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Advancing Sustainable Development in PROPER-Registered Public Companies through Green Accounting and Material Flow Cost Accounting

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ABSTRACT

This study investigates the impact of Green Accounting and Material Flow Cost Accounting on Sustainable Development among publicly traded companies participating in PROPER during the 2019–2023 period. The research population encompasses 661 companies consistently listed throughout those years. Using a purposive sampling method, the study selected companies that published complete financial reports and were listed in PROPER for the entire observation period. Based on these criteria, a final sample of 9 companies was identified, resulting in 45 data observations across five years. Panel Data Regression was employed as the analytical technique. The findings reveal that both Green Accounting and Material Flow Cost Accounting exert a positive and significant partial influence on Sustainable Development. Furthermore, the combined effect of these two accounting approaches contributes meaningfully to the advancement of sustainability practices among companies listed on the Indonesia Stock Exchange during the observed period.

Keywords: Green Accounting, Material Flow Cost Accounting (MFCA), Sustainable Development, Public Company, PROPER

ABSTRAK

Penelitian ini mengkaji pengaruh Green Accounting dan Material Flow Cost Accounting terhadap Sustainable Development pada perusahaan publik yang mengikuti PROPER selama periode 2019–2023. Populasi dalam penelitian ini mencakup 661 perusahaan yang secara konsisten terdaftar sepanjang periode tersebut. Dengan menggunakan metode purposive sampling, penelitian ini memilih perusahaan yang menerbitkan laporan keuangan lengkap dan terdaftar dalam PROPER selama seluruh periode observasi. Berdasarkan kriteria tersebut, diperoleh sampel akhir sebanyak 9 perusahaan, menghasilkan total 45 observasi data dalam lima tahun. Teknik analisis data yang digunakan adalah Regresi Data Panel. Hasil penelitian menunjukkan bahwa Green Accounting dan Material Flow Cost Accounting secara parsial berpengaruh positif dan signifikan terhadap Sustainable Development. Selain itu, pengaruh simultan dari kedua pendekatan akuntansi ini memberikan kontribusi yang bermakna dalam mendorong praktik keberlanjutan pada perusahaan-perusahaan yang terdaftar di Bursa Efek Indonesia selama periode penelitian.

Kata kunci: *Green Accounting, Material Flow Cost Accounting (MFCA), Sustainable Development, Public Company, PROPER*

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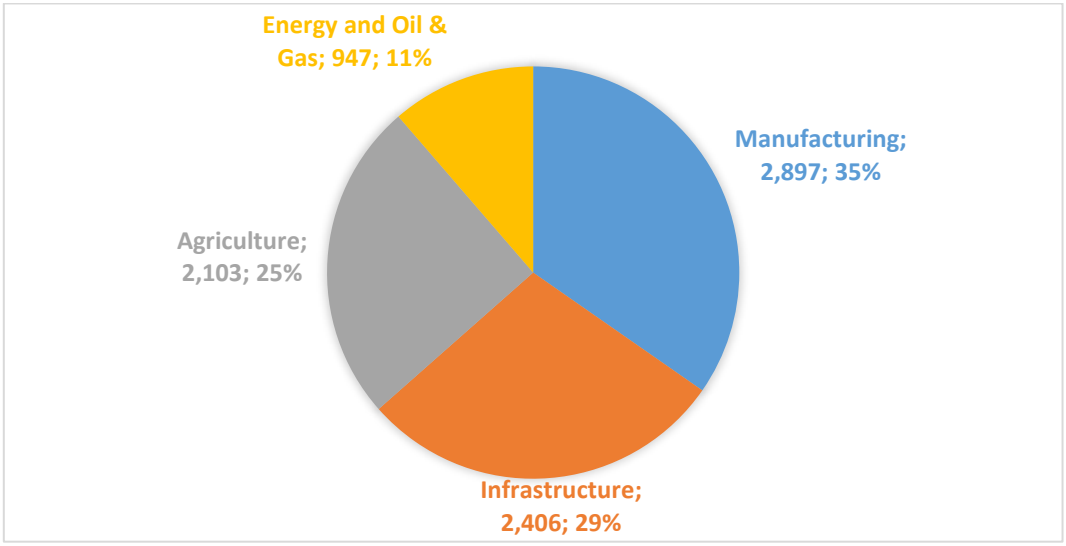
INTRODUCTION

Sustainable development has become a crucial issue in the modern era, particularly for companies engaged in natural resource management. It is defined as development that meets present needs without compromising the ability of future generations to meet their own needs. Sustainable development is highly significant because business operations in this sector directly interact with natural resource management and environmental sustainability. Excessive exploitation of resources may pose a threat to the long-term viability of businesses in the future (Rivai & Anugrah, 2016).

Indonesia is a country rich in natural resources. Thanks to its mineral-rich and fertile soil, which supports this natural wealth, the majority of Indonesians rely on agriculture for their livelihood. Agro-industry is one of the industrial sectors engaged in the production of raw materials and the management of natural resources, including food production, industrial raw materials, energy, and environmental management utilizing natural resources. (Sari, 2023).

According to information from the Kementrian Lingkungan Hidup Dan Kehutanan (KLHK)in 2021, Indonesia generated approximately 60 million tons of hazardous and toxic waste (B3 waste). The majority of this waste originates from the manufacturing industry, as illustrated in the following image (Dihni, 2022):



Source: Kementrian Lingkungan Hidup Dan Kehutanan (KLHK), 2021

Figure 1. Industries Generating Hazardous and Toxic Waste (B3 Waste)

Based on Figure 1, in 2021, the number of industries generating hazardous and toxic waste (B3 waste) in Indonesia was distributed across four main sectors. The manufacturing sector had the highest number of industries, with 2,897 industries, accounting for approximately 35% of the total B3 waste-generating industries. The infrastructure sector ranked second with 2,406 industries (29%), followed by the agriculture sector with 2,103 industries (25%), and the energy and oil & gas sector with 947 industries (11%). This data indicates that industries from various sectors contribute to B3 waste generation, highlighting the need for stricter waste management efforts. These efforts should include the implementation of environmental regulations, the adoption of environmentally friendly technologies, and waste reduction strategies to minimize the negative impact on ecosystems.

Additionally, the Ministry of Environment and Forestry (KLHK) in 2021 recorded that out of the 60 million tons of hazardous and toxic waste (B3 waste) generated, approximately 48.6 million tons could be utilized under technical permits (KLHK, 2021), This means that the potential recovery of B3 waste generated in the previous year reached 80.93%. However, the KLHK report stated that only 13.26 million tons, or 22.5%, of B3 waste was recycled. This figure remains relatively low, indicating that B3 waste utilization has not yet been optimized. Industrial waste not only contributes to environmental pollution but also has the potential to exacerbate the effects of global warming (Andre Rizaldy & Irwan Triadi, 2024).

Global warming is a phenomenon in which the average temperature across all layers of the Earth—in the atmosphere, land, and oceans—continues to rise. The World Meteorological Organization (WMO) estimates that the annual average temperature could increase by up to 20%, exceeding 1.5°C per year. This rise is projected to reach 1°C over the next five years. Such an increase in global average temperature may lead to extreme and unpredictable climate changes, causing disruptions in the agricultural sector, damage to marine ecosystems, and the outbreak of various diseases (Rakesa et al., 2022).

These efficiency measures will not only support Indonesia's efforts to reduce greenhouse gas emissions by 29%—or up to 41% with external support—by 2030 but also contribute to sustainable development. The savings in question refer to practices that reduce the consumption of natural resources, energy, and hazardous chemicals in production processes while minimizing waste and pollution. This includes energy efficiency, the use of more environmentally friendly raw materials, and sustainable production practices. By implementing these measures, companies can reduce their environmental footprint while simultaneously supporting sustainable development and adding value to their businesses. Currently, green industries have become a market demand due to the growing interest in environmental sustainability and sustainable development. However, many companies are still unaware of the importance of environmental conservation (Hassan, 2021).

Environmental accounting is a form of corporate responsibility in managing the environmental damage caused by business activities and is often regarded as one of the most effective approaches to addressing environmental degradation (Nursamsiah et al., 2019). Additionally, consumer and regulatory demands for environmentally friendly practices are increasing. To achieve sustainable development, companies must implement practices such as green accounting and Material Flow Cost Accounting (MFCA).

Green accounting encourages companies to identify and manage environmental costs, while MFCA helps reduce expenses by improving material efficiency and waste control. By adopting these two concepts, companies are expected to enhance economic performance, minimize negative environmental impacts, and contribute to the well-being of surrounding communities. Ultimately, this will support the achievement of sustainable development, particularly for publicly traded companies (Ulupui et al., 2020).

This study focuses on publicly listed companies and those registered in the PROPER program during the 2019–2023 period, aiming to analyze the causal relationship between the implementation of green accounting and sustainable development, particularly in economic, environmental, and social aspects. By examining the extent to which green accounting influences Sustainable Development, this research seeks to determine whether the identification, measurement, and disclosure of environmental costs contribute positively to achieving sustainable development. Furthermore, this study explores and analyzes the role of Material Flow Cost Accounting (MFCA) in Sustainable Development.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Stakeholder Theory

Stakeholder theory states that a company's survival is inherently linked to the position of both internal and external stakeholders, each of whom has their own interests, thus, it can be concluded that the sustainability of a company heavily depends on the support of stakeholders who have an interest in the company (Lindawati & Puspita, 2015).

Stakeholder theory argues that a company's survival requires support from its stakeholders, and the support provided by these stakeholders has a significant impact on the company's sustainability. This theory assumes that all corporate decisions and activities must first gain approval from stakeholders. Therefore, the relationship between the company and external stakeholders, such as the government and surrounding communities, must be harmonious to ensure the optimal implementation of sustainability concepts.

Legitimacy Theory

Legitimacy theory refers to a company's approach to ensuring that it operates within the established frameworks and norms of the society and environment in which it exists, thereby gaining acceptance as a legitimate entity (Deegan, 2002). One way to disseminate information is by disclosing green accounting practices. When a company makes an effort to disclose such information, it not only demonstrates its commitment to environmental and social responsibility as part of its business operations but also enhances public trust.

Therefore, this theory is highly relevant to the variables used in this study. Green Accounting and Material Flow Cost Accounting (MFCA) are variables related to environmental sustainability. These variables reflect a company's disclosure of its commitment to environmental responsibility, demonstrating its participation in achieving sustainable development goals.

Sustainable Develeopment

The concept of sustainability was widely introduced by a group known as the Brundtland Commission during the presentation of the report Our Common Future at the United Nations World Commission on Environment and Development (WCED). WCED integrated sustainability with social and environmental considerations to establish the concept of sustainable development.

According to the U.S. Environmental Protection Agency (US EPA), sustainability is based on everything necessary for maintaining human well-being while treating the natural environment responsibly. The next step involves creating and fostering an environment where humans and nature coexist harmoniously, ensuring that social, economic, and other essential needs are passed on from one generation to the next. The term sustainable development is used here to refer to projects that meet present needs without compromising the ability of future generations to fulfill theirs. The measurement of sustainable development variables incorporates economic, social, ecological, and technological aspects (Damayanti & Yanti, 2023)

Green Accounting

Green Accounting is a concept that prioritizes the role of the environment in the production process, which companies can achieve through the rational utilization of natural resources. This approach ensures that companies balance economic growth with environmental functions that benefit society. When implementing Green Accounting, there must be a consistent focus on land conservation, material efficiency, and energy savings. In other words, Green Accounting is entirely centered on the concept of saving, which includes land conservation, material efficiency, and energy efficiency, all of which are grounded in the ecosystem-based approach (Hayaah, 2023).

A company's environmental performance is assessed based on the outcomes achieved through the PROPER program. In PROPER, environmental performance is evaluated using a color-coded rating system, which is categorized on the following scale:

Table 1. PROPER Rating

Colour/ Category	Score	Explanation
Gold	5	The company has achieved satisfactory (excellent) results in its efforts to limit financial resource pollution and environmental degradation or in the implementation of clean production.
Green	4	Businesses or activities that have implemented pollution and environmental damage control initiatives and achieved results that exceed the requirements set by applicable laws and regulations (good).
Blue	3	Businesses or activities that have successfully implemented pollution and environmental damage control initiatives and achieved results in accordance with the minimum requirements stipulated by applicable laws and regulations (fair).
Red	2	Businesses or activities that have made efforts to control pollution and environmental damage but have not met the minimum requirements stipulated by applicable laws and regulations (poor).

Black	1	Businesses or activities that have not undertaken any pollution or environmental damage control measures (very poor).

Source: Kementrian Lingkungan Hidup (KLH)

The disclosure of a company's green accounting enhances its sustainable development, including economic, environmental, social, and technological aspects. Conversely, the poorer the green accounting information of a company, the weaker its sustainable development (Rachmawati & Karim, 2021) (Arum & Farida, 2023).

H_1: Green accounting has a positive and significant effect on sustainable development in PROPER-Registered Public Companies.

Material Flow Cost Accounting (MFCA)

MFCA (Material Flow Cost Accounting) is a tool or technique for managing production flow processes, including waste flow (undesirable material residues). By utilizing MFCA, SMEs and large enterprises can calculate and minimize material losses. Essentially, MFCA serves as a cost-reduction tool through waste minimization, ultimately leading to increased business productivity (Ardina et al., 2020). There are three key indicators in MFCA: material costs, system costs, and energy costs (Khotimah et al., 2022)(14051, 2011).

The disclosure of Material Flow Cost Accounting (MFCA) by a company positively contributes to its sustainable development. Conversely, the less a company discloses MFCA, the more its sustainable development will be disrupted (Selpiyanti & Fakhroni, 2020) (Rachmawati & Karim, 2021).

H_2: Material Flow Cost Accounting has a positive and significant influence on Sustainable Development in PROPER-Registered Public Companies.

METHOD

Both independent and dependent variables are used in this investigation. On the one hand, the The research method employed in this study is an associative method with quantitative data. The population consists of 661 companies that were continuously registered during the 2019–2023 period. The sample selection was conducted using a purposive sampling technique, with criteria including companies that published complete financial reports during the observation period and were listed in the PROPER program from 2019 to 2023. Based on these criteria, a total of 9 companies were selected as samples, with a five-year observation period, resulting in 45 data observations.

The data analysis technique used in this study is quantitative descriptive analysis, which begins with grouping data from the selected sample. The data is then processed using EViews, generating processed data in the form of tables, graphs, and conclusions to support decision-making in the analysis results. The data analysis includes Panel Data Regression Analysis, Classical Assumption Tests, and Hypothesis Testing.

RESULTS AND DISCUSSION

Regression Model Selection

There are three techniques available for estimating model parameters using panel data: the Common Effect Model (CEM), the Fixed Effect Model (FEM), and the Random Effect Model (REM). To determine the appropriate panel data estimation technique, three tests are conducted: the Chow test, the Hausman test, and the Lagrange Multiplier test.

Based on the results of the Chow test and the Lagrange Multiplier test, the probability value obtained is 0.7707. Since the probability value of 0.7707 is greater than 0.05 (0.7707 > 0.05), the appropriate estimation model for this study is the Common Effect Model (CEM).

Classical Assumption Tests

Normality Test

The normality test for residuals in this study was conducted using the Jarque-Bera (J-B) test with a significance level of α = 0.05. Based on the test results, the probability value of the J-B statistic was 0.114120. Since the probability value of 0.114120 is greater than 0.05 (0.114120 > 0.05), the normality assumption is satisfied.

Multicollinearity Test

Multicollinearity symptoms can be identified by examining the correlation values between variables in the correlation matrix. The results of the multicolli Table 2. Multicollinearity Test with Correlation Matrix nearity test are presented in Table 2 below.

Table 2. Multicollinearity Test with Correlation Matrix

	***Green Accounting* (X_1)**	***Material Flow Cost Accounting* (X_2)**
Green Accounting (X_1)	1.0000	0.3293
Material Flow Cost Accounting (X_2)	0.3293	1.0000

Source: Processed Data from Eviews 10 Software.

Based on Table 2, it can be observed that the correlation values between variables do not exceed 0.9. Therefore, it can be concluded that there is no multicollinearity among the independent variables.

Heteroscedasticity Test

A good regression model is one that exhibits homoscedasticity, meaning there is no heteroscedasticity, as shown in the following table.

Table 3. Glejser Test

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	2.338487	1.491939	1.567415	0.1245
Green Accounting (X_1)	-0.101959	0.258456	-0.394493	**0.6952**
Material Flow Cost Accounting (X_2)	-0.112618	0.102200	-1.101935	**0.2768**

Source: Processed Data from Eviews 10 Software

Based on the results of the Glejser test in Table 3, it can be observed that the Prob. Glejser value for Green Accounting (X1) is 0.6952, and the Prob. Glejser value for Material Flow Cost Accounting (X2) is 0.2768. Since all Prob. Glejser values are greater than 0.05, it indicates that heteroscedasticity is not present.

Autocorrelation Test

The assumption of residual independence (non-autocorrelation) can be tested using the Durbin-Watson test, as shown in the following table.

Table 4. Breusch-Godfrey Test

Breusch-Godfrey Serial Correlation LM Test:			
Obs*R-squared	0.520809	**Prob. Chi-Square**	**0.7707**

Source: Processed Results from Eviews 10 Software.

Based on Table 4, the probability value (Prob.) of the Chi-Square test in the Breusch-Godfrey Lagrange Multiplier (LM) Test is 0.7707 > 0.05. Therefore, it can be concluded that the model does not have an autocorrelation problem.

Panel Data Regression Analysis and Hypothesis Testing

Hypothesis testing in this study consists of the partial test (t-statistic test), simultaneous test (F-statistic test), and determination coefficient test, as presented in the following table 5.

Table 5. Hypothesis Testing (Common Effect Model - CEM)

Dependent Variable: Sustainable Development (Y)
Method: Pooled Least Squares
Sample: 2019 2023
Included observations: 5
Cross-sections included: 9
Total pool (balanced) observations: 45

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Green Accounting (X_1)	**1.436284**	0.349992	4.103762	**0.0002**
Material Flow Cost Accounting (X_2)	**0.731001**	0.138396	5.281962	**0.0000**
C	-1.729084	2.020330	-0.855842	0.3969
R-squared	0.464310	Mean dependent var		9.950359
Adjusted R-squared	**0.438801**	S.D. dependent var		2.148066
S.E. of regression	1.609186	Akaike info criterion		3.853674
Sum squared resid	108.7581	Schwarz criterion		3.974118
Log likelihood	-83.70767	Hannan-Quinn criter.		3.898575
F-statistic	18.20175	Durbin-Watson stat		1.482451
Prob.(F-statistic)	**0.000002**			

Source: Processed Results from Eviews 10 Software

$$\boldsymbol{Y = -1,73 + 1,44X_1 + 0,73X_2}$$

Based on Table 5, the results of the Partial Test (t-Statistic Test) indicate that the regression coefficient of the Green Accounting variable is 1.44, which is positive, with a probability value of 0.0002 < 0.05. This implies that Green Accounting (X1) has a positive and significant effect on Sustainable Development (Y), leading to the acceptance of Hypothesis 1. Furthermore, the regression coefficient of the Material Flow Cost Accounting variable is 0.73, which is also positive, with a probability value of 0.0000 < 0.05. This indicates that Material Flow Cost Accounting (X2) has a positive and significant effect on Sustainable Development (Y), confirming the acceptance of Hypothesis 2.

Table 5 also presents the Simultaneous Test (F-Statistic Test), where the probability value of F-statistics is 0.000002 < 0.05. This result suggests that both independent variables, Green Accounting (X1) and Material Flow Cost Accounting (X2), simultaneously have a significant effect on Sustainable Development (Y), supporting the acceptance of Hypothesis 3.

The results of the Coefficient of Determination Test in Table 5 show that the Adjusted R-squared value is R^2 = 0.44. This means that Green Accounting (X1) and Material Flow Cost Accounting (X2) jointly explain 44% of the variance in Sustainable Development (Y), while the remaining 66% is influenced by other factors not included in this study.

The Influence of Green Accounting on Sustainable Development

The results of this study validate Hypothesis 1, which states that Green Accounting has a positive and significant effect on Sustainable Development. Companies that implement green accounting by allocating costs for environmental conservation and disclosing them in their annual reports contribute significantly to enhancing sustainable development.

The implementation of Green Accounting within a company undoubtedly leads the company toward a better direction. Furthermore, by adopting Green Accounting, the company indirectly fulfills its responsibility to stakeholders. The implementation of Green Accounting has a positive and significant relationship in enhancing sustainable development (Selpiyanti & Fakhroni, 2020) and (Loen, 2019).. Companies that implement and report environmental preservation-related costs have been proven to enhance sustainable development.

Furthermore, the adoption of Green Accounting enables companies to better identify and manage environmental risks, ultimately improving operational efficiency and competitiveness. As awareness of the importance of sustainability continues to grow, many investors and consumers tend to favor

companies with transparent and responsible environmental policies. Therefore, the implementation of Green Accounting not only benefits the environment but also enhances the company's reputation and value in the eyes of stakeholders.

The Influence of Material Flow Cost Accounting on Sustainable Development

The test results of this study indicate that Material Flow Cost Accounting (MFCA) has a positive and significant effect on Sustainable Development, thereby supporting the acceptance of Hypothesis 2. This finding reinforces prior studies that demonstrated a positive and significant relationship between MFCA and Sustainable Development. (Selpiyanti & Fakhroni, 2020)(Loen, 2019). For MFCA to be successfully implemented within a company, there must be support and commitment from a bottom-up approach within the organization.

Top-level executives must demonstrate strong commitment to convince the subsequent levels of the organization. By involving both management levels, this concept can become an effective and powerful management tool for a company in developing its business. However, these research findings contradict some prior studies, which state that there is no significant relationship between Material Flow Cost Accounting and Sustainable Development (Loen, 2018).

On the other hand, MFCA implementation can encourage companies to innovate toward more environmentally friendly production processes. Through this approach, companies can improve compliance with increasingly stringent environmental regulations while also benefiting from incentives or support from governments and environmental organizations. Additionally, MFCA enhances transparency in financial and sustainability reporting, ultimately contributing to increased corporate value in the eyes of investors and consumers.

The Influence of Green Accounting and Material Flow Cost Accounting on Sustainable Development

The simultaneous effect of the variables indicates that Green Accounting and Material Flow Cost Accounting (MFCA) have a significant impact on Sustainable Development, there by confirming the acceptance of Hypothesis 3. The results of this study corroborate earlier research highlighting the significant role of Green Accounting and MFCA in advancing Sustainable Development. (Arum & Farida, 2023) (Rachmawati & Karim, 2021).

Proper disclosure of Green Accounting contributes to the enhancement of sustainable development. Resource efficiency strengthens the relationship between Green Accounting and sustainable development, as well-managed resources reinforce the positive link between environmental accounting and corporate sustainability. Likewise, MFCA plays a critical role in sustainable development, where improved MFCA implementation leads to enhanced sustainability outcomes.

Both Green Accounting and MFCA complement each other in supporting corporate sustainability goals. Green Accounting encourages companies to reduce environmental impact and environmental costs through policies and strategies that integrate environmental and economic aspects. Meanwhile, MFCA helps organizations manage resources and waste efficiently, which not only supports environmental sustainability but also reduces operational costs. The simultaneous implementation of Green Accounting and MFCA maximizes benefits for the environment, society, and corporate financial performance.

These findings highlight that the combination of Green Accounting and MFCA has a more significant impact on corporate sustainability. Green Accounting facilitates financial reporting and transparency regarding environmental activities, while MFCA enables companies to identify inefficiencies in resource utilization. By adopting both approaches concurrently, companies can develop a more comprehensive and effective sustainability strategy. Moreover, the combined application of Green Accounting and MFCA enhances corporate competitiveness at the global level. As environmental regulations become stricter and consumer awareness of sustainability increases, companies that adopt these practices will be better prepared for future business challenges. Additionally, this combination strengthens relationships with stakeholders, including investors, customers, and governments, who increasingly value socially and environmentally responsible business practices.

CONCLUSION

This study confirms that Green Accounting and MFCA significantly contribute to Sustainable Development in IDX-listed companies. Their integration not only enhances environmental accountability and resource efficiency but also supports long-term corporate value. To maximize impact, companies should strengthen management commitment, adopt supportive technologies, and implement these practices comprehensively.

Future research is encouraged to include Good Corporate Governance (GCG) as a moderating factor, considering the current model explains only 44% of sustainability outcomes. Practitioners, investors, and creditors may use these insights to guide sustainability strategies, assessments, and decision-making processes.

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