positive impact on Sustainable Development.

The Influence of Material Flow Cost Accounting on Sustainable Development

The results of the study indicate that Material Flow Cost Accounting (MFCA) has a positive influence on sustainable development. In contrast to Green Accounting, MFCA demonstrates a much stronger influence on sustainable development. These findings indicate that companies that effectively implement MFCA can improve material use efficiency, reduce waste, and reduce unproductive production costs. In mining companies, MFCA allows management to clearly see how much material actually becomes a salable product and how much ends up as waste or non-product, along with the costs associated with it. This detailed information enables companies to identify points of inefficiency in the process.

From a legitimacy theory perspective, these results indicate that companies implementing MFCA are perceived as better able to demonstrate compliance with environmental values expected by society. The success of MFCA in improving sustainable development is a concrete manifestation of the company's commitment to reducing its ecological footprint and utilizing natural resources responsibly. Unlike environmental cost disclosure, MFCA directly impacts the production process, enabling actual waste and emissions reductions to occur physically, not merely through discourse. When companies can demonstrate that the use of MFCA results in measurable material efficiencies and waste reductions, the public and regulators will perceive mining activities as being conducted within the framework of sustainability. This strengthens the company's social legitimacy, as its economic activities are proven to align with environmental protection and resource conservation.

Stakeholder theory is also highly relevant to explaining the impact of MFCA on Sustainable Development. Stakeholders in mining companies, such as shareholders, creditors, the government, and the community, have distinct but interrelated interests, such as cost efficiency, environmental quality, and social stability. MFCA provides information that can simultaneously address these diverse interests. For investors and management, MFCA reveals opportunities for cost savings and increased profitability. For the government and the community, MFCA demonstrates that the company is striving to reduce waste, emissions, and land degradation. Thus, implementing MFCA creates value that strengthens the company's

relationships with stakeholders and contributes directly to improvements in economic, social, and environmental dimensions.

Furthermore, MFCA supports increased stakeholder value through more efficient material and energy management. Waste reduction and increased productivity not only provide economic benefits to stakeholders but also mitigate environmental risks impacting the community and the government. By meeting stakeholder expectations regarding efficiency and environmental responsibility, companies can strengthen relationships with stakeholders and maintain the sustainability of their operations. Overall, the significant impact of MFCA indicates that this management accounting tool plays a crucial role in supporting the sustainable development of mining companies. The material efficiencies resulting from the implementation of MFCA help companies improve their economic performance while reducing their adverse environmental impacts. By continuously optimizing MFCA as part of their production strategy, they can take more appropriate action in resource management. This efficiency ultimately improves the company's economic and environmental performance, two key pillars of the concept of sustainable development. By communicating this transparently to stakeholders, the company can further strengthen its legitimacy and ensure its business sustainability in the future.

The finding that MFCA has the largest regression coefficient and beta coefficient indicates that this variable is a key driver of Sustainable Development compared to GA. This is understandable because MFCA operates within operational activities, where any increase in material efficiency is directly reflected in cost reductions, waste reduction, and increased productivity. In the capital- and resource-intensive mining sector, small efficiency improvements can have a significant impact on financial and environmental performance. Therefore, consistent implementation of MFCA will strengthen a company's resilience to commodity price fluctuations, increase competitiveness, and reduce public pressure regarding environmental damage.

Linked back to legitimacy theory, MFCA can be used as a company strategy to meet external demands within its internal management system. This is not just to meet regulations, but to exceed compliance standards through process and technological innovation. This action demonstrates that the company is not merely maintaining legitimacy symbolically but is genuinely incorporating sustainable values into its operational practices. When MFCA results are integrated into sustainability reports, for example, in the form of reduced waste intensity per ton of production or reduced energy consumption, public and regulatory trust will increase, thereby strengthening long-term legitimacy. From a stakeholder theory perspective, MFCA also demonstrates how companies can manage potential conflicts of interest between stakeholders. Efforts to reduce waste and increase efficiency are sometimes perceived as cost-saving measures that can harm employees or suppliers. However, through the information generated by MFCA, companies can design equitable improvements, such as replacing technology with more energy-efficient technologies that are also safer for workers, or waste recycling programs that create new business opportunities for the surrounding community. In this way, companies not only avoid conflicts but also create collaborative relationships with stakeholders.

Overall, Material Flow Cost Accounting can be viewed as an instrument that operationalizes the principles of legitimacy theory and stakeholder theory in the company's daily practices. MFCA helps companies demonstrate that economic and environmental goals can be achieved simultaneously, strengthening the company's legitimacy in the public eye while simultaneously addressing stakeholder demands for more responsible business practices. Thus, MFCA's strong influence on Sustainable Development aligns with the theoretical view that companies that integrate resource efficiency, environmental impact management, and stakeholder satisfaction will have better sustainability prospects than those focused solely on short-term profits.

The results of this study are in line with the results of previous studies conducted by (Selpiyanti & Fakhroni, 2020), (Juliana, Lasmini, & Puspitasari, 2025), (Nurul Fazmi, 2024), and (Hindriani, Siregar, Idayu, & Husni, 2024) that Material Flow Cost Accounting has a positive effect on Sustainable Development.

CONCLUSIONS

Green accounting has been proven to contribute positively to sustainable development through its role in integrating environmental aspects into corporate accounting systems. The application of green accounting encourages companies to systematically identify, measure, and disclose environmental costs, thereby increasing transparency and accountability to stakeholders. Environmental information presented in financial reports and sustainability reports can increase management’s awareness of the impact of the

company's operational activities on the environment and society. However, the environmental cost information that has been disclosed has not been fully utilized as a basis for strategic planning, internal control, or long-term investment decision-making. As a result, although green accounting is capable of building a company's image and commitment to sustainability, its optimal potential in driving significant operational change has not been fully realized.

Meanwhile, material flow cost accounting (MFCA) has a stronger influence on sustainable development due to its approach that focuses on operational processes. MFCA enables companies to trace material and energy flows in detail and identify costs attached to products and non-products, including waste and material losses. In addition to providing financial benefits, MFCA also contributes to reducing environmental and social risks, thereby increasing stakeholder trust and satisfaction. Thus, MFCA not only functions as a cost control tool, but also a strategic instrument that supports operational sustainability and long-term competitiveness.

Further research should consider using a more common currency, such as the US dollar, or adjusting exchange rates so that the analysis results are more comparable and reflect broader economic conditions. It is also recommended to add other variables that could potentially affect sustainable development, such as corporate social responsibility, environmental performance, or good corporate governance, so that the research result is more comprehensive.

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