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Research Article

Implementation of Green Accounting and Material Flow Cost Accounting in Supporting Sustainable Development

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Abstract: This study aims to examine the influence of green accounting and material flow cost accounting on sustainable development in palm oil companies listed on the Indonesia Stock Exchange (IDX) from 2015 to 2023. The sample consists of five companies observed over a nine-year period, resulting in a total of 45 data points. The analysis was conducted using WarpPLS version 7.0, including model fit testing, the calculation of the coefficient of determination, predictive relevance assessment, and hypothesis testing. The findings reveal that both green accounting and material flow cost accounting have a significant effect on sustainable development in the palm oil industry.

Keywords: ***Green Accounting; Material Flow Cost; Sustainable Development***

1. Introduction

The concept of sustainable development gained substantial global attention following the publication of the Brundtland Report in 1987 by the World Commission on Environment and Development (WCED). This report became a milestone in discussions concerning the balance between economic growth and environmental preservation. WCED defines sustainable development as an effort to meet the needs of the present generation without compromising the ability of future generations to meet their own needs (Loen et al., 2019). To enhance production performance, companies must adopt a holistic sustainability approach that emphasizes cost-efficiency, effective waste management, and the fulfillment of corporate social responsibilities.

Indonesia's palm oil industry plays a crucial role in the national economy but is also associated with environmental issues that significantly affect ecosystems. The sector faces increasing global pressure to strengthen sustainability commitments, comply with international market demands, and align with green market practices. As the world's largest producer of palm oil, Indonesia hosts a vast industry involving thousands of multinational and domestic companies. This sector contributes substantially to foreign exchange earnings, absorbs a large labor force, and drives infrastructure development in palm-oil-producing regions. Table 1 presents Indonesia's palm oil export volumes.

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Table 1. Palm Oil Exports (in thousand tons)

Years	Palm Oil
2019	30.380,4
2020	27.843,7
2021	27.570,8
2022	27.177,2
2023	28.628,4

Source: Central Bureau of Statistics (2024)

Data from the Central Bureau of Statistics shows a declining trend in palm oil export volumes from 2019 to 2022, dropping from 30,380.4 thousand tons to 27,177.2 thousand tons. Although exports increased to 28,628.4 thousand tons in 2023, the overall decline remains concerning, particularly given the industry's significant contribution to Indonesia's economic growth.

Since the outbreak of the COVID-19 pandemic, Indonesia's palm oil exports have fallen sharply. Global supply chain disruptions and reduced international demand have pushed palm oil prices downward in global markets (Abdullah, 2020) . At the same time, Indonesia experienced domestic shortages, which caused cooking oil prices to rise dramatically. In response, the Indonesian government imposed a temporary export ban on crude palm oil (CPO), red palm oil (RPO), palm oil mill effluent (POME), and refined, bleached, deodorized (RBD) products starting on April 28, 2022, as announced by the Cabinet Secretariat (Setkab, 2022). The policy was strictly enforced to stabilize domestic oil supply.

Following an oversupply and improved domestic conditions, the government lifted the ban in May 2022 and allowed the resumption of palm oil exports under Minister of Trade Regulation No. 38 of 2022, effective June 2022. The export acceleration program lasted two months and resulted in a modest increase in export volume in 2023, although the level remained below pre-pandemic figures.

Interestingly, despite the decline in export volume, data from the Central Bureau of Statistics indicates that the export value—based on Free On Board (FOB)—increased. This suggests that the palm oil industry has been able to adapt to shifting market conditions during and after the pandemic. Although challenges persisted, the sector continued to contribute to Indonesia's economic resilience. Rising global demand for palm oil has also encouraged expansion of plantation areas. However, such expansion must be carried out responsibly to prevent environmental degradation. For this reason, companies need to incorporate sustainable development principles into all aspects of their operations, from production planning to waste management.

To effectively achieve sustainable development, companies require suitable accounting tools that can measure environmental performance. Green accounting and Material Flow Cost Accounting (MFCA) are two such approaches that help companies assess the environmental impacts of their business activities. Implementing these tools improves waste management, enhances efficiency, and ultimately supports sustainable development goals (Wikansari et al., 2023).

According to Yuliani and Prijanto (2022), green accounting integrates environmental costs into the company's accounting system to support more informed and sustainability-oriented decision-making. It also functions as a bridge between companies and society by helping resolve conflicts related to environmental impacts (Damayanti & Yanti, 2023). Its implementation is considered an essential step to reduce environmental damage and optimize cost management. Empirical findings regarding the influence of green accounting on sustainable development vary: several studies report a positive effect (Somantri et al., 2023; Tyastuti & Heryana, 2024; Wiguna & Hariyani, 2023), while others find significant negative effects (May et al., 2023; Putri et al., 2024).

Material Flow Cost Accounting (MFCA) is a cost-management approach that analyzes the flow of materials throughout the production process (Dewi & Wiyono, 2023). MFCA

helps companies optimize production costs, reduce material losses, and lower environmental impacts by improving resource efficiency. Similar to green accounting, findings on MFCA's impact on sustainable development are inconsistent. Some studies report positive effects (May et al., 2023; Risma Aulia Putri et al., 2024), while others find no significant relationship (Rachmawati & Karim, 2021).

These inconsistent findings highlight a research gap, suggesting the need for further investigation. This study therefore focuses on examining the role of green accounting and MFCA in promoting sustainable development. Building upon Fakhroni's (2020) study on the palm oil sector, which found a significant relationship between both accounting practices and sustainability, this research differs by using more recent data (2015–2023 instead of 2009–2018).

The objective of this study is to analyze the causal relationship between the implementation of green accounting, MFCA, and indicators of sustainable development in palm oil companies listed on the Indonesia Stock Exchange. This study is expected to contribute empirical evidence that supports the advancement of sustainable business practices in the palm oil sector. Accordingly, the research question posed is: Do green accounting and material flow cost accounting have a significant positive effect on sustainable development?

LITERATURE REVIEW

Stakeholder Theory

Stakeholder theory is one of the most widely used theoretical foundations in sustainability research, emphasizing the importance of considering the interests of all parties affected by a company's activities. According to stakeholder theory, stakeholders are entities either individuals or groups that can influence or be influenced by an organization in pursuit of its mission and objectives (Donaldson & Preston, 1995; Freeman RE, 1983). Stakeholders are generally categorized into internal stakeholders, which include owners, management, and employees, and external stakeholders, such as government, communities, the natural environment, and future generations (Hodi Hernadi, 2012). The relationship between companies and stakeholders is built on mutual benefit, and strong stakeholder engagement is essential for long-term business continuity (Abdullah, 2017).

Widyowati and Damayanti (2022) further emphasize that stakeholder theory does not focus solely on profit generation but also on enhancing the welfare of stakeholders who directly influence a company's sustainability. Each stakeholder group has distinct expectations and demands (Dita Rari Dwi Rinining Tyastuty & Basuki, n.d.), resulting in a dynamic and reciprocal relationship between companies and their stakeholders.

Green Accounting

Green accounting refers to the integrated process of identifying, measuring, recording, summarizing, reporting, and disclosing financial, social, and environmental information within an accounting system. This approach aims to produce comprehensive and relevant information that supports both economic and non-economic decision-making (Lako, 2018). Green accounting promotes efficient and effective resource management while minimizing negative environmental impacts (Pertiwi et al., 2023). Through its implementation, companies can contribute to sustainable development and deliver greater benefits to society (Widyowati & Damayanti, 2022).

Material Flow Cost Accounting (MFCA)

Material Flow Cost Accounting (MFCA) is a management accounting method that enables companies to trace the flow of materials throughout all stages of the production process (Rachmawati & Karim, 2021). By analyzing both physical and monetary data, MFCA helps companies identify inefficiencies, improve material utilization, and reduce environmental impacts. As a result, MFCA supports corporate sustainability efforts by encouraging resource efficiency and environmentally conscious production decisions (Tyastuti & Heryana, 2024).

Sustainable Development (SD)

The United Nations (1987) defines sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. For companies, long-term sustainability depends heavily on their ability to adapt

to ongoing changes in economic, social, and environmental conditions. Therefore, firms must adopt a sustainable development framework that balances these three dimensions (Pertiwi et al., 2023). Environmental performance, which incorporates various indicators of ecological responsibility, plays a critical role in achieving comprehensive sustainable development (Somantri & Sudrajat, 2023).

Hypothesis Development

Green Accounting and Sustainable Development

Companies must balance their policies and strategic decisions to meet the expectations of all stakeholders (Risma Aulia Putri et al., 2024). By maintaining this balance, firms are better positioned to achieve long-term sustainability, maintain profitability, and contribute positively to both society and the environment. Consistent with stakeholder theory, environmental responsibility is essential not only for maintaining public trust but also as a long-term investment that supports corporate resilience (Wiguna & Haryani, 2023).

The implementation of green accounting serves as an effective approach to advancing sustainable development, as it enables companies to manage environmental costs more accurately and take appropriate actions to mitigate negative environmental impacts. Prior studies support the argument that green accounting positively influences sustainable development (Fakhroni, 2020; Loen et al., 2019; Wiguna & Haryani, 2023). Based on the findings of previous research, the following hypothesis is proposed:

H1: Green Accounting has a positive effect on Sustainable Development.

Material Flow Cost Accounting and Sustainable Development

Stakeholder theory aligns with the principles of corporate social responsibility, emphasizing that companies are expected to contribute to societal well-being and environmental preservation (Risma Aulia Putri et al., 2024). In today's competitive environment, firms must continuously improve productivity, product quality, and resource efficiency. One of the major challenges relates to waste generated from production activities. MFCA helps companies identify inefficiencies within the production process, thereby reducing both costs and environmental impacts (Pertiwi et al., 2023).

By applying MFCA, companies can better balance environmental and economic considerations, enabling more informed decision-making that supports sustainable development. Existing studies suggest that MFCA positively influences sustainable development (Fakhroni, 2020; Pertiwi et al., 2023; Risma Aulia Putri et al., 2024). Based on these findings, the following hypothesis is formulated:

H2: Material Flow Cost Accounting has an effect on Sustainable Development.

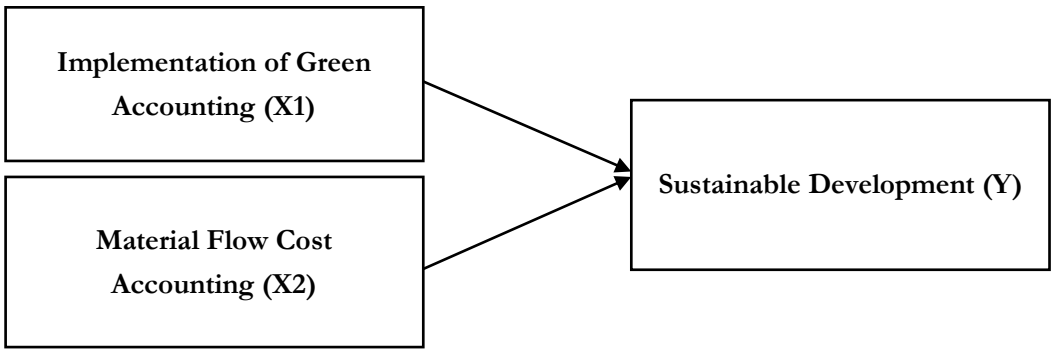

Figure 1. Conceptual Framework

METHOD

This study employs a quantitative research approach using secondary data as its primary source. The population consists of palm oil companies listed on the Indonesia Stock Exchange (IDX) from 2015 to 2023 that also participated in the Corporate Performance Rating

Program (PROPER). Through purposive sampling, the study selected companies that met the following criteria:

Palm oil companies listed on the Indonesia Stock Exchange during the 2015–2023 period.

Palm oil companies that participated in the PROPER environmental performance assessment conducted by the Ministry of Environment and Forestry.

Palm oil companies that provided complete financial statements for the 2015–2023 period.

Table 2. Sample Selection

No	Criteria	Amount
1	Palm oil companies listed on the IDX	26
2	Palm oil companies not participating in PROPER.	(18)
3	Palm oil companies without complete financial statements (2015–2023)	(3)
	Total Sampel	5
	Tahun Pengkajian	9
	Unit Sampel Pengkajian	45

Source: Processed Secondary Data

Based on these criteria, five palm oil companies were selected as the research sample, resulting in a total of 45 observations. To examine the causal relationships among the constructs, this study applies Partial Least Squares–Structural Equation Modeling (PLS-SEM). PLS-SEM is suitable for secondary data with relatively small sample sizes and does not require the assumption of normality. The analysis was conducted using WarpPLS 7.0, which includes model fit assessment, calculation of the coefficient of determination, evaluation of predictive relevance, and hypothesis testing.

Table 3. Measurements of Research Variables

No	Variable	Measurement	Description	Source
1	*Green Accounting* (X1)	PROPER	Color rating categories: (1)Black, (2)Red, (3)Blue, (4)Green, (5)Gold.	https://proper.menlhk.go.id/proper/
2	*Material Flow Cost Accounting* (X2)	Production Costs	Includes raw material costs, labor costs, and overhead costs	(Hernawati, 2018)
		Cultivated Area	Total plantation or factory area (in hectares)	
		Production Output	Total production obtained (in tons)	
3	*Sustainable Development* (Y)	Economic	Net income and sales	(Putri et al., 2024b)
		Social	Salary expenses and employee allowance	
		Environmental	Utility costs (electricity and water) and transportation costs	

	Technological	Research and Development expenses, including costs incurred for improving the quality of palm oil products.

ANALYSIS AND DISCUSSION

Table 4. Goodness of Fit Model

Model fit and quality indices

Average path coefficient (APC)=0.374, P=0,001

Avarage R-Square (ARS)=0.339, P=0.003

Avarage adjusted R-square (AARS)=0.307, P=0.006

Avarage block VIF (AVIF)=1.033, acceptable if<=5, ideally <=3.3

Source: Output WrapPLS7 (Processed Secondary Data, 2024)

Based on the above tests, the APC value obtained a model fit of 0.374 with P<0.017, while the ARS value obtained a model fit of 0.339 with P<0.003. Based on the above model fit, the AVIF value also meets the requirements, having a value of<5, and the ARS and APC values also meet the requirements because they have a p-value = P<0.05.

Table 5. Structural Model Results

Variabel	R^2 (R-Square)	Q^2 (Q-Square)	F^2 (F-Square)
X1 *(Green Accounting)*			0.113
X2 *(Material Flow Cost Accounting)*			0.226
Y (*Sustainable Development)*	0.339	0.338	

Source: Output WrapPLS7 (Processed Secondary Data, 2024)

The structural model results indicate that the Sustainable Development variable has an R^2 value of 0.339, meaning that 33.9% of its variation can be explained by the independent variables in this study, while the remaining percentage is influenced by other factors not included in the model. This suggests a relatively weak relationship between the independent and dependent variables (Sholihin & Ratmono, 2020).

The predictive relevance test (Q^2) produced a value of 0.338, or 33.8%, indicating that the model has good predictive capability in reconstructing the observed data. A Q^2 value above zero confirms that the model possesses predictive relevance.

The F^2 values represent the individual effect size of each independent variable. According to the classification large (0.35), medium (0.15), and small (0.02) (Sholihin & Ratmono, 2020) the effect size for X1 (Green Accounting) is 0.113 and for X2 (Material Flow Cost

Accounting) is 0.226. These results place both variables within the medium effect category in explaining changes in the dependent variable, Sustainable Development.

Hypothesis Testing

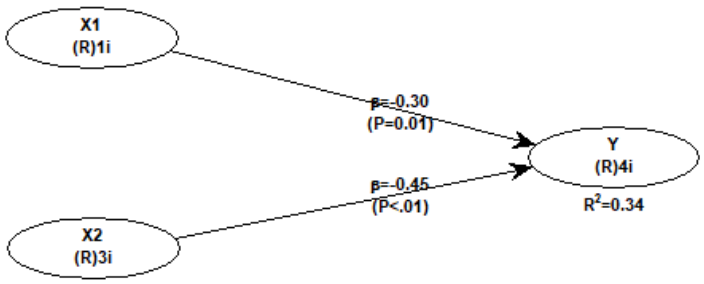

Figure 2. Research Results
Source: Research Results, 2023

Table 6. P-Value Table

Hypothesis	Variable	P-Value	Results
H1	*Green Accounting*	0.014	Significant
H2	*Material Flow Cost Accounting*	<0.001	Significant

Source: Output WrapPLS7 (Processed Secondary Data, 2024)

Interpretation of Research Finding
Green Accounting and Sustainable Development

The results of the analysis show a P-value of 0.014, which is below the 0.05 significance threshold. This indicates that green accounting has a significant effect on sustainable development. The findings demonstrate that companies implementing green accounting by allocating environmental preservation costs and maintaining transparency in financial reporting contribute meaningfully to sustainability outcomes. Therefore, hypothesis H1 is accepted.

Green accounting plays an important role in supporting sustainable development by integrating environmental costs and impacts into the accounting system. Through environmental cost disclosure, companies are encouraged to manage resources more efficiently, reduce pollution, and enhance environmental performance. As such, green accounting becomes a crucial instrument for achieving sustainability that encompasses economic, social, and environmental dimensions. Its implementation also motivates companies to seek more efficient ways to manage environmental impacts, which will influence future decision-making. Furthermore, green accounting supports sustainable growth and strengthens relationships with stakeholders, particularly the community. By optimizing resource use, minimizing waste, and reducing environmental harm, companies align with the principles of sustainable development. These findings are consistent with previous studies (Dura & Suharsono, 2022; Fakhroni, 2020; Wiguna & Hariyani, 2023).

Material Flow Cost Accounting and Sustainable Development

The analysis reveals a P-value of <0.001, which is also below the 0.05 threshold, indicating that material flow cost accounting significantly affects sustainable development. Thus, hypothesis H2 is accepted. The findings suggest that MFCA contributes to sustainability across economic, social, and environmental dimensions. The use of MFCA can reduce production costs, improve profitability through efficiency, minimize raw material usage, lower energy consumption, reduce waste and emissions, and promote cleaner production processes. In addition, MFCA can improve corporate reputation, strengthen regulatory compliance, and support community well-being through more sustainable industrial practices.

From a stakeholder theory perspective, MFCA enables companies to internalize environmental costs within the accounting system, encouraging more efficient and environmentally conscious production decisions. Therefore, MFCA serves as an essential tool for promoting sustainable development at the operational level.

Overall, the results indicate that MFCA is an effective approach for enhancing resource efficiency during production. By identifying waste-related and inefficiency-related costs more accurately, companies can make better decisions regarding waste management and environmental performance. These findings support previous studies (Fakhroni, 2020; Pertiwi et al., 2023; Risma Aulia Putri et al., 2024), which also highlight MFCA's role in reducing environmental costs and increasing profitability.

CONCLUSION

Palm oil companies that implemented green accounting in this study were found to have a significant influence on sustainable development. This occurs because companies that present complete annual reports and disclose environmental-related costs are better able to enhance their sustainability performance. The higher the level of green accounting disclosure, the stronger the signal sent to stakeholders regarding the company's commitment to sustainable development. As a result, this not only strengthens the company's reputation but also encourages continuous improvement in environmental performance.

Material Flow Cost Accounting (MFCA) in palm oil companies also shows a significant effect on sustainable development. By identifying and measuring hidden environmental costs, companies can take appropriate actions to improve efficiency and reduce waste. This contributes not only to environmental sustainability but also enhances the company's competitive position. By identifying inefficiencies in resource utilization, MFCA enables companies to optimize production processes. This reduces production costs while maximizing the value of each resource used, ultimately supporting environmental preservation.

LIMITATIONS AND RECOMMENDATION

This study, however, faces limitations related to data availability on the implementation of green accounting in palm oil companies listed on the Indonesia Stock Exchange. Not all companies consistently disclose relevant information, such as participation in the PROPER environmental performance assessment program. This limits the generalizability of the findings, as only 8 out of 27 palm oil companies listed between 2015–2023 reported green accounting practices through PROPER. Additionally, three companies did not publish complete financial statements throughout the study period, reducing the number of eligible samples.

Future researchers are encouraged to expand the scope by incorporating additional variables such as corporate social responsibility (CSR) disclosure or by applying modified research models, including moderating or intervening variables, to gain deeper insights into the factors influencing sustainable development.

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