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Towards Low-Carbon Economy: How Does Indonesia's Industry Decarbonize its Assets

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ABSTRACT

Fixed assets are signs of a significant source of carbon emissions in intensive carbon sectors. This study aims to investigate the impact of asset structure and asset utilization efficiency on the carbon emissions reduction in high polluting industry in Indonesia. The study uses the high-polluting industries in Indonesia in the period 2018-2022, as the sample. Secondary data were collected from the company's annual and sustainability report from the company's website. To test the hypotheses, the study used logistic regression. The results show asset structure does not have a significant effect on carbon emissions reduction, however, asset utilization efficiency has a negative effect on carbon emissions reduction. This study's results highlight the critical need for the government and research organizations to define the carbon emissions capacity of various fixed assets. As a result, it is easier for high-carbon industries to implement more detailed carbon management strategies and maximize their carbon advantages.

1. INTRODUCTION

Climate change such as extreme weather that is occurring, is one of the consequences of global warming [1]. One of the most serious systemic threats that impacts not just businesses but also the future of the entire planet is climate change [2]. Increased greenhouse gas (GHG) emissions, such as methane (CH_4), nitrous oxide (N_{20}), carbon dioxide (CO_2), and other greenhouse gas emissions are the primary reason for climate change, this is due to the greenhouse effect [3, 4]. One of the reasons also causing climate change increase is carbon emissions from business operations [5].

From that issue, the Paris Agreement was born in December 2015, which was ratified by 195 nations and seeks to enhance the worldwide dedication to addressing the threat of climate change, aligning with the principles of the United Nations Framework Convention on Climate Change (UNFCCC) from 1992 and the Kyoto Protocol from 1997. Indonesia has implemented several international agreements through Presidential Regulation No. 98 Year 2021. This regulation confirms the Indonesian government's commitment to participation in mitigating carbon emissions to achieve sustainable development. In Chapter 4 Government Regulation No. 61 of the Year 2011, it is stated that businesses are also obligated to play an active role in efforts to reduce greenhouse gas emissions through the obligation to disclose carbon emissions.

From Figure 1, Indonesia ranks as the eighth biggest emitter of carbon globally and as the fourth largest emitter in Asia after China, India, and Japan [6]. According to a report from the Ministry of Energy and Mineral Resources (ESDM) in 2022, Indonesia succeeded in reducing carbon emissions by 91.5 million tons, in 2021, 70 million tons, 2020 64.4 million tons, 2019 54.8 million tons, and in 2018 reduced by 40.6 million tons [7]. Shows that from the period 2018-2022, Indonesia has decreased its carbon emissions. Sustainable growth at both corporate and national levels is placing greater emphasis on environmental accountability [8].

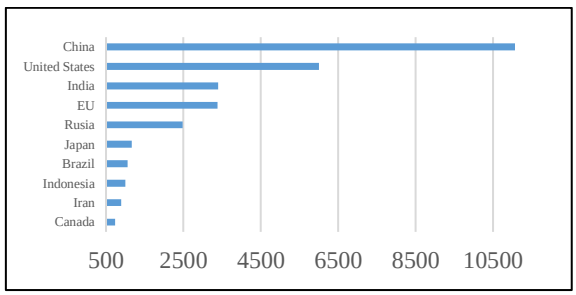

Figure 1. Top 10 countries contributing to the highest carbon emissions (mtCO2e)

Reducing corporate carbon emissions has become a key requirement for green companies in Indonesia as the low-carbon economy grows. Therefore, more research into carbon emissions reduction is required to highlight the benefits of carbon emissions mitigation. Stakeholder theory encompasses instrumental stakeholder theory, emphasizing that strong relationships between companies and critical stakeholders, like environmentally friendly initiatives impacting financial outcomes, result in market achievements and ultimately boost financial success [9, 10]. Stakeholder attention regarding high

carbon emissions encouraged companies to disclose companies to reveal their carbon emissions and performance [11]. The regulation of climate regulations and changes in the behavior of environmentally concerned stakeholders have made greenhouse gas emissions a more prominent risk for companies, especially with many companies moving towards a low-carbon emissions economy. Climate regulations and the pressure placed on companies by stakeholders to address greenhouse gas emissions can impact company performance, this can influence the extent to which a company can achieve its goal of maximizing company value by improving company performance [12]. Companies that achieve good financial performance have more financial capability to make decisions regarding environmental issues, including regarding disclosure of environmental activities [13]. Therefore, companies with financial stability tend to be active in mitigating carbon emissions and increasing the disclosure of greenhouse gas emissions [14].

The long-term goal of reducing carbon emissions is intricately linked to companies' endeavors to advance. As low-carbon regulations like carbon taxes, carbon quotas, and green investments are put into practice, the effects on the company's asset structure become apparent [15]. Analyzing the structure of a company's assets is beneficial for understanding how the company's financial performance is related to carbon emissions performance [16]. The operational capabilities of the company represent asset utilization efficiency, which can drive improved business planning and management, ultimately leading to higher profitability and business performance [17, 18]. Research indicates that businesses with a higher fixed asset ratio tend to have poorer carbon emissions performance. This is because companies with significant carbon emissions typically have a comparatively high proportion of fixed assets. Moreover, significant investments in fixed assets can worsen carbon emissions [19]. The main factor that causes bad carbon emissions caused by fixed assets is the added value of the industry, and the most vital factor that worsens carbon emissions is fixed asset investment because industrial activities are accompanied by large-scale fixed asset investment, it will exacerbate carbon emissions and it is important to consider the impact of carbon emissions [20]; the lower the level of asset utilization efficiency, the higher the impact on carbon emissions [21, 22]. As a result, the connection between asset utilization efficiency has the potential to affect carbon emissions and could lead to a decrease in the amount of carbon emissions being produced.

This research focuses on high-polluting industrial companies because this sector has high environmental risks, so this sector tends to have to disclose carbon emissions resulting from its business operational processes. This can improve the company's image regarding the company's environmental awareness and with an observation period between 2018 to 2022. Based on SAL POJK Number 51/POJK.03/2017 regulates the Implementation of Sustainable Finance for Financial Services Institutions, and public companies, these companies are required to prepare a sustainability report. This obligation was planned to be implemented in 2020 [23]. However, due to COVID-19, the implementation was delayed one year in 2021, but not all companies implemented the sustainability report, in 2022, 88% of companies in Indonesia implemented the sustainability report [24]. Given this, this study uses the observation period of 2018-2022, that all sampled companies are still in the same regulation environment.

In carrying out its business activities, the industry also needs to manage its assets so that it can generate profits for its business. Asset structure is a resource or wealth owned by a company to carry out its operations [25], and asset utilization efficiency is used to measure and see how efficiently a company can use its assets to generate income and reduce costs. This research uses high-polluting industry sectors for the sample since industries have high risk to the environment. An increase in asset structure causes an increase in energy consumption which causes an increase in carbon emissions [26]. The higher the fixed assets, the higher the carbon emissions caused by high business activity. However, the higher the sales, the more efficient a company will be in carrying out its operations.

This paper delves into the factors that impact the reduction of carbon emissions in high-polluting industries, focusing on asset structure and asset utilization efficiency. It also suggests implications for how enterprises in high-polluting industries can manage carbon emissions. The paper emphasizes the need for the government and research institutions to explain the carbon emissions associated with fixed assets and sales. The research aims to raise awareness among the government and the high-polluting sector in Indonesia regarding carbon emissions and to provide insights into how asset structure and asset utilization efficiency can influence the reduction of carbon emissions.

The following sections outline the paper's progression: To begin, study hypotheses were formulated following a review of relevant literature. Subsequently, the research methodology, encompassing empirical data collection, variables, model design, as well as empirical outcomes and findings, is addressed. Lastly, we analyze our findings within the context of the theoretical frameworks utilized, highlighting their contributions, limitations, and implications for further research.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Carbon emissions reduction and the influencing factors

Human activities, including transportation, construction, power generating industry, and daily living, contribute to carbon emissions [27]. Economic growth primarily drives CO_2 emissions, prompting efforts to decrease energy intensity to mitigate these emissions [28]. Reducing carbon emissions can unveil process optimization avenues, cutting energy, material, and transportation expenses [29]. This underscores the significance of reducing emissions in the industry to achieve sustainability [30]. Carbon emissions rise due to higher fuel oil consumption [4]. Total energy, primary coal, and petroleum consumption exhibit statistically significant positive correlations with carbon emissions in the short term [31]. Rai et al. [32] analyzed the relationships between CO2 emissions, energy consumption (EC), foreign direct investment (FDI), gross domestic product (GDP), and openness of the economy in India from 1978 to 2014. The result is a there is a two-way causal relationship over a long period of time between CO2 emissions and the openness of the economy.

The financial performance experiences a significant and positive impact due to the decrease in greenhouse gas emissions [33]. The correlation between company finances and greenhouse gas (GHG) emissions is n positively

significant, demonstrated by the statistical importance of GHG emissions factors in influencing a company's Tobin's q. Higher Tobin's q values often correspond to increased GHG emissions in different industrial sectors [15]. Reducing the emission of carbon has a notable beneficial impact on cost savings and asset investment, this reduction can lead to sustainable cost reductions. Whereas cost-saving initiatives often result in long-term carbon emissions, additional investments in green initiatives promote carbon emissions reduction [15]. Investors consider carbon performance and environmental performance when making investment decisions that impact market value [34]. National governments can also have an impact on reducing carbon emissions. Effective pollution management is crucially influenced by the central government, while country and local governments have a limited effect on carbon emissions reduction [35].

2.2 Asset structure

The rise in asset structure, as indicated by the ratio of fixed assets to total assets with a high proportion of fixed assets, leads to higher energy consumption, resulting in increased carbon emissions [26]. The company is focused on ramping up production activities without completely acknowledging the adverse consequences of emissions and pollution on the environment [36]. Strong relationships between companies and stakeholders for environmentally friendly initiatives will encourage companies to discover their carbon emissions and performance to reduce carbon emissions [9, 11]. Girerd-Potin et al. [37] divide stakeholders into three groups, (1) business stakeholders consisting of employees, customers, and suppliers, (2) societal stakeholders consisting of the environment and society, and (3) financial stakeholders consisting of shareholders and debt holders. In terms of financial stakeholders [37], of course, the financial stakeholders want high profits achieved by the company, and this creates pressure for the company from these financial stakeholders.

Some studies have found the variation in asset structure. The composition of working capital in the total assets of a company is known as asset structure, indicating liquidity, profitability, and solvency [38]. Capital structure is significantly formed by profitability, liquidity, and asset structure [39]. The asset structure negatively impacts the carbon emissions performance in the low-carbon industry [16]. Asset structure significantly positively influences carbon emissions, when the asset structure increases, energy consumption rises, leading to a corresponding increase in carbon emissions [26]. In reverse outsourcing on manufacturing industries toward green technological progress, fixed assets have a negative impact on green technological progress, indicating that companies continue to prioritize resource consumption for production without adequately considering the adverse environmental effect of emissions [36].

An elevated asset structure leads to higher carbon emissions, effectively diminishing the reduction of carbon emissions. Wang and Song [36] and Huang and Yang [40] conducted research supporting the idea of a negative correlation between asset structure and carbon emission reduction. Based on this, our hypothesis is that:

H_1: Asset structure has a negative effect on carbon emission reduction.

2.3 Asset utilization efficiency

The efficiency of asset utilization plays a role in how efficient the company's asset management is. The better a business is in control of its assets, the more productive the use of these assets will become, resulting in higher sales and greater profits, ultimately raising the company's value [41]. The total asset turnover ratio serves as a measure of asset utilization efficiency. A higher total asset turnover ratio indicates that the company is more efficient at managing its assets, resulting in increased sales and higher profits for the company [42].

The most valuable unit of analysis in business is the relationship between stakeholders and how these relationships relate to each other [43]. The total asset turnover ratio increases as sales increase, indicating greater efficiency in managing the company's assets. Concurrent when the great efficiency, the financial stakeholders will benefit from increased sales. At a high level of company efficiency, this condition certainly increases the carbon emissions produced by its business activities. Because company assets carry out their operations with high efficiency, which results in increased carbon emissions and a decrease in the level of carbon emissions reduction.

Some studies have established the variation in asset utilization efficiency on firm size has a positive significance, but on capital structure has a negative significance, this research shows that asset utilization efficiency can enhance company value, and the company's capital structure can amplify the impact of asset utilization efficiency [44]. The asset utilization efficiency has a negative impact on financial fragility [45]. Besides the studies that impact asset utilization efficiency on a company's finances, asset utilization efficiency can also be influenced by managerial ownership or family ownership. For example, the impact of sole family ownership on asset utilization efficiency exhibits a significant positive, which endorses the perspective that equity conflicts diminish in the presence of controlling family ownership [46]. The study findings indicate a significant negative correlation between managerial share ownership and asset utilization efficiency [47].

By analyzing the above literature, we can see that many studies use disparate topics to emphasize the role of asset utilization efficiency in business operations. High sales cause total asset turnover to increase, the company tries to increase its production to meet demand for its products. Therefore, companies use high energy consumption which will outcome in an increase in the amount of carbon emissions produced. This is supported by research conducted by Dan et al. [16] that the higher the efficiency of asset utilization, the higher the carbon emissions and the worse the carbon emissions reduction will be. Given this, we hypothesized that:

H_2: Asset utilization efficiency has a negative effect on carbon emission reduction

2.4 Control variables

The control variables in this study are profitability, firm size, and equity concentration. Characteristics of a company such as profitability, firm size, and equity concentration also affect the company's concern for environmental problems that occur. Profitability shows the level of success of the company in generating profits. Companies that generate high profitability can provide adequate resources to cover the costs

of environmental disclosure, conversely, companies with low profitability tend to focus more on achieving the company's financial goals [48].

Firm size is associated with the total assets of the company which describes the company's resources. Firm size also moderates customer integration, business performance, and operational performance which reflect the company's capabilities [47]. Research conducted by Clarkson et al. [48] using a sample from a database of companies that comply with the Global Reporting Initiative (GRI), found that firm size has a positive value in sustainability inclusion. Greater sustainability values can be found in larger companies that tend to include more environmental metrics in their annual reports. Large companies also have more resources and tend to invest more in various forms of environmental disclosure, such as social and environmental accounting systems, fair trade certification, better working conditions, and attracting stakeholders who care about the environment.

Equity structure is an important issue in modern corporate governance, and a reasonable equity structure can improve the efficiency of resource allocation, reduce the risk of corporate operations, and balance the relationship of interests between different economic entities. The proportion of equity held by shareholders varies, making the company show a concentrated or decentralized equity state [49]. If equity concentration is relatively high, it means that the company's equity is concentrated in companies with a small number but large shareholders, if equity concentration is low, it means that equity is relatively balanced [49]. Equity concentration can be shown by the ratio of shareholders to the largest shareholder and the total of the top five shareholders [16]. The operation of a company certainly gets capital from shareholders, this can be used to support carbon emission reduction by replacing the company's production machines.

3. RESEARCH METHODOLOGY

3.1 Sample and data

The data for this research is based on secondary sources and comes from high-polluting industries in Indonesia that are listed on the Indonesian Stock Exchange between 2018 and 2022. The sample selection utilized the purposive sampling method, which involves choosing samples based on specific criteria. These criteria include: (1) firms in industrial sectors associated with environmental pollution such as pulp and paper, chemicals, oil and gas, metals and mining, and utilities, as defined by Clarkson et al. [48]; (2) firms that have published annual reports and sustainability reports from 2018 to 2022; and (3) the availability of research variables in the sustainability report and annual report which are to be investigated.

In the high-polluting industry, there were 200 companies initially. After reviewing the companies' websites, annual and sustainability reports for the 2018-2022 period were published by 148 companies. Out of these, 128 companies did not disclose complete data on research variables. Additionally, one company's 2018 report also lacked complete data on research variables. Consequently, the study included 99 observations (Table 1).

Based on SAL POJK Number 51/POJK.03/2017 concerning the Implementation of Sustainable Finance for Financial Services Institutions, Issuers, and Public Companies to realize a national economy that develops stably, inclusively, and sustainably with the aim of reducing socio-economic disparities, mitigating and avoiding environmental damage, maintaining biodiversity, and increasing energy and natural resource efficiency. The implementation of sustainable finance principles is also a real form of Indonesia's commitment to the international world by mitigating and adapting to climate change. In Article 2 of SAL POJK Number 51/POJK.03/2017 Financial Services Institutions (LJK), issuers, and public companies are required to implement Sustainable Finance in their business activities and in Article 10 paragraph 1 Financial Services Institutions (LJK), issuers, and public companies are required to prepare sustainability reports. From these regulations, the observation period used in 2018-2022 for this research because there are already regulations that require companies to prepare sustainability reports.

Table 1. Sample selection process

Criteria	Total
Pulp and paper Indonesian companies from 2018-2022	10
Chemicals	20
Oil and gas Indonesian companies from 2018-2022	15
Metals and mining Indonesian companies from 2018-2022	56
Utilities Indonesian companies from 2018-2022	99
Total companies in the polluting sector companies based on Clarkson et al. [48]	200
The companies that do not publish sustainability reports from 2018-2022	(52)
The companies that do not have complete carbon emissions data regarding research variables	(128)
Total samples	20
Total observation (20 × 5 years)	100
Unpublished one-year data sample on the annual report	(1)
Data observation	99

3.2 Variable measurements

The dependent variable of this study is carbon emission reduction (CER), which is measured by considering company size comprehensively, this study uses coding as an indicator of carbon emissions reduction. The first calculation for carbon emissions reduction uses the formula: Scope 1+2 in year t divided by total asset in year t minus scope 1+2 in year t-1 divided by total asset in year t-1. After this initial calculation, the results are used for the coding. If the result is positive (i.e., emissions increase) the score is 1; if the change is negative (i.e., emission decrease), the score is 0. The formula for the dependent variable is below:

$$CER = \frac{(scope1+2)t}{(tatal\ asset)t} - \frac{(scope1+2)t-1}{(tatal\ asset)t-1} \quad (1)$$

In this study, there are two variables that are independent: Asset Structure (AS) and Asset Utilization Efficiency (AUE). The fixed asset ratio is used to measure AS, considering both direct and indirect carbon emissions from fixed assets are a significant source of emissions for organizations, the fixed asset ratio is of significant relevance in measuring their carbon emissions capability [16]. The formula for the AS is below:

$$FAR = \frac{Fixed\ Asset}{Total\ Asset} \quad (2)$$

The total asset turnover ratio is used to calculate AUE. Asset utilization efficiency refers to management's capability to enhance revenue generated from investments in income-producing assets [45]. Thus, the total asset turnover ratio is a key indicator for assessing the asset utilization efficiency. The formula for AUE is below:

$$Tatr = \frac{Sales}{Total\ Asset} \quad (3)$$

This study also includes Profitability (P), Firm Size (FS), and Equity Concentration (EC_Most and EC_Top5). Profitability is measured by Return on Asset (ROA), and Firm Size (FS) is measured by high polluting industries company's total assets. Assessing the equity structure's significant effect on a company's financial performance makes equity concentration (EC) an important indicator [49]. Measuring equity concentration uses the two proxies, EC_Most for the first largest ownership and EC_Top5 for the top 5 largest ownership.

In order to examine the hypotheses of this research, logistic regression was utilized and the following equation was formulated:

$$CER_{it} = \beta_0 + \beta_1 AS_{it} + \beta_2 AEU_{it} + \beta_3 P_{it} + \beta_4 FS_{it} + \beta_5 EC\_Most_{it} + \beta_6 EC\_Top5_{it} + \varepsilon_{it}$$

where, CER=Carbon emissions reduction high polluting industry in the period 2018-2022; AS=Asset Structure; AUE=Asset Utilization Efficiency; P=Profitability; FS=Firm Size; EC_Most=Equity Concentration (the first largest ownership); EC_Top5=Equity Concentration (the top 5 largest ownership); ε_{it}=Error.

The use of logistic regression requires that the dependent variable is conducted dichotomy, which is a dummy score. The method of logistic regression tests the potential for predicting the dependent variable using the independent variable [50]. The independent variable in logistic regression analysis does not need to follow a normal distribution [50]. As a result, conducting normality tests, heteroscedasticity tests, or autocorrelation tests on the independent variables is unnecessary for logistic regression analysis. Rather, the test assumptions for logistic regression comprise overall model fit, goodness of fit test, nagelkerke R square, and classification matrix.

3.2.1 Overall model fit

Overall model fit is used to determine whether all independent variables in the study affect the dependent variable. The statistic used is Likelihood. Likelihood L is the probability that the hypothesized model describes the input data [50]. To test the null hypothesis and alternative hypothesis, L is transformed into -2 Log Likelihood. This test is carried out in the next step. If the value of -2 Log Likelihood Block Number = 0 is greater than the value of -2 Log Likelihood Block Number = 1, then the decrease indicates a better regression model [50].

3.2.2 Goodness of fit test

The goodness of fit test was assessed using Hosmer and Lemeshow's which was measured by the chi-square value. This model was used to test the null hypothesis whether the empirical data was in accordance with the model, meaning that there was no difference between the model and the data so that the model could be said to be fit [50].

3.2.3 Nagelkerke R square

The Nagelkerke R Square value which is close to zero indicates that the ability of the independent variables to explain the dependent variable is very limited, whereas if the Nagelkerke R Square value is close to one, it indicates that the independent variables are able to provide all the information needed to predict the variability of the dependent variable [50].

3.2.4 Classification matrix

The classification matrix is used to determine the accuracy of the prediction, namely how well the regression model can group cases [50].

4. RESULT AND DISCUSSION

4.1 Frequency table and descriptive statistics

Table 2 delivers the summary of the frequency table consisting of frequency, percent, valid percent, and cumulative percent value for dependent variables in this study. As defined for the carbon emissions reduction variable, the company proxied the dependent variable of carbon emission reduction by using carbon emission data and total assets. The variable was determined by dividing carbon emissions in year t by total assets in year 1 and subtracting the result from carbon emissions in year t-1 divided by total assets in year t-1. Following this calculation, CER coding was employed, assigning a score of 1 for positive outcomes (carbon emissions increasing every year) and a score of 0 for negative outcomes (carbon emissions decreasing every year). A score of 0 for carbon emission reduction signifies effective reduction, whereas a score of 1 indicates unsuccessful reduction with an increase in carbon emissions each year.

Table 2. Frequency table carbon emissions reduction

	Frequency	Percent	Valid Percent	Cumulative Percent
Negative	77	77.8	77.8	77.8
Positive	22	22.2	22.2	100.0
Total	99	100.0	100.0	

Based on the results of the frequency table in Table 2, the negative score was 77 out of 99 samples (77.8%) while the positive score was 22 out of 99 samples (22.2%). These results show that 77.8% of the sample has reduced carbon emissions originating from its business activities, while 22.2% of the sample has not been able to reduce carbon emissions caused by the company.

Table 3. Descriptive statistics

Variables	N	Min	Max	Mean	Std. Dev.
AS	99	0.00	0.87	0.40778	0.284051
AUE	99	0.10	3.85	0.6508	0.58591
P	99	-0.580	0.600	-0.0512	0.1123
Total Asset (in Trillion Rupiah)	99	0.8	15.143.200	3.959.381	3.546.477
EC_Most	99	0.200	0.910	0.5675	0.17462
EC_Top5	99	0.340	1.00	0.8030	0.1695

The summary of descriptive statistics in Table 3 includes minimum, maximum, mean, and standard deviation values for the independent and control variables in this study.

The average fixed asset ratio, for the variable AS listed on the Indonesia Stock Exchange is industrial companies with high levels of pollution for the period from 2018 to 2022, the average is 0.40778 or 40.78%, which shows that the company applies its fixed assets for 40.78% of the total per year from total assets. The average TATR, for the variable AUE listed on the Indonesia Stock Exchange is industrial companies with high levels of pollution for the period from 2018 to 2022 is an average of 0.6506 or 65.08% which shows that the company can effectively utilize the assets it owns, this average value means that Every Rp. 1 of assets owned by a company can generate sales for the company of Rp. 0.6506.

The control variables show that Return on Assets (ROA), which is a proxy for Profitability (P), has a positive average of 0.0512. Lestari and Sugiharto [51] revealed that the ROA value obtained by a company can be said to be good if the percentage is more than 0.02 or 2%. It can be concluded that the average company in the polluting industry sector has a good ROA, and has a good ability to utilize its assets to gain profit. The FS, the maximum value of total assets in trillion rupiah, which is greater than the average value indicates that the total assets of the high-polluting industry for the 2018-2022 period are relatively large. Ownership of assets of high-polluting companies is large because these companies include large companies such as private and state-owned companies. Equity concentration shows that the higher the ratio obtained, the greater the shareholders who invest in a company and can measure the share ownership structure and stability of a company [16]. The mean value is 0.5675 and the standard deviation value is 0.174615 for EC_Most, and for the EC_Top5 mean value is 0.8030 and the standard deviation value is 0.16953, which shows the mean value is greater than the standard deviation value means the share ownership structure which can be seen from the EC_Most and EC_Top5 shows a share ownership structure of more than 50% and shows the condition a stable company as seen from the investment of shareholders who invest more than 50% in high-polluting industrial companies.

4.2 Regression result

In this section, we present the findings of the logistic regression and engage in discussions about our hypotheses. The results indicate the t-statistic with a significance level of 0.05.

Table 4. Classification matrix

			Prediction		
	Observed		Carbon Emissions Reduction		Percentage Correct
			Negative	Positive	
Step 0	Carbon Emission Reduction	Negative	77	0	100.0
		Positive	22	0	0
	Overall Percentage				77.8

Based on the test results shown in Table 4, it appears that the number of samples that experienced a reduction in carbon emissions was 77 samples, while the number of samples that experienced increased carbon emissions was 22 samples. Thus, the results provide an overall percentage value of 77.8%, which means that the accuracy of this research model is 77.8%.

According to Table 5, before adding the independent variable, the overall model fit -2 Log Likelihood value stands at 104.882. while it decreases to 84.375 after including the two independent variables. The reduction in the -2 Log Likelihood value indicates that the regression model, which encompasses all independent variables is superior, or it can be inferred that the hypothesized model is a good fit for the data.

The Hosmer and Lemeshow Test output shows a significant value of 0.524, which exceeds the probability of 0.05. As a result, we can't reject the null hypothesis, indicating no significant difference between the predicted classification and the observed classification. With 95% confidence, we can assert that the regression model effectively explains the data and the relationship between the two variables.

The Nagelkerke R Square value is 0.286, which equates to 28.6%. This indicates that the variables included in this study account for 28.6% of the explanation for carbon emissions reduction. The remaining 71.4% of the explanation is attributed to variables not addressed in this study.

Table 5. Logistic regression results

Dependent Variable: CER	B	Std. Error	Sig.
AS	-1.649	1.109	0.137
AUE	-1.489	0.685	0.030
P	-2.363	2.840	0.406
FS	-0.076	0.056	0.174
EC_Most	5.451	2.519	0.030
EC_Top5	-8.293	2.746	0.003
F-stat	0.002		
Overall Model Fit:			
Block 0	104.882		
Block 1	84.375		
Nagelkerke R Square	28.6%		
Hosmer and Lemeshow Test	0.524		

The results show that the significant value of AS measured by fixed asset ratio is 0.137 and the coefficient value is -1.649. It means asset structure does not affect carbon emissions reduction. The AS will not affect the carbon emissions reduction. This result is inconsistent with Wang and Song [36] and Huang and Yang [40], which found a negative significant relationship between asset structure and carbon emissions reduction. Therefore, the first hypothesis is rejected.

AUE is measured by the total asset turnover ratio, which is the second independent variable. According to the regression results, the significant value is 0.030 and the coefficient value is -1.489 which is negative, indicating that there is a negative relationship between asset utilization efficiency and carbon emissions reduction. The higher asset utilization efficiency will affect lower carbon emissions. This result is consistent with Dan et al. [16]; therefore, this result is aligned with the second hypothesis.

For control variables, we found P regression result for significant value is 0.406 and the coefficient value is -2.363. FS regression result for significant value is 0.174 and the coefficient result is -0.076, we can conclude that P and FS do not affect carbon emission reduction same as the AS result. However, EC_Most and EC_Top5 with significant value

results are 0.030 and 0.003, and the coefficient results are 5.451 and -8.293. Form that results EC_Most has a significant relationship with carbon emissions reduction, while EC_Top5 has a negative relationship result same as the AUE result that has a negative relationship with carbon emission reduction.

4.3 Discussions

4.3.1 Asset structure on carbon emissions reduction

The results acquired indicate that the study does not support the original hypothesis claiming that asset structure has a significant negative impact on reducing carbon emissions. Even though sustainability disclosures in companies have shown that all companies in this sample realize the importance of carbon emissions disclosure, in reality, companies are still unable to reduce carbon emissions. Asset structure does not have a significant effect on carbon emissions reduction, meaning that changes that occur in the asset structure, whether decreasing or increasing, do not have a strong impact on carbon emissions reduction.

This shows that if the asset structure increases, carbon emissions reduction decreases or increases, which means it does not affect carbon emissions reduction activities. Having a negative effect means that asset structure is inversely proportional to carbon emissions reduction, while asset structure does not have a significant impact on carbon emissions reduction because carbon emissions reduction is not only influenced by assets but also internal factors such as management or stakeholders.

The findings of this study do not align with the research carried out by Wang and Song [36], as well as Huang and Yang [40] which stated that there is a negative impact of asset structure on carbon emissions reduction. This means that companies that have a high fixed asset ratio will produce high carbon emissions which will reduce carbon emissions reduction. However, this research produces an asset structure that does not have a significant impact on carbon emissions reduction, meaning that if the condition of the asset structure goes up or down, it will not significantly affect carbon emissions reduction.

4.3.2 Asset utilization efficiency on carbon emissions reduction

Asset utilization efficiency on carbon emissions reduction has a significant negative impact on carbon emissions reduction in high-polluting industries listed on the Indonesia Stock Exchange in 2018 - 2022. The total asset turnover ratio can be seen as an indication that higher sales and increased asset efficiency go hand in hand. Businesses that contribute to high energy consumption may also lead to an increase in carbon emissions. This is related to research conducted by Dan et al. [16], shows that the higher the efficiency of asset utilization in a company, the worse the carbon emissions performance. Companies that have high sales result in efficiency in their assets and also may produce high carbon emissions. High sales of fixed assets can increase the profits enjoyed by financial stakeholders, for the investors and creditors. Financial stakeholders tend to only pay attention to profits for shareholder dividends loan returns and interest payments for creditors.

As demand for products or services increases, product or service sales increase, resulting in increased efficiency of a company's assets. The rise in product demand leads to an increase in production capacity, referred to as the scale effect. However, this also means that greater efficiency of a company's assets negatively impacts the reduction of carbon emissions. Essentially, increasing demand results in higher production capacity, leading to increased energy consumption from carbon-producing machines or those that are not yet environmentally friendly. This is related to carbon lock-in, where a carbon-based technology has been locked into fossil energy because of the dependency formed due to interactions with technological systems and regulatory institutions, thus strengthening carbon lock-in. Carbon technology has been locked in by fossil energy and produces high profits, so stakeholders or regulatory institutions will develop high-carbon technology and form a Techno-Institutional Complex (TIC). The above TIC outlines that carbon lock-in happens when technological systems and regulatory institutions interact in combination [52]. Demands from financial stakeholders regarding high profits generated by companies require companies to continue to make high sales which continue to generate profits for financial stakeholders which results in increased carbon emissions because energy consumption increases and also due to the use of assets that are not yet environmentally friendly.

Efforts to reduce carbon emissions will increase production costs and weaken the company's competitiveness [53]. This will cause companies to be competitive and companies that do not comply with carbon emissions policies are referred to as carbon leakage [54, 55]. The threat of carbon leakage and its impact on the economy and environment is because most of a country's economy comes from industrial activities. The state must be firm about carbon emissions that cause climate change. The state can create policies such as a carbon tax to overcome the problem of carbon emissions produced by business activities. Introducing a carbon tax has become a compelling policy option to protect environmental health while transitioning to a green economy and achieving sustainable economic growth [56].

5. CONCLUSIONS

The study investigates the variables impacting the reduction of carbon emissions in heavily polluting industrial firms in Indonesia. According to the data analysis, it is determined that the asset structure does not significant impact on the reduction of carbon emissions, whereas the efficiency of asset utilization has a significant negative impact on carbon emissions reduction. This implies that the greater the efficiency of the company, the higher the level of sales, leading to an increase in the production of carbon emissions [57, 58].

This study is conducted in the Indonesian context, and the results may reflect carbon emissions reduction in Indonesia. Future research can be conducted in a broader context such as ASEAN or ASIAN or worldwide, to gain wider insight and generalization. This study contributes to the literature on the impact of resource allocation preferences on carbon emissions reduction, specifically in high-polluting industries. In practical terms, this study also extends our understanding of how asset structure and asset utilization efficiency may be used to design tools for mitigating carbon emissions.

The limitations of this study can be identified as companies' carbon disclosures are drawn from companies' sustainability reports which are voluntary disclosures; therefore, the data reliability is questionable. In addition, some public companies in Indonesia do not prepare and publish sustainability reports.

This may reduce the number of observations. The lack of previous research journals that directly discuss the influence and the measure used of asset structure and asset utilization efficiency on carbon emission reduction will be a gap in this study. As a result, there are few previous studies collected in this study that are related to the relationship between the influence of asset structure and asset utilization efficiency on carbon emission reduction. The sample in this study is not limited to companies that have implemented ISO 14000. So this sample is still general and not too detailed. The limitation for the time period chosen (2018-2022) is not all the companies already attached carbon emissions in the time period because regarding from the regulation in 2017 that requires companies to prepare sustainability reports.

For further research add more sample sizes and classify them according to the industry sector in Indonesia or those listed on the Indonesia Stock Exchange (IDX) that have adopted low carbon practices in order to achieve more accurate results depicting the overall carbon emissions reduction in Indonesian companies. The sample sizes for further research can also add the companies that have implemented the ISO 14000 for more detail. Analyze the differences or similarities in factors influencing carbon emissions reduction in various countries through a comparative study. The utilization of fixed assets involves categorizing variables into assets for waste processing. This is due to a government of Indonesia initiative mandating the construction of smelters for mining companies, which was initiated in 2012.

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