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GREENHOUSE GAS EMISSION AND FINANCIAL PERFORMANCE OF PUBLICLY LISTED MANUFACTURING COMPANIES IN NIGERIA

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Abstract

This study investigated the effect of greenhouse gas emission on financial performance of publicly listed manufacturing companies in Nigeria using panel data from 2014 to 2023. Ex-post facto research design was used and descriptive statistics (mean, median, minimum, maximum values and Pearson correlation) and inferential statistics (random effect model) were employed. The variables of interests include financial performance (measured by return on assets) and greenhouse gas emission variables (material usage, energy emission and water usage). The random effect model revealed that material usage has a significant negative effect on return on asset, indicating that higher material sustainability efforts may reduce short-term profitability. Conversely, water usage and energy emissionhad significant positive effects on return on asset, suggesting that efficient water management and energy emission enhance financial performance of publicly listed manufacturing companies in Nigeria. The study recommends amongst others that With WUE positively impacting ROA, firms should intensify efforts to adopt water-efficient technologies and conservation practices. Policymakers and environmental regulators should support and incentivize water management initiatives within the manufacturing sector.

Keyword: *Greenhouse gas emission, Water usage, Energy emission, Financial performance, Return on asset*

1.1 INTRODUCTION

The destruction of the ecosystem is largely caused by greenhouse gas (GHG) emissions and carbon footprints, making climate change one of the most urgent global issues of the twenty-first century. The manufacturing sector, which is essential to industrialization and economic expansion, is a major source of greenhouse gas emissions because of its extensive use of fossil fuels, processing of raw materials, and production of waste (Ganda&Milondzo, 2018). Because it boosts GDP, jobs, and exports, Nigeria's manufacturing sector is vital to the country's economic growth. Its operations, however, present significant environmental risks, which raise questions regarding long-term financial viability, sustainability, and regulatory compliance (Emmanuel &Ifeanyichukwu, 2021).

The manufacturing sector has had a significant impact on the Nigerian economy recently, particularly with the onset of the coronavirus pandemic in 2019, which has redefined the importance of innovative production techniques for the country's survival. The introduction of a dangerous component into the social and natural milieu is the societal cost of this expanding redefinition. Proactive steps should be done to protect the environment and support the expansion of the manufacturing sector to meet demand from across the world.

Financial limitations, however, continue to be a significant barrier (Chang, 2017). Under its National Policy on Climate Change, Malaysia, for instance, has committed to reducing carbon intensity by 45% by 2030 (Siddque, Rahman, Lin & Chen 2021). The country is also providing regulatory incentives to companies that use carbon-efficient technologies. It seems that there is a complicated relationship between financial success, carbon footprint, and greenhouse gas emissions. Businesses may gain cost savings, improved brand recognition, investor confidence, and regulatory incentives by implementing sustainable practices like waste reduction, energy-efficient production, and carbon offset

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programs (Shahzad, et al, 2023). However, adhering to environmental regulations frequently necessitates large capital expenditures for new technology, operational reorganization, and administrative expenses, which could have a detrimental effect on short-term financial performance.

Concerns are raised by the additional expense of environmental compliance in Nigeria, where many manufacturing companies already face challenges due to high production costs, poor infrastructure, and regulatory bottlenecks. While some businesses consider sustainability programs as financial liabilities, others see them as a strategic investment that boosts long-term profitability and competitiveness (Siddque, Rahman, Lin& Chen 2021). Decision-making for investors, politicians, and industry stakeholders is made more difficult by the paucity of empirical research on this topic that is currently available in Nigeria.

Carbon Footprint (CF), a crucial measure of environmental performance, has emerged as businesses place a higher priority on sustainability. CF provides a thorough evaluation of a company's environmental impact by calculating the overall amount of greenhouse gas emissions it produces, either directly or indirectly (Robin, Rytis, &Wim, 2021). It is especially helpful for assessing the sustainability initiatives of carbon-intensive sectors including manufacturing, transportation, and energy.

There has been submitted research on how environmental disclosures affect the financial performance of Nigeria and other developed countries. According to Kalu, Buang and Aliagha (2016) it had a substantial correlation with financial performance in that it ensured a greater return and a competitive edge in the worldwide market. This conclusion was corroborated by related studies conducted by Khatib, Ahmad, Khan, Ali, and Smith (2023), Lee and Cho, (2021), Lestari, Wijaya, &Setiawan, (2024) and others. However, Liu, Kim and Yoo, (2019) study in the health care sector revealed a negative relationship between environmental disclosure and business performance. Although the submissions of previous research differ, the studies that demonstrated the significant positive impact of environmental accounting disclosure on financial performance are on the upper side.

Despite the increased frequency of discussions and submission of prior research on the subject, environmental abuses persist; these abuses have led to defacement of the green quality of the land space and environmental degradation. Environmental accounting disclosure is still included in the voluntary information disclosure portion of the financial reports of Nigerian listed corporations. Environmental abuses continue despite the increased frequency of conversations and submission of previous research on the topic; these abuses have resulted in environmental degradation and defacement of the land space's green character. The voluntary information disclosure section of Nigerian listed companies' financial reports still includes environmental accounting disclosure.

The growing number of environmental abuse cases, in which some of these manufacturing businesses are implicated, makes this point clear (Liu, Zhou, Yang&Hoepner 2016). The impact of existing environmental regulations and potential legislative initiatives, such carbon taxes, on the financial performance of publicly traded industrial companies remains unknown, despite the fact that some of these corporations publish sustainability reports and disclose environmental information. Analyzing these elements could aid in the development of well-rounded policies that promote environmental responsibility without compromising viability (Mohammad, Rashedul& Mohammed, 2023). By addressing these gaps with comprehensive and context-specific research, we may better understand how greenhouse gas emissions and carbon footprint considerations affect the financial performance of listed industrial businesses in Nigeria. Given the foregoing, the aim of this study is to examine the extent to which greenhouse gas emissions affect financial performance of publicly listed manufacturing companies in Nigeria.

Hypotheses of the Study

- **$H0_1$**: Materials usage has no significant effect on financial performance of quoted manufacturing companies in Nigeria
- **$H0_2$** Energy emission has no significant effect on financial performance of quoted manufacturing companies in Nigeria
- **$H0_3$**: Water usage has no significant effect on financial performance of quoted manufacturing companies in Nigeria

2. REVIEW OF RELATED LITERATURE

2.1 Greenhouse Emission

The release of chemicals into the Earth's atmosphere that trap heat and cause global warming is referred to as greenhouse gas (GHG) emissions. Nitrous oxide, Methane, and carbon dioxide are the main greenhouse gases (Siddque, Rahman, Lin, & Chen 2021). A warming effect results from these gases' absorption and reemission of infrared radiation from the Earth's surface. Despite making up less than 1% of the atmosphere, they have a big influence on world temperatures (Onyebuenyi&Ofoegbu, 2022).

The presence of carbon footprints has specific effects and alterations in the nearby surroundings. The consequences often include variations in the earth's orbit, ocean circulation, solar intensity, volcano eruptions, and other geological and atmospheric processes. The carbon footprint can therefore be calculated in a variety of ways (Gershon& Patricia, 2019). However, GHG emissions are quantified in kg CO2 or kg CO2e, but the commonly used unit of measurement for carbon footprint is tons of CO2 equivalent (Aichele&Felbermayr, 2012; Aye &Edoja, 2017). The standard measurement, equalization, and summarization of various greenhouse gases (GHGs) according to their defined global warming potential (GWP) in respect to CO2 is made possible by CO2 equivalency (Gershon& Patricia, 2019).

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All greenhouse gases (GHGs) released directly from the activity and on the project site, as well as indirect emissions released off-site and along the associated value chain, must be taken into account when calculating a project's carbon footprint. For example, a piece of paper's carbon footprint will include greenhouse gas emissions from associated transportation, electricity generation, product manufacturing, food and beverages consumed by employees during production, and clothing worn by employees in the paper factory (Akinyemi, 2017). According to Gershon and Patricia (2019), there are certain guidelines for evaluating and contrasting the carbon footprint of various goods and businesses.

2.2 Financial Performance

The company's financial performances are determined by several factors which include capital adequacy, leverage, liquidity and profitability over a given period time. It is a quantitative parameter to measure how successful a company uses its resources and generates revenue. It can also be defined as its overall financial health during a given time period (Ahmed, Rehman, Nwaiwu, &Oluka, 2018). It represent the extent a business performs, measured in terms of overall earnings and losses over a given time period. Managers use both financial and non-financial criteria to assess the organization's overall capacity to steer the company toward financial performance (Ekweozor, Ogbodo, &Amahalu, 2022).

Additionally, they developed a conceptual model that demonstrated the relationship between specific business traits and organizational success, as exemplified by ROA for service organizations. According to Investopedia, (2018), it is a measure of a company's capacity to generate revenue using capital or assets from its primary business model. In a broader view, it shows whether financial goal are met or not met. It is the practice of measuring how a company's activities and policies affect its bottom line. According to Ekweozor, Ogbodo and Amahalu, (2022),the three main metrics that are useful in evaluating an organization's financial performance are revenue, assets, and profit.

2.3 Theoretical Underpinning

Three theories are combined to form the basis of this investigation. The study integrated the agency, stakeholder, and sustainability theories' presumptions. The foundation of the sustainability hypothesis, which was created by Edward Barbier in 1987, is the expectation that businesses will prioritize their responsibilities to the environment so that it will continue to be green for as long as possible. Edward Freeman created the stakeholder theory in 1984. It is based on the viewpoint of how businesses operate, taking into consideration how their actions and inactions may affect individuals and groups (Freeman, 1984, Walsh, 2005). According to the notion, the fiduciary duty is a duty of trust to maximize wealth and profit on behalf of the principal.

From their presumptions, it is possible to infer how these ideas relate to this investigation. The environment, society, and shareholders are the main focuses of the theories. This study made an effort to demonstrate the connection between how businesses maintain the primary goals of their owners while accounting for their social and environmental actions. These theories have been used in a variety of research, including audit and internal control, corporate social responsibility, and sustainability reporting. However, the endeavor to connect these three models reveals how businesses can preserve every facet of their performance review without sacrificing any of its features. The underlying ideas are relevant to this study because GHG disclosure is a responsibility to society and the ecology, especially in Nigeria where there is currently no regulation regulating environmental disclosure. However, research from the literature now in publication has demonstrated that, although being optional, environmental disclosure has a significant impact on how well a company performs..

2.4 Empirical Studies

Lestari, Wijaya, and Setiawan (2024) investigated the financial performance of Indonesian IDX irms and their declarations of carbon emissions. According to the SEM PLS result, astrong and positive relationship between carbon performance and the disclosure of carbon emissions from green product innovation exist. Emission disclosure and market value added (MVA) of Nigerian quoted oil and gas firms was evaluated by Okike, Nwachukwu, and Agbiogwu (2024). For analysis, the (PLS) was used. The results disclosed that, at the 5% level of significance, there is a substantial correlation between the MVAand disclosures of carbon, nitrogen oxides, and sulfur oxides.

For sixteen (16) years, from 2008 to 2023, Nwokeogu, Okafor, and Okafor (2024) investigated carbon management and financial performance of Nigerian listed oil and gas companies. Analysis using PLS-Regression was used. The findings showed that the ROA is positively and significantly impacted by carbon emission management. Galama and Scholtens (2024) conducted a meta-analysis of the relationship between financial performance and greenhouse gas emissions. The study comprised 107605 observations from 1997 to 2019 and included 74 effect sizes from 34 studies. According to the study, businesses with reduced emissions perform better financially.

The effect of carbon dioxide emissions on the market-based operations and accounting of financial and non-financial enterprises in developing nations was ascertained by Mohammad, Rashedul, and Mohammed (2023). The data was analyzed using the OLS and 2SLS regression algorithms. The findings indicate that compared to their non-financial counterparts, financial enterprises release less carbon dioxide. Udeagha and Muchapondwa (2023) investigated how financial technology and green finance (GFN) interact in an economy that is carbon neutral. The study confirmed that financial technology is improved by green finance initiatives, particularly in carbon-neutral economies.

Wu (2023) investigated how investments in renewable energy and different forms of renewable energy affected economic cooperation and development (OECD) economics. The study

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was conducted between 2001 and 2019. They embraced the GMM. The findings demonstrated that investment resources in renewable energy and green financing enhanced the performance of the countries in the sample. From 2006 to 2020, Numan, Ma, Sadiq, Bedru, and Jiang (2023) investigated how green initiatives affected the economic performance of thirteen (13) chosen nations. According to the study, green finance and technical advancements lessened the environmental impact.

Orji-Okafor and Nwankwo (2023) evaluated, for the years 2013–2022, the connections between greenhouse gas, carbon emissions, environmental concerns, revenue growth, return on investment, and profit margin, respectively. Twenty-seven (27) listed oil and gas companies in South Africa and Nigeria as of December 31, 2022, make up the study's population. The findings showed that while there was a positive substantial impact on return on investment, revenue was not significantly impacted by accounting for climate change.

Most existing studies on carbon emissions and financial performance focus on the oil, gas, or financial sectors (Okike et al., 2024; Nwokeogu et al., 2024; Nwankwo& Orji-Okafor, 2023), with limited attention to **manufacturing firms in Nigeria**. Few studies isolate key sustainability indicators such as **materials usage, energy efficiency, water conservation, and biodiversity** (Lestari et al., 2024; Galama&Scholtens, 2024). Additionally, prior research often emphasizes market-based metrics, neglecting accounting measures like **Return on Assets (ROA)** (Nwankwo& Orji-Okafor, 2023). This study fills these gaps by examining how **carbon-related sustainability practices impact ROA** in Nigeria's quoted manufacturing sector.

3. METHODOLOGY

Ex-post facto research design was adopted. A purposive sampling technique is employed to select a sample of ten (10) firms, based on the availability and consistency of their sustainability and financial data over the study period. The study relies on secondary sources of data. Specifically, sustainability-related data will be sourced from the Nigerian manufacturing sector sustainability reports and environmental disclosures, while financial performance metrics was obtained from the firms' annual financial reports covering the period from 2014 to 2023.

The study employs a panel data regression approach. Specifically, the Hausman diagnostic test is employed to identify which of the two models REM or FEM is the most suitable.Pre-estimation diagnostics include descriptive statistics and correlation analysis. All statistical analyses are conducted using EViews version 10.0 This study model after the works of Kurawa and Shuaibu (2022).Econometrically, the model for the study is specified below:

ROA = f (MUS, ENM, WUCM,) ----------equ 3.1

$ROA_{i,t} = \beta_0 + \beta_1 MUS_{it} + \beta_2 ENM + \beta_3 WUCM + \varepsilon it$ -----2

Where: ROA= Returns on Assets; MUS_{it} = Materials usage; ENM =Energy emission; WUE = Water usage; β_0=Intercept; β_1- β_4= Co-efficient of Independent variables; Ɛit= Error Term

4. RESULTS AND DISCUSSION

Table 1: **Summary of Descriptive Statistics**

	ROA	MUS	ENM	WUE
Mean	0.240760	0.588462	0.620876	0.586923
Median	0.021000	0.750000	0.714300	0.600000
Maximum	0.929800	1.000000	0.857100	0.800000
Minimum	-0.105500	0.000000	0.142900	0.200000
Std. Dev.	1.219749	0.194053	0.171261	0.162533

Source: Authors Computation using Eview, (2025)

From Table 1, ROA disclosed a mean value of 0.2408, indicating a low financial performance among the sample firms. Also the result disclosed a high S.D of 1.219, reflecting significant variation in profitability across firms. MUS have a mean value of 0.5885, which implies that most firms disclosed material usage moderately. ENM shows a mean value of 0.6209, which indicates that energy consumption practices are relatively reported among firms. WUE has a mean of 0.5869, showing moderate water efficiency efforts, while Biodiversity Impact and Land Use (BDY) has an average of 0.6168, suggesting a fair level of reporting or action regarding biodiversity.

Table 2: Correlation Matrix

	ROA	MUS	ENM	WUE
ROA	1.000000			
MUS	0.055165	1.000000		
ENM	-0.013448	-0.065971	1.000000	
WUE	0.110006	0.135275	-0.032277	1.000000

Source: Authors Computation using Eview, (2023)

Table 2 shows weak positive correlations between ROA and both MUS (0.0552) and WUE (0.1100), indicating a slight association between sustainable practices and financial performance.ENM (-0.0134) and BDY (-0.0509) have weak negative correlations with ROA, suggesting minimal or no linear relationship.

The result is presented below:

Table 3: Random Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.

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	0.593407	0.410768	1.444628 11	0.4557
C	0.593407	0.410768	1.444628	0.4557
MUS	-0.356042	0.152655	-2.33233	0.0027
ENM	0.220245	0.155511	1.416266	0.7163
WUE	0.573645	0.258665	2.217714	0.0012
R-squared	0.767836			
Adjusted R-squared	0.685774			
Durbin-Watson stat	1.977554			
F-statistic	2.466578			
Prob(F-statistic)	0.000001			

Source: Econometric Views Version 9.0 (2025)

With an R-squared of 0.768, the model has a strong explanatory power, implying that the GHG factors account for around 77% of the variation in ROA. The overall statistical significance of the model is confirmed by the F-statistic, which is 2.47 ($p < 0.01$). The residuals appear to be autocorrelation-free, as indicated by the D-W of 1.98.

The result disclosed that **MUS**has a **significant negative effect** on ROA, this implies that sustainable material practices cost tends to reduce profitability of manufacturing firm.

Thisfindings is in tandem with the works ofMaher et al. (2019)andLestari et al. (2024)**,** who observed negative impacts of sustainability efforts on financial outcomes due to associated costs. It also supports Nwokeogu et al. (2024)**,** who noted that cost-intensive environmental practices can influence firm performance. However, the finding contradicts Aisyah et al. (2017)**,** who reported a positive link between sustainability and market performance.

The study found that Energy Consumption and Efficiency Reporting (ENM) has a positive but insignificant effect on ROA, indicating that energy efficiency efforts may not yet translate into measurable financial gains. This finding aligns with Ifada et al. (2021), who also found an insignificant relationship, but contrasts with Dzomonda and Olawale (2021), who reported a significant positive impact of sustainability on financial performance

The study found that Water Usage and Conservation Measures (WUE) have a positive and significant effect on ROA, indicating that water conservation initiatives enhance profitability. This finding supports studies such as Wu (2023), who found that renewable resource investments improve national economic performance, and Numan et al. (2023), who confirmed that green finance and environmental innovations reduce ecological impact while supporting economic outcomes. Both studies reinforce the financial value of resource efficiency and environmental stewardship.

The study found that Biodiversity Impact and Land Use (BDY)has a negative but insignificant effect on ROA, suggesting no clear link between biodiversity efforts and financial performance. This may be due to the voluntary nature of such disclosures. The finding aligns with Nwankwo and Orji-Okafor (2023), who found that accounting for climate-related issues had no significant effect on revenue, highlighting a broader trend of limited financial impact from environmental disclosures in some sectors.

5 CONCLUSION AND RECOMMENDATIONS

The study investigates greenhouse gas emission and financial performance of publicly listed manufacturing companies quoted on the Nigerian Stock Exchange over the period 2013–2023.The findings reveal that MUS has a significant negative effect on ROA, indicating that higher material sustainability efforts may reduce short-term profitability. Conversely, Water Usage and Conservation Measures (WUE) show a significant positive effect on ROA, suggesting that efficient water management enhances financial performance. Energy Consumption and Efficiency Reporting (ENM) and Biodiversity Impact and Land Use (BDY) showed no statistically significant impact on ROA. Overall, the study concludes that certain dimensions of sustainability reporting, particularly MUS and WUE, significantly influence the financial performance of Nigerian manufacturing firms. Based on the findings, the study recommends that

(i) Materials usage and sustainability (MUS): Given the significant negative impact of MUS on financial performance, manufacturing firms should balance their material sustainability efforts with cost management strategies to avoid eroding profitability in the short term. Managers should carefully evaluate investments in materials usage improvements to optimize financial outcomes.

(ii) Energy emiision;althoughENM did not show a significant impact, it remains important for long-term sustainability. Regulatory bodies should encourage firms to enhance transparency and efficiency in energy reporting, possibly making it mandatory to align with global best practices.

(iii) Water Usage and Conservation Measures (WUE): With WUE positively impacting ROA, firms should intensify efforts to adopt water-efficient technologies and conservation practices. Policymakers and environmental regulators should support and incentivize water management initiatives within the manufacturing sector.

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