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The Effect of Green Accounting Implementation on Environmental Performance Moderated by Material Flow Cost Accounting

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ABSTRACT

Environmental sustainability has become increasingly critical due to global challenges such as climate change, pollution, deforestation, and biodiversity loss. These issues underscore the importance of managing natural resources efficiently to meet human needs while minimizing environmental impact. This study explores the role of Green Accounting and Material Flow Cost Accounting (MFCA) in improving environmental performance, emphasizing their potential to contribute to both sustainability and financial performance. Green Accounting integrates environmental concerns into business strategies, while MFCA focuses on cost-efficient production and waste reduction. The study analyzes secondary data from companies listed on the Indonesia Stock Exchange (IDX) between 2020 and 2023, using Partial Least Squares (PLS) for data analysis. Findings indicate that Green Accounting significantly enhances environmental performance by promoting resource optimization and waste reduction, which also contributes to financial performance, as reflected in the PROPER program. However, while MFCA supports environmental performance, it does not directly influence the relationship between Green Accounting and environmental outcomes, indicating that the two frameworks, though complementary, serve different purposes. Green Accounting aligns with broader sustainability goals, while MFCA optimizes operational efficiency at the technical level. Together, these approaches provide companies with the tools to balance environmental sustainability and business profitability, ultimately supporting long-term sustainability objectives.

Keywords: *Environmental sustainability, Environmental performance, MFCA, Green Accounting*

ABSTRAK

Kelestarian lingkungan menjadi semakin penting karena tantangan global seperti perubahan iklim, polusi, deforestasi, dan hilangnya keanekaragaman hayati. Isu-isu ini menggarisbawahi pentingnya mengelola sumber daya alam secara efisien untuk memenuhi kebutuhan manusia sekaligus meminimalkan dampak lingkungan. Studi ini mengeksplorasi peran *Green Accounting* dan *Material Flow Cost Accounting* (MFCA) dalam meningkatkan kinerja lingkungan, menekankan potensinya untuk berkontribusi pada keberlanjutan dan kinerja keuangan. Akuntansi Hijau mengintegrasikan masalah lingkungan ke dalam strategi bisnis, sementara MFCA berfokus pada produksi yang hemat biaya dan pengurangan limbah. Studi ini menganalisis data sekunder dari perusahaan yang terdaftar di Bursa Efek Indonesia (BEI) antara tahun 2020 dan 2023, menggunakan Partial Least Squares (PLS) untuk analisis data. Temuan menunjukkan bahwa Akuntansi Hijau secara signifikan meningkatkan kinerja lingkungan dengan mempromosikan optimalisasi sumber daya dan pengurangan limbah, yang juga berkontribusi pada kinerja keuangan, seperti yang tercermin dalam program PROPER Namun, meskipun MFCA mendukung kinerja lingkungan, hal itu tidak secara langsung mempengaruhi hubungan antara Akuntansi Hijau dan hasil lingkungan, menunjukkan bahwa

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kedua kerangka kerja, meskipun saling melengkapi, memiliki tujuan yang berbeda. Akuntansi Hijau selaras dengan tujuan keberlanjutan yang lebih luas, sementara MFCA mengoptimalkan efisiensi operasional di tingkat teknis. Bersama-sama, pendekatan ini memberi perusahaan alat untuk menyeimbangkan kelestarian lingkungan dan profitabilitas bisnis, yang pada akhirnya mendukung tujuan keberlanjutan jangka panjang.

Kata Kunci: Kelestarian lingkungan, Kinerja lingkungan, MFCA, Akuntansi Hijau

INTRODUCTION

The environment faces numerous challenges today, including climate change, air and water pollution, deforestation, and declining biodiversity (Liu, Khan, Aslam, Rasheed, & Mohsin, 2022). These issues highlight the increasing importance of environmental sustainability, which refers to the use and management of natural resources in a way that meets human needs while minimizing environmental impact (McKinnon, 2010). Environmental conservation aims not only to maintain the carrying capacity of ecosystems for humans but also to ensure the well-being of other living organisms. Additionally, it focuses on reducing greenhouse gas emissions, optimizing energy and resource usage, and minimizing fuel consumption (Ögmundarson, Herrgård, Forster, Hauschild, & Fantke, 2020);(McKinnon, 2010)

The urgency of environmental sustainability is closely linked to human survival. As pollution levels reach alarming heights, maintaining environmental well-being has become a global priority. Environmental pollution, defined as the introduction of living organisms, substances, or energy into the environment beyond acceptable standards (BPS, 2023), encompasses issues such as air and water pollution. These types of pollution are commonly measured using indices like the Air Quality Index (AQI) and Water Quality Index (WQI), which are issued by the Ministry of Environment and Forestry (KLHK). Addressing these pressing concerns requires a comprehensive and effective approach to environmental management.

One such approach is the adoption of Green Accounting and Material Flow Cost Accounting (MFCA), which provide valuable frameworks for allocating costs and enhancing environmental management practices. While Green Accounting integrates environmental factors into business strategies, MFCA focuses on accurately calculating production costs and identifying opportunities to minimize waste (Dura & Suharsono, 2022). Together, these approaches support businesses in aligning their operations with sustainability goals, promoting better resource optimization and cost efficiency, ultimately contributing to long-term environmental and economic sustainability.

MFCA, as part of modern management accounting, provides valuable financial and non-financial information to support decision-making on waste reduction (Marota, 2017). Recognized in ISO 14051 on Green Productivity, MFCA helps companies improve financial performance by reduce ng costs and enhancing productivity. By accurately calculating material and energy costs, MFCA enables businesses to optimize resource utilization and boost profitability. This systematic approach offers significant financial savings, increased resource efficiency, and

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improved environmental performance (Sahu, Padhy, Das, & Gautam, 2021). Moreover, Rachmawati (2021) supports that MFCA can enhance company profitability and productivity as long with mitigating environmental harm.

As global awareness of the environmental impacts of human activities grows, the urgency to address these challenges intensifies (Husain, 2019). A healthy environment is characterized by the absence of technological hazards, resource degradation, and global conflicts, aligning with the principles of sustainability (Stokols, 1992).

The integration of Green Accounting and MFCA plays a critical role in supporting sustainable resource management. MFCA tracks material flows within organizations, analyzing the costs associated with these processes (Huang, Chiu, Chao, & Wang, 2019). This approach enables companies to identify potential waste, optimize production processes, and minimize resource use. When combined with Green Accounting, MFCA provides a comprehensive view of both the environmental and economic impacts of a company's activities, fostering long-term business sustainability.

RESEARCH METHODS

The data analysis method utilized in this study is Partial Least Squares (PLS). This analytical technique integrates two methodological approaches: the statistical perspective, which emphasizes prediction, and psychometrics, which facilitates the representation of models involving latent variables. Latent variables are those that cannot be measured directly but are instead assessed through their associated indicators, known as manifest variables (Latan & Temalagi, 2013).

This study uses secondary data obtained from the Indonesia Stock Exchange (IDX). Secondary data refers to information that is not directly collected by the researcher but is sourced from other individuals or documents. It can be acquired from various secondary sources, such as company records or archives, government publications, industry analyses from the media, websites, and the internet (Sekaran & Bougie, 2016). The data utilized in this study includes annual reports and sustainability reports of companies listed on the IDX during the 2020–2023 period. These secondary data were obtained from the official IDX website (www.idx.co.id), individual company websites, and the PROPER reports published by the Ministry of Environment and Forestry (KLHK).

RESULTS AND DISCUSSIONS

1. Outer Model Evaluation

This analysis aims to ensure the validity and reliability of the data used in the study. Several indicators are applied for this purpose, including Average Variance Extracted (AVE), standardized loading factors, and Cronbach's alpha.

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- **Validity Test**

The validity test is conducted to assess the ability of indicators to accurately represent latent variables. For the convergent validity test, the outer loading value must exceed 0.7, and the AVE value must be greater than 0.5. For the discriminant validity test, the cross-loading value of each indicator must be higher than 0.7.

Testing was conducted using SmartPLS version 4. The first test was to see the outer model of the research model. Here are the results of the outer model test:

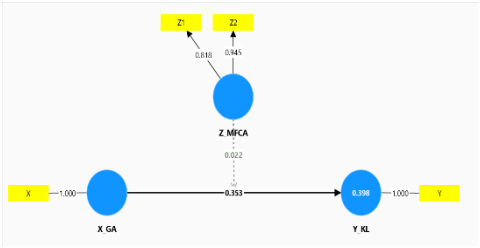

Figure 1. Validity Test

From the picture, the dimension of MFCA are 2 which is Z1 – Production costs and Z2 – Production area. Z3 is being taken out from the model because the cross-loading factor are less than 0.7 Based on the rule of thumb, the value for each cross loading must be >0.7 so that the Z3 indicator must be removed. For the other constructs, they had met the rule of thumb criteria, namely a value above 0.7.

- **Reliability Test**

The reliability test evaluates the consistency and accuracy of the model in making measurements. A model is considered reliable if the composite reliability value exceeds 0.7 and Cronbach's alpha is greater than 0.6.

The test results can be seen in the table below:

Table 1. Construct Reliability and Validity

	Cronbach's Alpha	Composite Realibility	Average Variance Extracted (AVE)
Z_MFCA	0.739	0.909	0.781

Table 2. Discriminant Validity

	X_GA	Y_EP	Z_MFCA	Z_MFCA x X_GA
X_GA				
Y_EP	0.153			
Z_MFCA	0.391	0.584		

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Z_MFCA x X_GA	0.009	0.109	0.255

A construct or variable is said to be reliable if it provides a Cronbach's Alpha value greater than 0.6 and a Composite Reliability value greater than or equal to 0.7. Table 2 shows the results of Cronbach's Alpha and Composite Reliability of the research instrument used, which shows a Cronbach's Alpha value greater than 0.6 and Composite Reliability greater than 0.7, namely 0.739 and 0.909, so the instrument used is said to be reliable. It also can be seen that the discriminant validity is appropriate because each construct indicator has a higher value than each other construct indicator.

2. Inner Model Evaluation

The inner model, also known as the structural model or inner relation, specifies the relationships between latent variables as defined by the research's substantive theory. It illustrates the connections among latent variables within the framework of the study. Evaluating the inner model involves assessing the R-square (R^2) value and the model fit. The second step focuses on interpreting the R^2 value, which is similar to its interpretation in linear regression—it represents the extent to which the variability of the endogenous variable is explained by the exogenous variables.

Structural model testing through R-Square value and goodness of fit. The closer to one value, the R-Square indicates a greater level of diversity of independent variables.

The results can be seen in the table below:

Table 3. R - Square

	R-Square	R-Square Adjusted
Y_EP	0.398	0.342

Table 4. Model Fit

	Saturated Model	Estimated Model
SRMR	0.085	0.085
NFI	0.714	0.714

Based on the table above, the R-square value of the environmental performance variable is 0.398 or 39.8%. This indicates that the large influence of Green Accounting on environmental performance is 39.8%, the remaining 60.2% is explained by other variables outside the model. It is also seen that the NFI and SRMR values have met the rule of thumbs so that the model is said to be good.

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4. Hypothesis Testing

In SmartPLS, testing of each hypothesis is done using the bootstrap method on the data sample. This approach aims to reduce the problem of abnormality in research data. A hypothesis is considered valid if the p-value is <0.05. The test results can be seen in the following table:

Table 5. Hypothesis Testing

	T-Statistics	P values	Result
Z_MFCA→ Y_EP	2.666	0.008	Significant
X_GA → Y_EP	4.683	0.000	Significant
Z_MFCA x X_GA → Y_EP	0.129	0.898	Not Significant

Discussion

The company's environmental performance, as measured by the PROPER index, is significantly enhanced by the implementation of Green Accounting (p-value: 0.000). This is because Green Accounting fosters greater transparency and accountability to stakeholders, encouraging companies to adopt improved environmental practices. The detailed information provided through Green Accounting aids management in making environmentally conscious decisions, such as investing in cleaner technology or implementing waste reduction initiatives. Additionally, it facilitates monitoring compliance with environmental regulations, thereby minimizing the risk of sanctions and ultimately boosting environmental performance.

Empirical evidence further substantiates the positive impact of Green Accounting on environmental performance such as a study by Pramiana et al. (2024) demonstrated that Green Accounting significantly improves the environmental performance of manufacturing companies in Indonesia. By identifying, measuring, and allocating environmental costs, Green Accounting integrates these considerations into business decision-making processes. It also emphasizes the importance of disclosing this information to stakeholders, thus promoting corporate responsibility in addressing social and environmental issues. These practices align with the overarching goal of achieving sustainability while positively influencing corporate behavior (Pramiana, Indrasah, & Suprapto, 2024).

Furthermore, enhanced Green Accounting practices are closely tied to better environmental performance, as assessed by programs like PROPER, reflecting legitimacy theory (Ratmono, Mail, Cahyonowati, & Janie, 2024). This theory underscores the importance of aligning corporate actions with societal expectations to maintain legitimacy and sustain long-term success. Similarly, Ramadhani et al. (2022) found that Green Accounting not only enhances environmental performance but also strengthens the positive relationship between environmental efforts and financial performance through the application of good governance principles. These

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findings reaffirm that Green Accounting is a critical tool for supporting sustainable development while simultaneously improving both environmental and financial outcomes.

The second hypothesis, which examines whether MFCA moderates the relationship between Green Accounting and environmental performance, revealed that MFCA does not significantly influence this relationship (p-value = 0.994) but have a significant effect on environmental performance (p-value = 0.008). This finding contrast with the study by Ulupui (2020), which reported no direct effect of MFCA on environmental performance. MFCA directly impacts environmental performance because of its focus on identifying inefficient material flows and waste management. MFCA can be implemented by increasing the transparency of material losses which can reduce environmental impacts and improve business efficiency (Ulupui et al., 2020). By helping companies reduce waste and maximize resource use, MFCA directly contributes to improving environmental performance.

The lack of direct influence can be attributed to the differing focus and objectives of these two concepts, even though they are complementary. Green Accounting takes a broader approach, integrating economic, social, and environmental dimensions into a company's financial statements. In contrast, MFCA is a more technical tool designed to analyze material flows, identify cost efficiencies, and minimize waste (ISO 14051).

While Green Accounting provides a comprehensive framework for sustainability reporting, MFCA serves as a specific method to support targeted sustainability initiatives. The role of MFCA is more indirect, as it focuses on operational-level efficiencies rather than broader strategic goals. Consequently, the impact of MFCA on Green Accounting may not always manifest in a direct relationship with environmental performance.

This research finding highlights that while MFCA and Green Accounting are interrelated, their influence tends to be indirect. Moreover, not all MFCA indicators contribute equally to Green Accounting, reinforcing the complexity of their interplay in achieving environmental performance and sustainability goals.

CONCLUSION AND SUGGESTION

Green Accounting plays a significant role in enhancing a company's environmental performance by integrating economic, social, and environmental aspects into the accounting system. This integration encourages companies to adopt more responsible resource management and waste reduction practices. Additionally, Green Accounting promotes transparency and accountability, enhancing a company's reputation and its performance in programs like PROPER. As a result, it not only positively impacts sustainability but also contributes to financial performance (Dura & Suharsono, 2022).

On the other hand, while Material Flow Cost Accounting (MFCA) has an impact on environmental performance, it does not influence the relationship between Green Accounting and environmental performance. Green Accounting serves as a

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comprehensive framework for integrating sustainability into financial reporting, while MFCA is a more technical tool aimed at improving material flow efficiency and minimizing waste (ISO 14051).

The implementation of MFCA and Green Accounting has significant implications for companies, both from an operational and strategic perspective. The implementation of MFCA can reduce production costs and improve operational efficiency. By identifying inefficient material flows, companies can reduce waste and maximize the use of resources (Kouřilová & Plevkova, 2013).

Despite their differing objectives, both approaches contribute in unique ways to environmental performance, with Green Accounting addressing strategic sustainability goals and MFCA focusing on operational-level efficiencies. Together, they offer complementary pathways for companies to enhance their environmental practices.

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