CARBON FOOTPRINT AND FINANCIAL PERFORMANCE OF PUBLICLY LISTED MANUFACTURING FIRMS IN NIGERIA

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ABSTRACT
This study examines carbon footprint and financial performance of publicly listed manufacturing firms in Nigeria using ex-post facto research design. Secondary data was obtained from the yearly audited financial statements of ten publicly listed manufacturing firms from the period of 2014 to 2023. The independent variable is carbon footprint measured by energy consumption, waste management and biodiversity while financial performance was employed as the dependent variable (return on asset). The study employed descriptive statistics, Pearson correlation matrix, ordinary least square and the fixed effect model. Findings indicate that energy consumption has a negative significant effect on financial performance while waste management and biodiversity has insignificant effects on financial performance of the publicly listed manufacturing firms in Nigeria. The study recommends that management of publicly listed manufacturing firms should implement sustainable energy practices and energy-efficient technologies due to the substantial detrimental effects of energy usage on financial performance. In addition, there is the need for management to engage in strategies aimed at reducing excessive energy use through policy that can increase return on assets and cost effectiveness. More so, regular audits and incentive-based initiatives should be used to strengthen adherence to environmental requirements.

Keyword: Carbon footprint, Environmental disclosure, Waste management, Biodiversity, Return on assets

1 INTRODUCTION

One main risk to the existence of life on earth is the release of greenhouse gases (GHGs), which have caused the environment to undergo drastic climate changes over time. Global warming and climate change are the results of unfavorable effects on the environment caused by the excessive release of GHG into the atmosphere (Liu, 2015). Because climate change impacts both human beings and natural and physical capital, it can have a significant worldwide social and economic impact. The effects of climate change may result in decreased worker productivity and a negative impact on the growth of the global gross domestic product (GDP) (Hardiyansah, Agustini, & Purnamawati, 2021). As one of the biggest emitters of GHG, companies have undoubtedly always contributed significantly to the difficulties associated with climate change (Ofoegbu, Odoemelam &Okafor, 2018).

Stakeholders, including creditors, shareholders, and regulatory bodies, have begun to put pressure on businesses to reduce their greenhouse gas emissions in recent years (Amahalu & Obi 2020). As a result, companies must play a crucial role in lowering GHG emissions and helping to stabilize climate change by giving their top stakeholders the information they need about activities related to climate change, also known as carbon disclosure. A significant victory in the fight to raise awareness and encourage action against climate change activities among businesses

and their stakeholders through environmental disclosures has been the research and explosive expansion of carbon disclosure over the years. Three main factors led to carbon disclosure: legislative compliance, pressure from non-governmental organizations, and managerial information systems designed to lower energy costs, manage reputational concerns, and make it easier to participate in carbon markets. Not only does carbon disclosure assist a company's stakeholders, but it also helps them track and control their carbon emissions, which improves the company's carbon performance.

A company's long-term financial performance drastically changes and improves when its carbon performance is stable and significantly enhanced (Mohammad & Aisa, 2020). Assessments of market opportunities and risks are derived from corporate carbon profiles, which have obvious financial ramifications for investors and companies. In fact, according to Diah, and Efita (2016), this is the main reasoning behind the carbon disclosure campaign. Here, the overall process and methodology are not as important as the larger societal purpose of reporting and accounting. More people are realizing that carbon disclosure is an example of informational governance, or data-driven governance (Mohammad & Aisa, 2020).

Specifically, carbon disclosure uses accountability and transparency frameworks to sway target investors' decisions. A UK-based group established the Carbon Disclosure Project (CDP) in 2000 to push businesses to reveal their GHG(Mohammad, Aisa & Indah, 2020). Since then, it has developed into a strategic ability that has gained broad support for reporting standards and appealed to a variety of stakeholders. According to Muhammad et al. (2020), CDP currently has over 3000 organizations across 66 countries that measure and disclose their emissions and climate policies. Investors, stockholders, and decision-makers can use the publicly accessible data gathered from these businesses.

In addition to raising awareness of climate change, renewable energy, and energy efficiency, disclosure of carbon emissions has become increasingly significant as a governance mechanism and validates the idea of external responsibility. Most importantly, the voluntary increase in carbon disclosure has demonstrated to companies the feasibility of doing so and the possible advantages of carbon reporting and monitoring, including energy costs and reputation management. This creates political room for projects that require the formalization and public disclosure of carbon accounting regulations (Omaliko, Onyeogubalu &Akwuobi, 2020). External constraints are the main emphasis of carbon disclosure, with little to no attention paid to internal governance systems within businesses.

The relationship between board members' general characteristics and business sustainability disclosure has been examined in earlier studies. These features include a sustainability-related committee, board independence, diversity (gender), and size. The more varied a board of directors is, the more it can help management make decisions, according to research like Liu, Wan and Fang, (2015). First of all, a supervisory team with a diverse range of expertise, experiences, and professional networks can be more innovative and creative. Broad environmental and social backgrounds increase the likelihood that directors will understand carbon disclosure in the context of climate change and even be aware of more open channels aimed at various stakeholders, such as answering annual questions about the carbon disclosure project (CDP) from institutional investors and including carbon-related information in their

public sustainability report (He, Tang & Wang, 2016). Therefore, it makes sense to believe that the board will be positively associated with the likelihood of disclosing information about carbon. Additionally, a more embedded board can collect additional industry-specific information to help the company manage a range of uncertainty (Liu,Wang, & Liu, 2018).

1.2 Statement of the Problem

In actuality, most businesses have problems with climate governance and change because their board of directors isn't committed to keeping an eye on their carbon emissions and performance (Diah and Efita, 2016). A director or subcommittee tasked with educating other directors and management about climate change issues, or even offering incentives to them, can assist the company in mitigating its carbon footprint, thereby reducing greenhouse gas emissions, global warming, and other adverse environmental effects (Bui, Houqe & Zaman, 2020). Nigeria, a developing nation with more than 200 million people living there as of 2021, engages in a number of economic activities that negatively impact the environment and the economy in an attempt to increase productivity in businesses (Hardiyansah et al., 2021).

Due to the detrimental effects on the environment, which include global warming, the release of hazardous waste products into the atmosphere by the oil and gas or manufacturing sectors, and the significant release of greenhouse gases into the atmosphere, stakeholders are now more interested in corporate environmental reporting. Nigeria is ranked seventh by flare volume as of 2020 and second by gas flaring rate among the top 20 countries (Omaliko et al., 2020). Since the high rate of GHG traps heat in the atmosphere and contributes to global warming, this has caused significant concern in the Niger Delta region. The environment (land, water, and air) is currently impacted by the acts of people and businesses engaged in production that results in emissions because no one seems to take accountability for their actions. If these behaviors are not stopped, they often have an impact on both the present and the future.

Nowadays, the majority of wealthy nations worldwide have embraced environmental or sustainability reporting as a voluntary worldwide reporting program. But in a developing nation like Nigeria, this is not the case (Badingatus & Ukhti, 2021). By appropriately disseminating qualitative environmental information, businesses look for solutions to lessen their adverse effects on the environment (Gershon & Patricia, 2019). Nevertheless, despite the importance of greenhouse gas emissions to the environment, there is still a significant study gap over what drives businesses to reveal their carbon footprints, especially in developing nations.

Prior research, such that done by Omaliko and Okpala (2020), has mostly looked at how business size, firm characteristics, and leverage affect carbon disclosure levels; however, most of these studies have been conducted in developing nations other than Nigeria. As a result, little empirical data exists regarding the environmental disclosure policies of businesses doing business in Nigeria, a nation whose economy is industrializing quickly and where environmental problems are becoming more pressing. Therefore, this study aims to close this gap by examining how the financial performance of mentioned manufacturing firms in Nigeria is affected by carbon footprint disclosure. This study adds to a more sophisticated understanding of environmental reporting practices in Nigeria and offers insights pertinent to policy and regulatory development

by concentrating on a developing nation that has been underrepresented in the body of previous work.

1.3 Objectives of the Study

(i) Determine the extent to which energy consumption influences the financial performance of quoted manufacturing firms in Nigeria.
(ii) Analyze the effect of biodiversity-related initiatives on the financial performance of quoted manufacturing firms in Nigeria.
(iii) Evaluate the relationship between waste management practices and the financial performance of quoted manufacturing firms in Nigeria

1.4 Hypotheses of the Study

$H0_1$: Energy consumption has no significant effect on financial performance of quoted manufacturing companies
$H0_2$: Biodiversity has no significant effect on financial performance of quoted manufacturing companies
$H0_3$: Waste managements has no significant effect on financial performance of quoted manufacturing companies

2 REVIEW OF RELATED LITERATURE

2.1 Carbon Footprints

The term "carbon footprint" refers to a measurement of the overall quantity of greenhouse gases produced into the atmosphere as a result of the acts of a person, business, or country. Tonnes of CO2e (carbon dioxide equivalent) are typically used to measure it. Accordingly, the total amount of carbon dioxide (CO2) released during the production of food, clothing, housing, and transportation activities that an individual or organization consumes or engages in on a daily, weekly, monthly, or annual basis is known as their "footprint" (Gershon& Patricia, 2019). The amount of greenhouse gases (GHGs) released by man's everyday regular economic activities, such as utilizing hydrocarbons for transportation, heating, cooling, and lighting, is conceptually related to the term "carbon footprint."

According to Okike, Nwachukwu, andAgbiogwu, (2024) the existence of board-level environmental committees tasked with addressing carbon concerns indicates that the company has adopted an active strategic approach to carbon management and is prepared to balance the conflicting interests of numerous stakeholders (Nimanthi & Priyadarshanie, 2021). Such committees often spearhead the implementation of environmental management systems (EMS) to improve communication with external stakeholders (Liu, 2019). The fact that environmental committees are much more receptive to institutional calls to reduce carbon emissions is another argument in favor of having them on boards (Liu, Wang& Liu, 2018).

Gershon and Patricia (2019) asserts that one crucial internal component of governance for climate change is the inclusion of an environmental committee in the board committee structure. However, Diah, and Efita, (2016) discovered that the likelihood of risk disclosure and the quality of that disclosure are positively correlated with the existence of an environmental committee and

a Chief Sustainability Officer (CSO). Additional research reveals that the quality of GHG disclosure is correlated with the experience of the CSO and the members of the environmental committee, but lower disclosure quality is typically linked to larger committees.

2.2 Financial Performance

The financial performance of a business is based on its liquidity, profitability,efficiency, capital adequacy, leverage and solvency during a given time period that includes funding collection and distribution.A company's entire financial health over a specific time period can also be referred to as its financial performance, which is a quantitative indicator of how well it uses its resources and makes money (Amahalu& Obi, 2020).

In terms of total earnings and losses over a certain time period, financial performance can be defined as the degree of performance of a business. When evaluating the capabilities of the entire organization to move the firm towards financial performance, managers employ both financial and non-financial criteria (Abdullah, Hamzah, Ali, Tseng, & Brander, 2020). They also created a conceptual model that showed how certain business attributes relate to organizational success, which is represented by ROA for service firms.

2.3 Theoretical Framework

The signaling theory, proposed by Michael Spence in 1973 (Donavan, 1984), states that firms that score highly on carbon metrics are more likely to be driven to give investors and stakeholders detailed information about their performance and climate change-related issues because they stand to benefit from higher financial returns, including a lower cost of capital and a higher market valuation (Liu, Wang, & Fang, 2015).According to the signaling theory, businesses aim to set themselves apart by informing stakeholders of their superior carbon performance in order to obtain a competitive edge.

Instead of concealing underlying performance or evading accountability for subpar performance, underperforming firms may worsen information asymmetry by lowering carbon disclosure. According to a signaling approach, some studies showed a favorable correlation among financial performances and environmental disclosures (Dibia and Onwuchekwa, 2015). He et al. (2016) found that greater disclosure of measurable pollution-related variables is linked to good environmental performance. For instance, Gershon, and Patricia, (2019) discovered a connection between carbon performance and disclosure.

2.4 Empirical Studies

Lestari, Wijaya, and Setiawan (2024) looked at the financial success of IDX companies in Indonesia between 2020 and 2022 as well as their declarations of carbon emissions. The SEM PLS analysis results indicate a strong positive correlation between carbon performance and the disclosure of carbon emissions related to green product innovation. For eleven (11) years, from 2012 to 2022, Okike, Nwachukwu, and Agbiogwu (2024) evaluated the relationship between emission disclosure and the market value added (MVA) of listed oil and gas companies in Nigeria. Regression analysis using Panel Least Squares (PLS) was used. The result shows a

substantial correlation between the MVAand disclosures of carbon, nitrogen oxides, and sulfur oxides.

Ifada et al. (2021) look at how manufacturing and coal mining companies listed on the Indonesia Stock Exchange (IDX) performed in terms of the environment between 2017 and 2019. Multiple linear regression analysis method was employed. The results of this study indicate that financial performance is significantly improved by environmental performance. Badingatus and Ukhti (2021) look into the extent and quality of environmental disclosure (ED) in manufacturing companies. The study hypothesis was tested using (PLS-SEM). According to the findings, environmental awards and media attention can enhance the caliber of environmental disclosure, and if a business focuses on using CG principles, the correlation will rise.

The impact of ED on the environmental performance of Chinese listed mining corporations is investigated by Agyemang et al. (2021). At the 1% level, the cointegration estimation study demonstrated a positive and substantial association between environmental information disclosure and business environmental performance. Nimanthi and Priyadarshanie (2021) investigate how Sri Lankan firms' performance is affected by environmental disclosure procedures. Regression analysis was used in this study to analyze the data. The results of the study showed that environmental disclosures and company financial success were significantly positively correlated.

Abdul et al. (2020) investigate the connection between financial success and environmental disclosure among Malaysian, Singaporean, and Thai enterprises that choose to include environmental information in their financial reports. However, the findings imply that there is no connection between the company's profitability and the creation of thorough or cursory environmental disclosure. The combined impact of climate governance and carbon disclosure was studied by Mohammad et al. (2020), who found a connection between climate governance and both performance alignment and carbon disclosure. The results indicate that low polluters disclose more to set themselves out, whereas comprehensive disclosure reduces over-acclaim of excellent performance.

Using firm-level data and a fixed-effects model, this study fills two gaps in the literature on environmental disclosure: the majority of previous studies concentrate on Asian countries and the oil and gas sector, with little attention to Nigerian industrial goods firms; the impact of specific environmental factors such as energy consumption, waste management, and biodiversity on financial performance; and the reasons for disclosure in developing countries are still unclear.

3 METHODOLOGY

The ex-post facto research design was adopted. All manufacturing companies listed on the Nigerian stock exchange as of December 31, 2024, were included in the study population. Only ten manufacturing companies that are listed on the Nigeria Exchange Group (NGX) are included in the sample size, though. The sample size was determined using a purposive sampling technique. The chosen annual reports of the manufacturing companies from 2013 to 2024 served as the source of the data. The panel data methodology served as the model for the investigation.

This study models after the works of Kurawa and Shuaibu (2022) in line with the objectives of this study. Econometrically, the model for the study is specified below:

ROA = f (WTM, BDTY, ENCOM)

$ROA_{it} = \beta_0 + \beta_1 WTM_{it} + \beta_2 BDTY_{it} + \beta_3 ENCOM_{it} + \varepsilon_{it}$

Where: ROA= Return on Asset; WTM = waste management; BDTY= Biodiversity; ENCOM = Energy Consumption; β_0 = Intercept; β_1- β_3 = Co-efficient of Independent variables; Ɛit = Error Term

4. RESULTS

Table 1: Summary of Descriptive Statistics

	ROA	ENCOM	WTM	BDTY
Mean	34.37903	0.620215	0.612903	0.619355
Median	33.25000	0.600000	0.600000	0.750000
Maximum	96.51000	0.800000	0.800000	0.750000
Minimum	0.000000	0.200000	0.200000	0.250000
Std. Dev.	17.44100	0.166156	0.180054	0.162489
Observations	100	100	100	100

Source: Eview 9.0 Output (2025)

From the result above, ROA, ENCOM, WTM, and BDTY disclosedaverage mean values of 34.37903, 0.620215, 0.612903, and 0.619355 with S.D values of 17.44100, 0.166156, 0.180054 and 0.162489 respectively as seen in Table 4.2 above, suggesting a low volatility exist among variables.

Table 2: Summary of Correlation Analysis

	ROA	ENCOM	WTU	BDTY
ROA	1.000000			
ENCOM	-0.016552	1.000000		
WTM	0.091850	-0.043316	1.000000	
BDTY	-0.038244	-0.013725	0.061426	1.000000

Source: Eview 9.0 Output (2025)

From the table 4.2 above ENCOM and BDTY have weak negative relationship with ROA with coefficient values of -0.016552 and -0.038244, respectively. However WTM disclosed a weak positive relation with ROA with a coefficient value of 0.091850.

Table 3: Variance Inflation Factors

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	0.089069	29.32807	NA
ENCOM	0.000436	13.41847	1.090389
WTM	0.593901	1.682604	1.040930
BDTY	0.048815	3.558948	1.045121

Source: Eview 9.0 Output (2025)

The VIF evidenced that the model did not exhibit any trace of multicollinearity problem.

Table 4: Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	20.255783	3	0.0014

Source: Eview 9.0 (2025)

From the table 4.4 above, the P-value of the chi-square which stood at 0.0014 this implies that FEM is fit for the study.

Table 5: Fixed Effect Model.

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	6.910195	0.148956	46.39095	0.0000
ENCOM	-0.498327	0.187336	-2.660064	0.0084
WTM	0.680437	0.444524	1.530710	0.1272
BDTY	-0.122252	0.119814	-1.020354	0.3087
R-squared	0.767333			
Adjusted R-squared	0.655583			
F-statistic	45.27538			
Prob(F-statistic)	0.000000			

Source: Eview 9.0 (2025)

The F-statistics and P-Value value suggests that, on theoverall, all the study variables jointly determine financial performance with coefficient values of 45.27538 and 0.000000 respectively.Additionally, the R^2 value is 0.767333, meaning that changes in the determinants might account for roughly 0.722433 of the fluctuations in Return on Asset, while other unexplained factors, such as the error term, could account for roughly 0.655583. With a coefficient of -0.498327 and a p-value of 0.0084 (< 0.05), the regression result demonstrates that energy usage has a negative and statistically significant impact on financial performance. This indicates that the return on assets decreases by 0.498% for every 1% increase in energy use. Higher energy use may result in higher operating expenses, inefficiencies, or environmental penalties, all of which can lower a company's profitability, according to this negative link.

The outcome is consistent with sustainability concepts, which state that cutting energy use can improve financial and environmental results. This finding is supported by Lestari, Wijaya, and Setiawan (2024), who found that green product innovation often tied to lower energy consumption positively influences carbon disclosure and performance, and by Ifada et al. (2021), who reported that environmental performance significantly enhances financial outcomes. Similarly, Nimanthi and Priyadarshanie (2021) found a strong positive relationship between environmental disclosures and financial success, aligning with the idea that efficient resource use

contributes to profitability. However, this outcome is contradicted by Abdul et al. (2020), whose findings show no significant link between environmental disclosures and profitability, implying that reductions in energy use may not always result in immediate financial returns.

Although the direction indicates that effective waste management may improve financial performance, possibly through cost savings, regulatory compliance, or enhanced reputation, the insignificance indicates that this effect is not strong enough to be statistically validated in this model, and further research may be required to confirm this potential relationship. Waste management and ROA have a positive but statistically insignificant relationship, with a coefficient of 0.680437 and a p-value of 0.1272 (> 0.05). This interpretation is partially supported by Badingatus and Ukhti (2021), who found that environmental awards and media attention often influenced by good waste practices enhance the quality of environmental disclosures, potentially boosting performance. Similarly, Lestari et al. (2024) linked environmentally friendly innovations to improved carbon and financial performance, indirectly suggesting a role for waste management. However, Abdul et al. (2020) contradict this by showing no meaningful relationship between environmental disclosure (which may include waste management initiatives) and company profitability.

With a p-value of 0.3087 and a coefficient of -0.122252, biodiversity has a negative and statistically negligible impact on ROA. According to this finding, biodiversity-related projects might not have an immediate or quantifiable effect on business profitability in the near term, even though they might be advantageous in the long run. On the other hand, it might represent the expenses of biodiversity conservation initiatives, which haven't yet been compensated for by profits. This outcome is supported by Mohammad et al. (2020), who suggest that some environmental disclosures, including those around biodiversity, are more about signaling than immediate financial gain, and may not directly reflect superior firm performance.

Abdul et al. (2020) also found no significant link between profitability and the extent of environmental disclosure, which may include biodiversity initiatives. In contrast, Agyemang et al. (2021) provide a differing view, showing a strong positive and significant relationship between environmental disclosure and environmental performance at the 1% level, implying that biodiversity initiatives may contribute positively over time. Similarly, Ifada et al. (2021) suggest that stronger environmental performance in general can enhance financial results, possibly encompassing biodiversity efforts

5 CONCLUSION AND RECOMMENDATIONS

This study evaluated the effect of carbon footprint on financial performance of manufacturing companies in Nigeria. The study focused on effect of energy consumption, waste management and biodiversityand dependent financial performance proxy by ROA. To answer the research questions, data were collected on 10 (ten) quoted manufacturing firms. The data used for the study was extracted from the annual report of the manufacturing firms under study. The study concludes that energy consumptionhas a negative yet significance effect on financial performance of manufacturing firms in Nigeria.

(i) The management of industrial product firms should implement sustainable energy practices and energy-efficient technologies due to the substantial detrimental effects of

energy usage on financial performance. Reducing excessive energy use through policy can increase return on assets and cost effectiveness. Regular audits and incentive-based initiatives should be used to strengthen adherence to environmental requirements.

(ii) The positive correlation between waste management and ROA indicates possible financial gains from better waste processing, even though it is not statistically significant in the current model. Businesses should put in place more efficient strategies for resource recovery, waste reduction, and recycling. Long-term operating hazards can be decreased and public perception enhanced by promoting environmentally friendly trash disposal methods and sustainable production.

(iii) The positive correlation between waste management and ROA indicates possible financial gains from better waste processing, even though it is not statistically significant in the current model. Businesses should put in place more efficient strategies for resource recovery, waste reduction, and recycling. Long-term operating hazards can be decreased and public perception enhanced by promoting environmentally friendly trash disposal methods and sustainable production.

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