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Eco-Efficiency and Financial Performance: An Evidence from Indonesian Listed Company

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ABSTRACT
This study uses natural resource-based theory to provide empirical evidence regarding the effect of sustainability policies in the form of emission reductions on the financial performance of companies listed on the Indonesia Stock Exchange. The concept of eco-efficiency is measured using the emission intensity approach. This study uses a period of data panels from 2019 to 2021 to capture the effect of eco-efficiency on the company's financial performance. Using three accounting measures of financial performance in the research model: ROA, ROE, and ROS, to understand in more detail the impact of eco-efficiency on the company's financial performance. We find evidence that eco-efficiency has a positive impact on financial performance. This finding implies that the fewer GHG emissions the company produce, the higher the company's financial performance. This finding has implications as support for companies that emission reduction policies can positively affect the company's financial performance.

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INTRODUCTION

Recently, the business world has shown a growing interest in reducing pollution. Chicago Climate Change shows how companies, financial markets, and governments design strategies to mitigate climate change impacts together (Hoffman, 2005). Through continuous adaptation, the company seeks to meet the demands of public investors. This phenomenon shows a shift in the company's strategy on a commitment to environmental responsibility (Perez-Calderon et al., 2011). Fu, Wright, and Blazenko (2020) state that social goals are one of the goals investors achieve in addition to financial goals. Meanwhile, Ho, Li, and Gong (2021) found that responsible investment in emerging markets can bring investors portfolio returns.

The concept of eco-efficiency was first described by (Diebold & Schmidheiny, 1992) and widely published by (Schaltegger & Sturm, 1996) and the World Business Council for Sustainable Development (WBCSD). Since then, eco-efficiency has been accepted as a leading strategy topic in global business concerning commitment and sustainable development.

WBCSD (2000) describes eco-efficiency as "the achievement of competitively priced delivery of goods and services that meet human needs and improve the quality of life, while gradually reducing ecological impacts and resource intensity throughout the life cycle to levels at least in line with the estimated carrying capacity of the Earth."

According to Ehrenfeld (2008), eco-efficiency can be measured by the production value approach in two ways. The first approach is to use a ratio of several measures of economic value added to several measures of environmental impact: the higher this ratio, the more efficient the environment is the environmental performance. On the other hand, an inverse relationship, known as eco-intensity — a measure of the environment divided by economic value, with a lower indicator meaning better eco-efficiency — is also an acceptable measure.

The notion of eco-efficiency and its relationship to financial performance is a relatively new topic in developing countries, both in business and academia (Fernández-Viñé et al., 2010). In contrast, developed countries have focused on environmental public policies to maintain corporate value and improve market efficiency and business models (Al-Najjar & Anfimiadou, 2012; Bianchi et al., 2020; Perez-Calderon et al., 2011; Scarpellini et al., 2020).

In addition to being new, the idea of sustainability raises debate about whether the initiation of sustainability will impact company profits or value. On the one hand, a group believes that any attempt to improve social or environmental performance will reduce the company's profits. The general thought is that the company's cost to comply with such ethical standards will lead to higher product prices which will put the company at a disadvantage in the industry, leading to lower profitability (Walley dan Whitehead, 1994). Another group argues that social or environmental performance improvement strategies can increase the efficiency of a firm's output or even create a niche market (Porter dan Van Der Linde, 1995). They assert that better environmental performance will lead to the cost-effective use of organizational resources so that environmentally responsible businesses can report higher profits leading to increased value than less responsible companies.

Several studies provide mixed evidence for the relationship between eco-efficiency and profitability or firm value (Caiado et al., 2017; Guenster et al., 2011; Suh et al., 2014; Sudha, 2020; Sinkin et al., 2008; Al-Najjar & Anfimiadou, 2012; Broadstock, 2019; Czerny & Letmathe, 2017).

In general, research on eco-efficiency associated with environmental performance and economic performance of companies uses several different terminology and measures, both in measuring eco-efficiency and in measuring the economic-financial performance of companies. So this may be the cause of the different and inconsistent results. Therefore, this study will try to contribute to the eco-efficiency literature by using eco-efficiency measures in the context of the impact or impact on the environment from company operations which can be measured by energy, water, materials used, or emissions and waste generated (WBCSD, 2000).

This study uses greenhouse gas (GHG) emissions as a measure of eco-efficiency because this measure not only measures sustainability activities but is an independent objective and actual result based on the resources used by the company.

There are two reasons to justify GHG emissions as an eco-efficiency proxy. First, political and practical development focuses on the realization of the SDGs and the Paris Commitment with a focus on climate mitigation and supporting policies on carbon risk portfolios. This policy concentrates on reducing energy consumption and GHG emissions. Second, GHG, measured by the equivalent of carbon dioxide emissions, is a well-accepted and well-used operationalization in business research (Qian & Schaltegger, 2017).

Besides that, this study uses three accounting measures of financial performance in the research model: ROA, ROE, and ROS, to understand in more detail the impact of eco-efficiency on the company's financial performance. Furthermore, this study uses the specific characteristics of the company's leverage and company size as control variables. Firm size is a control variable because larger firms can exploit economies of scale and scope better than smaller firms (Mandal and Madheswaran, 2011). Leverage is part of the company's risk associated with debt. Many previous studies have proved leverage as a factor that affects profitability (Wagner, 2005; Elsayed dan Paton, 2005; Trumpp dan Guenther, 2015).

The originality of this study lies in providing empirical evidence of the economic effects of the eco-efficiency of companies listed on the Indonesia Stock Exchange. This research contributes to the ongoing debate on the relationship between eco-efficiency and financial performance through an environmental intensity approach; that is, evaluating whether energy consumption and a low ratio of CO2 emissions to production can improve a company's financial performance. This research also explains how environmental sustainability, measured by eco-efficiency, affects a company's financial performance. In addition, this study uses a period of three data panels from 2019 to 2021 to capture the effect of eco-efficiency on the company's financial performance.

Furthermore, this paper is organized into five parts. Part two presents the theoretical framework for eco-efficiency and reviews studies on the relationship between financial performance and eco-efficiency. Part three presents the data and methods. Finally, sections four and five present the esults and conclusions of the respective studies.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Eco-efficiency as a concept of environmental efficiency began to emerge in the 1970s. As an environmental factor, this concept renewed interest in the manufacturing sector in the 1990s. Environmental efficiency is extended to eco-efficiency as a business link for sustainable development (Schaltegger and Sturm 1990). Eco-efficiency is a concept beginning to be applied in academia and practice to assess environmental management and corporate responsibility (Hahn et al. 2010).

Efficiency generally refers to producing the maximum amount of output with the least amount of input. However, eco-efficiency in environmental management has a slightly different meaning; for example, carbon emissions are an undesirable output (Burritt et al., 2011). In this regard, the eco-efficiency theory proposed by Porter and van der Linde (1995) states that firms can maximize their efficiency by reducing costs and creating value while minimizing their environmental impact. Huppes and Ishikawa (2009) mention that eco-efficiency is a multidimensional concept related to context-specific analysis.

In addition, Huppes and Ishikawa (2009) show that eco-efficiency metrics have been used differently. There are four variable inversion sequences, and two approaches are used: first, the value of the production approach, which focuses on environmental intensity (environmental measure divided by economic measures) or environmental productivity (economic measures divided by environmental measures). The second is environmental improvement approaches, which focus on environmental cost-effectiveness (environmental measures divided by economic measures) or cost environmental improvements (economic measures divided by environmental measures). The eco-efficiency metric is the environmental intensity metric, namely environmental impact (CO2) per sale. A decrease in the ratio of CO2 to sales implies a lower environmental intensity of the company, in other words, an improvement in its eco-efficiency.

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Several studies have analyzed the relationship between eco-efficiency and financial performance in the last two decades and obtained different results. Some of these studies found that better financial performance is achieved when companies integrate eco-efficiency into their operations. Guenster et al. (2011) observe higher financial ratios in portfolio analysis when the eco-efficiency of US firms is presented. In addition, Pogutz and Russo (2011) show a positive relationship between environmental strategies by analyzing greenhouse gas (GHG) emissions and short-term financial performance for companies listed on the Global Fortune 500 Index.

On the other hand, other researchers argue that strategies and actions that improve environmental performance run counter to financial objectives because reducing emissions generates costs and diverts resources from other strategic investments (Lothe et al., 1999).

Choi, Han, and Lee (2020) conclude that positive environmental performance has a negative impact on stock price results and, in turn, on long-term financial returns and argues that investors consider environmental activities to be carried out at the cost of increasing future profits. Several studies have also shown mixed and inconsistent results in the literature. Busch and Friede (2018) found that although there is evidence for a positive relationship between environmental performance and firms' financial performance, it is still unclear whether pollution prevention affects firms' financial performance or whether high-performing firms can provide environmental benefits. In this regard, studies using a microfinance approach generally analyze the effect of eco-efficiency or other environmental measures on firms' financial performance. Financial performance measures in the form of accounting metrics, market metrics, or a combination of the two can be used.

Suh et al., 2014 examined 272 firms in 16 industries in South Korea. Results show that firms in product and service-intensive industries tend to have higher eco-efficiency scores than those in raw material or chemical-intensive industries. In addition, most industries reveal no relationship between traditional financial performance metrics and eco-efficiency scores.

Guenster et al. (2011) found that eco-efficiency relates positively to operating performance and market value. They use return on assets (ROA) which represents operating performance and profitability, and Tobin's q (Q), which proxies for a company's valuation.

Research by (Al-Najjar & Anfimiadou, 2012) investigates the link between eco-efficiency, environmental policy, and firm value in the United Kingdom (UK) for the period 1999 to 2008. This research reflects eco-efficiency as ISO 14001, an external environmental certification as the measure used by Sinkin et al. (2008). Al Najjar (2011) found that eco-efficient firms have higher market values than those lacking environmental strategies.

Sinkin et al. (2008) examine the proposition that adopting eco-efficient business strategies is associated with higher firm value. According to Sinkin, companies that adopt an eco-efficient business strategy can reduce costs and earn more profits. The market will appreciate this company more than similar companies that do not adopt an eco-efficient business strategy. Examining 431 firms, Sinkin found significant evidence that eco-efficient firms consistently have higher market values than a sample of non-eco-efficient firms.

Broadstock et al. (2018) examine the effect of company choice on environmental, social, and governance (ESG) strategic investment compliance on the company's level of eco-efficiency. Their findings show that adopting ESG choice of firms has a positive effect on the firm's level of eco-efficiency but only to a certain extent, after which the effect becomes negative.

Czerny and Letmathe (2017) examine the relationship between the focus of environmental strategies and proactive GHG reductions related to improving environmental performance and economic performance. Czerny and Letmathe (2017) did not find a significant direct relationship between environmental and economic performance.

According to (Hart, 1995), a firm's strategy and competitive advantage will be rooted in the capabilities that facilitate environmentally sustainable economic activity — a natural resource-based view of the firm (NRBV). The NRBV considers three key strategic capabilities: pollution prevention, product stewardship, and sustainable development. The NRBV also provides a theoretical mechanism by which links between environmental actions and profits can be established. The NRBV argues that the relationship between environmental

strategy and competitive advantage depends on the form of environmental improvement, as the mechanisms are very different for pollution prevention.

Based on the theory of natural resource-based view (NRBV), the company will achieve a sustainable competitive advantage by reducing the negative impact of the company's operations on the environment by using a proactive strategy toward the environment. Porter and Linde (1995) imply that environmental protection strategies can reduce costs such as raw materials and energy. Recent studies document that green product/process innovation reduces energy consumption and leads to competitive advantage and better organizational performance. The drivers of such innovation are big data, management commitment, green human resource management, and green transformational leadership (Huang & Li, 2017; Bhatia, 2021).

This study uses the emission intensity-based CEP metric that captures the results of a proactive environmental strategy, namely an environmental strategy based on pollution prevention. Proactive strategies result in reduced energy consumption and emissions and ultimately reduced spending on electricity and fuel. Thus, this strategy is expected to reduce costs and increase financial benefits while preserving the natural environment. Low eco-efficiency figures indicate that the company produces fewer emissions for each unit/monetary. For this reason, the following hypotheses were formulated for this study:

Hypothesis: Eco-efficiency positively affects the company's financial performance

One methodological problem often raised is the lack of consistency in operationalizing financial performance variables. The lack of uniformity in size is one reason for the inconsistent findings in the literature (Dixon-Fowler et al., 2013). Although competitive advantage resulting from reputational benefits from positive environmental performance, reduced risk perception, and meeting stakeholder needs can be reflected in market-based measures, according to (Busch & Friede, 2018) and (D. Z. X. Huang 2021), accounting measures may be better indicators of efficiency and organizational capability. Therefore, following this suggestion, this study uses accounting-based measures to measure a company's financial performance – namely, return on assets (ROA), return on sales (ROS), and return on equity (ROE). The advantage of using an accounting-based measure is that it captures management's effectiveness in asset utilization, plan implementation, and operations (Sudha, 2020). This study uses the three measures of company performance to strengthen the study's results and provide additional evidence of the effect of eco-efficiency on the company's financial performance.

RESEARCH METHODS

The research method explains the design of activities, scope or objects, main materials and tools, places, data collection techniques, operational definitions of research variables, and analysis techniques. [Times New Roman, 12, normal].

This study analyzes data for 2019 to 2021 with a sample of companies listed on the Indonesia Stock Exchange that have data related to eco-efficiency, namely emissions produced by companies. The research population is all companies listed on the Indonesia Stock Exchange for 2019 – 2021. This study excludes financial companies because financial companies have different characteristics from non-financial companies. Based on the availability of data related to eco-efficiency measurements, namely, emissions produced by companies, the study's final sample was 48 companies that consistently had the data in question. So in total, this study has 144 units of analysis. The following are the criteria for this research sample.

Table 1. Sample Criteria

Criteria	Unit
Companies that prepare Sustainability Reports	102
Companies that do not consistently prepare 2019-2020 sustainability reports	40
Companies with incomplete data	14
Sample Company	48

Furthermore, to test the hypothesis, the following model is formulated to examine the effect of Eco-efficiency on the company's financial performance (ROA, ROE, ROS).

$$CFPit = \alpha + \beta 0\, ECO1 + \beta 2SIZE + \beta 3LEV + \in$$

Regression will be carried out for each measure of the company's financial performance (ROA, ROE, and ROS) with independent and

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control variables ECO, SIZE, and LEV. Firm size and leverage are used as control variables in this study. Firm size is a significant control variable because larger firms may have greater resources for social investment, placing more significant pressure on firms to engage or not engage in socially responsible activities (Margolis et al., 2009). Many studies have consistently proven that company size and leverage are variables that affect the company's financial performance (Ali, et al., 2017; Andries & Stephan, 2019; Boussenna, 2020; Danso et al., 2020; Meutia, et al., 2021; Yusof et al., 2020).

The measurement of each variables can be seen in the following table:

Table 1. Research Variables

CODE	VARIABLE	MEASUREMENT
ROA	Return on Asset	Profit after taxes (PAT) scaled by total assets.
ROE	Return on Equity	PAT divided by paid-up equity share capital
ROS	Return on Sales	PAT divided by total sales
ECO	Emissions Intensity	Metric tons of CO2 emissions per year divided by sales (millions of rupiah)
SIZE	Firm size (Control Variable)	natural logarithm of total assets
LEV	Leverage (Control Variable)	total debt scaled by total assets

This study uses a panel data regression model –either the Least Squares Dummy Variable (LSDV) model or the Random Effects (RE) model. It is a cross-sectional time series with firm-level data covering three years from 2019 to 2011. LSDV is a form of fixed effect (FE) model. Hausman test is used to decide between the feasibility of using the FE or RE model and; the null hypothesis using the RE model. If Hausman's test is invalid, the Breusch-Pagan Lagrange Multiplier (BP-LM) test is used to decide between the simple combined OLS regression or the RE model. The mean-variance inflation factor (VIF) is 1.57, which is within the acceptable range (VIF < 5), implying that there is no multicollinearity in the research model.

RESULTS AND DISCUSSION

There are 144 samples from 9 sectors listed on the Indonesia Stock Exchange. More detailed data is in the following table:

Table 2. Sample by Sectors

No	Sectors	Sample	Percentage
1	Basic Materials	30	20,8%
2	Consumer Cyclicals	6	4,2%
3	Consumer Non-Cyclicals	24	16,7%
4	Energy	48	33,3%
5	Healthcare	6	4,2%
6	Industrials	12	8,3%
7	Infrastructure	9	6,3%
8	Property	6	4,2%
9	Transportation and Logistic	3	2,1%
	Total	144	100,0%

Table 2 shows the number of samples per sector in this study. Of the 144 samples of companies that compile sustainability reports, 33.3 percent came from the energy sector, followed by the basic materials sector with 20.8 percent and the consumer non-cyclical sector with 16.7 percent. The number of energy sectors that disclose data related to CO2 emissions indicates a better level of awareness in this sector in disclosing the emissions it produces. In several other sectors, such as transportation and logistics, health, and consumer cyclical, very few companies have or disclose data on the CO2 emissions they produce.

Table 3. Eco-Efficiency per sector

No	Sectors	Eco-Efficiency
1	Basic Materials	0,54128
2	Consumer Cyclicals	0,19665
3	Consumer Non-Cyclicals	0,15785
4	Energy	0,32868
5	Healthcare	0,00362
6	Industrials	0,03860
7	Infrastructure	0,15957
8	Property	15,23098*
9	Transportation and Logistic	0,00410

Table 3 above shows the average value of eco-efficiency by sector. The property sector has the highest emission eco-efficiency value compared to other sectors (15.23098). Meanwhile, the healthcare sector has the lowest eco-efficiency at 0.003624. This figure shows that per one million rupiahs of sales generated by companies in the health sector produce 0.003624 tons of CO2 emissions. Declining sales may influence the high number of

eco-efficiencies in the property sector during the COVID-19 pandemic. At the same time, the cost of using and maintaining offices remains high, which results in high energy use that produces emissions. On the other hand, the health sector is a sector whose sales increased significantly during the Covid-19 pandemic, showing low eco-efficiency.

In addition to the health sector, basic materials and energy are two sectors that produce relatively high emissions (0.54128 and 0.32868). The basic material is a group of companies that produce products that become raw materials for other companies. Included in this category are cement and mining companies. Meanwhile, the energy sector includes companies that sell products and services related to energy extraction, including non-renewable energy such as mining oil, natural gas, and coal, and companies that provide services to support these industries. These two sectors are considered more significant emitters than others (Liu et al., 2021; Shah et al., 2020; Changwichan et al., 2018).

Table 4. Descriptive Statistic

Statistic	ECO[1]	ROA[2]	ROE[3]	ROS[4]	DER[5]	Ln TA[6]
Mean	0,905	0,076	0,177	0,159	1,371	29,259
Std. Deviation	5,012	0,156	0,443	0,268	2,332	3,345
Skewness	8,338	7,682	6,211	2,187	7,594	-1,431
Kurtosis	73,783	74,250	47,047	29,963	72,856	1,921

Furthermore, Tables 5 - 7 show the regression estimation results using ROA, ROE, and ROS as dependent variables.

Table 5. Effect of Eco-efficiency on ROA

Dependent variable: ROA	LSDV model		Random effects model
Variables	1	2	3
ECO	-0,152***	-0.1461***	-0.052***
	(-6,19)	(-5,94)	(-5,13)
DER	-0.2240***	-0.2234***	-0.2243***
Ln TA	0,0008	0,0018	0.0027***
Hausman test statistic			0
Prob > χ2			1
BP-LM test statistic			
Prob > χ2			0
R2	0,4062	0,4207	0,3693
N	144	144	144

Note(s): (1) ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.10; (2) Robust t-values in parentheses in models 1 and 2. (3) Robust z-values in parentheses in model 3

Table 5 shows the perimeter estimation using ROA as the dependent variable. BP-LM statistical test shows that the more appropriate model is the random effect model. Based on the random effect model, eco-efficiency has a negative and significant effect on ROA at the 1 percent level. This finding means that a decrease of 1 unit in the eco-efficiency number (which indicates that the company produces fewer emissions) will increase the ROA by 0.052 units. Meanwhile, the DER variable shows a negative and significant effect on financial performance in contrast to Ln TA, which has a positive effect.

Table 6. Effect of Eco-efficiency on ROE

Dependent variable: ROE	LSDV model		Random effects model
Variables	1	2	3
ECO	-0,0078	-0.0081***	-0.009***
	-0,12		
DER	-0.1240***	-0.1234***	-0.114***
Ln TA	-0,0028	-0,0021	-0.0027***
Hausman test statistic			0
Prob> χ2		0	1
BP-LM test statistic			7,75
Prob> χ2			0,005
R2	0,1365	0,1472	0,1248
N	144	144	144

Note(s): (1) ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.10; (2) Robust t-values in parentheses in models 1 and 2. (3) Robust z-values in parentheses in model 3

Table 6 shows the regression results using ROE as the dependent variable. BP-LM statistics show that the RE model is suitable. The RE model proves that the ECO variable affects ROE negatively and significantly at the 1% level. It can be interpreted that a decrease of 1 unit of ECO (which indicates that the company produces lower emissions) will cause an average ROE to increase by 0.009. The two control variables, both AND and LnTA, have a negative effect on ROE, the opposite result when using ROA as the dependent variable.

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Table 7. Effect of Eco-efficiency on ROS

Dependent variable: ROS	LSDV model	Random effects model	
Variables	1	2	3
ECO	-0,152***	-0.1461***	-0.1175***
DER	-0.2240**	-0.2234**	-0.2243**
Ln TA	-0,0008	-0,0018	-0.0027**
Hausman test statistic			18,16
Prob> χ2			0,011
BP-LM test statistic			8,64
Prob> χ2			0,003
R2	0,09	0,1	0,065
N	144	144	144

Note(s): (1) ***p ≤ 0.01, **p ≤ 0.05, *p ≤ 0.10; (2) Robust t-values in parentheses in models 1 and 2. (3) Robust z-values in parentheses in model 3

Furthermore, table 7 reports the regression results using the ROS variable as the dependent variable. The FE model is appropriate because the Hausman test statistic shows a significant number. Based on the LSDV model, Eco-Efficiency negatively affects ROS at the 1% level. Figures in table 7 indicate that a decrease in Eco-efficiency (Emissions) of 1 unit will cause ROS to increase by 0.152. This analysis also proves that both DER and Total Assets have a negative effect on ROS.

This finding proves that in all cases, eco-efficiency (emissions intensity) positively impacts the company's financial performance as measured by the three measures (ROA, ROE, and ROS). This finding indicates that companies that produce less emissions in their operations can generate better profits. Thus the hypothesis in this study is proven. This finding is in line with (Porter and Linde, 1995; Guenster et al., 2011; Sinkin et al., 2008; Czerni, 2017). This study shows a consistent effect of eco-efficiency on the financial performance of companies with accounting measures and performance measurements with market measures. This confirms that the company's sustainability initiatives can improve management and market performance, as found by previous research.

In addition, these findings support the theory of the natural resource-based view (NRBV). The company will achieve a sustainable competitive advantage by reducing the negative impact of the company's operations on the environment by using a proactive strategy toward the environment. Besides increasing economic value, increasing eco-efficiency also reduces environmental impacts (Suh et al., 2014). The findings of this study support the statement by (Guenster et al., 2010) that managers need not worry too much that pro-environmental policies will conflict with the company's financial goals.

CONCLUSION

This study cannot be separated from several limitations, including the small sample of companies that disclose data on the emissions produced. Although many companies have prepared sustainability reports, not all companies disclose data on the emissions they produce.

Another limitation is that this study analyzes all companies without differentiating the company sector. Since there may be differences in the type and characteristics of companies by sector that can affect the company's sustainability policy, future research can identify eco-efficiency by sector of the company to get better results.

This research has very good implications for the business world, especially for those still hesitant to carry out sustainability initiatives in their operational activities. This study provides additional evidence that supports the theory of the natural resource-based view (NRBV). Companies will achieve a sustainable competitive advantage by reducing the negative impact of the company's operations on the environment by using a proactive strategy for the environment.

Further research can expand by measuring eco-efficiency not only based on emissions but also on other eco-efficiency indicators such as energy, raw materials, water, and waste generated so that a complete picture will be obtained regarding the impact of sustainability initiatives carried out by the company.

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