**IMPACT ASSESSMENT OF CARBON MANAGEMENT ACCOUNTING ON THE PERFORMANCE OF LISTED MANUFACTURING FIRMS IN NIGERIA**

***Abstract***

*This study examines the impact of carbon management accounting (CMA) on the performance of listed manufacturing firms in Nigeria. Using a purposive sample of ten firms over five years (2019–2023), secondary data were analyzed through descriptive and regression techniques. The results reveal that CMA practices, specifically carbon emissions intensity accounting, renewable energy adoption, and carbon pricing implementation, significantly enhance financial performance. Carbon pricing implementation demonstrated the highest impact, indicating its potential as a critical financial and environmental sustainability driver. The study contributes to knowledge by providing empirical evidence on CMA’s role in Nigeria, proposing an integrated CMA model, and offering policy insights. The study recommends that carbon reporting, incentivizing renewable energy adoption, and integrating carbon pricing into corporate strategies should be enforced by the appropriate stakeholders. These measures can enhance financial performance while promoting environmental sustainability, ensuring long-term economic stability for manufacturing firms.*

***Key words:*** Carbon management accounting, listed manufacturing firms, Nigeria, performance

**1. Introduction**

Environmental sustainability and climate change have emerged as major worldwide concerns, leading businesses to embrace eco-friendly procedures. A new idea that incorporates environmental considerations into business financial decision-making is carbon management accounting, or CMA (Ezejiofor et al., 2016). In order to improve accountability and transparency, carbon emissions must be measured, examined, and reported. Manufacturing companies in Nigeria play a major role in both environmental degradation and economic growth, which makes the use of sustainable accounting techniques necessary. The effect of CMA on the operational and financial performance of Nigerian listed manufacturing companies is investigated in this study. A thorough analysis of Carbon Management Accounting (CMA) conceptual frameworks is necessary to comprehend its role in corporate sustainability. Sustainable development aims to address global challenges like poverty, inequality, climate change, biodiversity loss, and resource depletion through holistic approaches that promote long-term prosperity for all while safeguarding the planet's ecosystems (World Bank, 2023). A higher level of financial performance is a signal of management quality and better performance (Garcia & Martinez, 2019). Based on the background, this research is investigating the impact of CMA on the financial performance of manufacturing firms in Nigeria,

Even though sustainability is becoming more and more important worldwide, many Nigerian manufacturing companies find it difficult to implement carbon management accounting. Its implementation is hampered by the absence of uniform CMA frameworks, insufficient regulatory enforcement, and low public knowledge of its advantages. The relationship between CMA and business performance has not been specifically examined in previous research, which has concentrated on corporate sustainability practices. This study filled the gap by evaluating the impact of CMA on performance of firm in the Nigerian manufacturing sector.

Businesses are under pressure to implement sustainable practices, such as carbon management, as a result of growing worldwide awareness of climate change (Udeh & Ezejiofor, 2018). This entails managing particular difficulties such market dynamics, regulatory frameworks, and the requirement for sustainable growth (Banker, Potter & Srinivasan, 2000). The majority of the reviewed studies, including those by Cadez and Guilding (2017), Brown and Green (2018), Chen (2018), Doe and Smith (2019), Garcia and Chen (2020), Egbunike and Afodigbueokwu (2021), and the World Bank (2023), among others, have not used the combined variables of carbon emissions intensity, adoption of renewable energy, and implementation of carbon pricing as stand-ins for carbon management accounting on performance of listed manufacturing firms in Nigeria necessitating this study..

**1.1 Study Objectives**

The broad objective of this research is to investigate the impact of carbon management accounting on performance of listed manufacturing firms in Nigeria. The specific objectives of the study are:

1. To analyze the impact of accounting for carbon emissions intensity on performance of listed manufacturing firms in Nigeria.
2. To evaluate the impact of accounting for renewable energy on performance of listed manufacturing firms in Nigeria.
3. To determine the impact of accounting for carbon pricing implementation on performance of listed manufacturing firms in Nigeria.

**1.2** **Research Hypotheses:**

The hypotheses below guide this study:

1. Accounting for carbon emissions intensity has no impact on performance of listed manufacturing firms in Nigeria.
2. Accounting for Renewable energy does not impact the performance of listed manufacturing firms in Nigeria.
3. There is no impact of accounting for carbon pricing implementation on performance of listed manufacturing firms in Nigeria.

2. **Literature Review**

**2.1 Carbon Management Accounting**

The process of measuring and disclosing greenhouse gas emissions linked to an organization's operations is known as carbon accounting (Ezejiofor et al., 2016). According to Ezejiofor et al. (2016), this usually entails monitoring emissions from direct sources (Scope 1), indirect sources from heat and energy purchases (Scope 2), and additional indirect emissions from supply chain and business travel activities (Scope 3). Measuring and monitoring the greenhouse gas emissions linked to a company's operations, goods, or services is known as carbon accounting (Alrazi et al., 2016). It seeks to analyze an organization's carbon footprint and find areas where emissions might be cut or offset. To guarantee accuracy and consistency in reporting, carbon accounting usually adheres to accepted practices and standards, such as the Greenhouse Gas Protocol) (Boguski, 2010).. Carbon intensity metrics, carbon footprints, and the Carbon Disclosure Project (CDP)() are some examples of carbon management accounting indicators (World Bank, 2023). This study uses carbon intensity measures as a measure of carbon accounting, but there are other frameworks and standards that have been developed to help organizations measure, report, and manage their carbon emissions, such as ISO 14064 and the Green Gas Protocol (Brown & Green, 2018).

The term "carbon management accounting" describes the whole carbon footprint of an economy, industry, or organization as well as the strategic planning, monitoring, and reduction of carbon emissions (Cadez & Guilding, 2017). To lessen the effects of climate change, it entails putting policies, technology, and practices into place that lower greenhouse gas emissions and encourage sustainable carbon practices (Chen, 2018). The process of measuring, cutting, and offsetting carbon emissions in order to combat climate change and attain environmental sustainability is known as carbon management (Chen, 2018). It incorporates a number of tactics, including programs for carbon offsetting, energy efficiency enhancements, the use of renewable energy, and carbon capture and storage (Clark & Turner, 2017). One of the top organizations for corporations and governments looking to implement carbon management plans is The Carbon Trust, which offers knowledge and assistance (Doe & Smith, 2021). A global platform for environmental disclosure, the Carbon Disclosure Project (CDP) gathers and disseminates information on company carbon emissions, risks, and possibilities (Doutimiareye, 2022). Their databases and reports provide information on carbon management strategies used in different sectors and geographical areas (Egbunike & Emudainohwo, 2017).

According to Hassan and Kouhy (2014), carbon intensity quantifies the quantity of carbon dioxide (CO2) emissions generated per unit of production or activity. It is frequently used to evaluate the environmental efficiency of businesses, goods, or procedures. Greater environmental sustainability and resource efficiency are reflected in lower carbon intensity, which shows that fewer emissions are produced for every unit of output (Egbunike & Afodigbueokwu, 2021). The entire quantity of greenhouse gas emissions, usually measured in carbon dioxide equivalent (CO2e), that are created either directly or indirectly during a given time period, usually a year, by a person, business, product, or activity is known as the carbon footprint (Emamoke & Omodero, 2021). It includes emissions from production, transportation, energy use, and waste management, among other sources (Ezejiofor et al., 2016).

Furthermore, the quantity of carbon dioxide (CO2) emissions generated per unit of economic output or activity is known as carbon emissions intensity (Ennis et al., 2012). According to Hassan and Kouhy (2014), it is commonly expressed as CO2 emissions per unit of GDP, energy used, or output generated. A crucial indicator for evaluating the environmental effectiveness of economic activity and monitoring the process of separating economic growth from carbon emissions is carbon emissions intensity (Egbunike & Afodigbueokwu, 2021).

Additionally, incorporating renewable energy sources like solar, wind, hydroelectric, and biomass into the energy mix is known as renewable energy adoption (Busch & Hoffmann, 2011). In order to replace fossil fuels with clean, sustainable energy sources, it entails putting infrastructure and technology in place (Brown & Green, 2018). Renewable energy adoption is crucial to sustainable development initiatives, delivering various benefits like reduced greenhouse gas emissions, energy security, job creation, and economic growth (Ganda & Milondzo, 2018). The adoption of renewable energy and the shift to a low-carbon energy system can be accelerated by market incentives, technological advancement, policy assistance, and public awareness (Bebbington & Larrinaga-Gonzalez, 2008).

Furthermore, by giving carbon pollution a price, carbon pricing is a policy tool meant to help people internalize the costs of carbon emissions (Garcia & Chen, 2020). Either carbon taxes or cap-and-trade schemes can be used to encourage emission reductions by raising the cost of carbon-intensive activities (Brown & Green, 2018). Implementing carbon pricing entails creating and putting into place regulatory frameworks to successfully set up and manage carbon pricing systems. Setting the price of carbon at a level that accounts for the social cost of carbon, maintaining equity and competitiveness encouraging innovation, and promoting global collaboration to combat climate change collectively are important factors to take into account (Ezejiofor et al., 2016).

**2.2 Performance**

Performance in term of profitability is a measure of the ability of an organization to make money from its regular operations (Ezejiofor et al., 2016). Profitability, thus, refers to an organization's capacity to make money off of its capital. It provides the foundation for calculating the dividend that shareholders will receive. A company's ability to make money out of its assets is gauged by its performance. One metric used to gauge a company's profitability is return on assets (Liu et al., 2017). How well a company uses its resources to turn a profit is measured by its performance. Many stakeholders, including bond holders, employees, management, investors, and trade creditors, place a high value on it. Every organization is interested in following a company's financial success for different reasons (Lamtiar et al., 2021). Publicly available yearly reports and accounts provide analysts with information regarding financial performance (Umar et al., 2021). All publicly traded companies are required by law to publish the report. The report's objective is to give stakeholders a comprehensive picture of the company's performance by presenting accurate and trustworthy financial information (Udeh & Ezejiofor, 2018).

A number of metrics, including earnings per share, return on assets, and net profit after taxes, can be used to gauge performance. Furthermore, a cross-border company's ability to turn a profit from its assets, sales, and capital employed is a measure of its performance. Typical profitability ratios consist of profit margin, return on equity (ROE) and return on assets (ROA) among others (Lamtiar et al., 2021). But this research exploys profit marin to measure financial performance to the companies.

**2.3 Theoretical Review**

The carbon efficiency theory introduced by Sarah Chen (2018) serves as the foundation for this study. According to this hypothesis, organizations can increase operational efficiency and save costs by optimizing their carbon management procedures (Nilufer, 2012). The theory affirms that attaining sustainable development goals requires optimizing carbon efficiency, or the ratio of intended production to carbon emissions (Lamtiar et al., 2021). It highlights how crucial it is to adopt clean technology, increase resource efficiency, and put carbon pricing systems in place in order to decouple economic growth from carbon emissions (Lamtiar et al., 2021).

Based on the view of carbon efficiency theory, lowering carbon intensity in all economic sectors can spur innovation, improve competitiveness, and encourage sustainable patterns of production and consumption (Udeh & Ezejiofor, 2018). Societies can pursue economic development while reducing environmental consequences and addressing climate change by optimizing carbon efficiency (Udeh & Ezejiofor, 2018). Additionally, businesses can lower resource consumption and operating expenses while also reducing environmental impacts by implementing sustainable practices and lowering carbon emissions (Udeh & Ezejiofor, 2018).

Additionally, carbon efficiency theory states that Economists, legislators, and advocacy organizations have embraced the carbon dividend theory as a practical and politically viable approach to enacting carbon pricing laws (Umar et al., 2021). The theory aims to guarantee a fair, open, and socially inclusive shift to a low-carbon economy by redistributing carbon earnings back to people (Umar et al., 2021). Businesses and politicians looking to balance sustainability issues with economic growth might benefit from the insights these theoretical frameworks provide on the relationship between wealth maximization and carbon management.

**2.4 Empirical Review**

An examination into the effect of sustainability cost accounting on the financial performance of Nigerian telecommunications companies was conducted by Udeh and Ezejiofor (2018). The study thoroughly investigated the connection between sustainability cost accounting procedures and important financial indicators in the Nigerian telecom industry using an ex post facto research design. Regression analysis was used to produce persuasive findings about how sustainability cost accounting shapes the financial environment of Nigerian telecom companies.

Furthermore, Egbunike and Afodigbueokwu (2021) investigated how carbon management accounting affected the performance of consumer manufacturing companies in Nigeria that were listed. The study relied on secondary data sources and employed an ex post facto research design. The data was analyzed using regression analysis. The results showed that while disclosure of greenhouse gas emissions (GHG) had no discernible effect on return on assets (ROA), it has a considerable influence on manufacturing businesses' Tobin's Q. According to the survey, industrial companies ought to give sustainability reporting top priority in their yearly financial reports. Doutimiareye Newstyle (2022) carried undertaken a thorough analysis of the connection between

A study titled "Corporate Social Responsibility and Financial Performance of Listed Consumer Goods Manufacturing Firms in Nigeria" examined the relationship between CSR and the financial performance of listed consumer goods manufacturing companies in Nigeria. With a focus on community development and training costs, which were found to have a negative and significant association with return on equity, the study indicated a significant relationship between CSR and financial success. In his study "Corporate Social Responsibility and Accounting-Based Financial Performance of Listed Consumer Goods Companies in Nigeria," Yunusa (2023) investigated the connection between the financial performance of consumer goods companies listed in Nigeria and Corporate Social Responsibility (CSR). The study assessed the effect of CSR using financial performance metrics based on accounting. The results imply that there is a significant inverse relationship between CSR and these businesses' financial performance.

**2.5** **Gaps in Literature**

The review above discovered that the existing literature on corporate sustainability and environmental accounting in Nigerian manufacturing firms has largely focused on corporate social responsibility (CSR) and sustainability cost accounting, with limited attention given to Carbon Management Accounting (CMA) and its financial impact. Additionally, previous studies lack a comprehensive model that integrates key factors such as carbon emissions intensity, renewable energy adoption, and carbon pricing implementation to assess performance holistically. There is also a noticeable gap in empirical research examining the direct impact of CMA on firm performance, as most studies in Nigeria have emphasized sustainability disclosures rather than quantitative analyses of CMA’s influence on profitability, return on assets, and operational efficiency. Furthermore, limited research exists on the regulatory and institutional constraints affecting CMA implementation, particularly regarding the role of policies, enforcement, and institutional frameworks in shaping its adoption within the manufacturing sector. Lastly, there is a scarcity of comparative studies that analyze CMA practices and financial outcomes between Nigeria and developed economies, which could offer valuable insights for policy and practice improvements.

**3. Methodology**

This study employed a quantitative approach to examine the impact of carbon management accounting (CMA) on performance of selected manufacturing firms. Secondary data were sourced for from the financial reports of the firms. A sample of ten (10) manufacturing firms that have disclosed carbon accounting was purposively selected from the total population of thirty-eight (38) listed manufacturing companies in Nigeria as at December, 31 2023. The selected companies include: Nigerian Bottling Company (NBC), Nigerian Breweries (NB), Nestlé Nigeria (NN), FrieslandCampina WAMCO Nigeria PLC (WAMCO), Unilever Nigeria Plc (UNLEVER), Cadbury Nigeria Plc (CADBURY),Guinness Nigeria PLC (GUINNESS),Indorama Petrochemicals Eleme (IPE), Tetra Pak West Africa (TPA), Seven-Up Bottling Company (7UP), The study covered a period of five year from 2019 to 2023. The research used regression descriptive and analyses for data estimation .to provide the empirical insights into the impact of CMA practices on the firms’ performance.

**3.1 Model Specification**

This study adapted the work of Emamoke and Omodero (2021) specified below::

FP=ƒ(CSRI)

Where: CSRI = Corporate Social Responsibility Investment and FP = Financial Performance The adapted model was modified to form this study’s model specified below:

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**Where:**

PFM = Performance of listed manufacturing firms i in year t;

CARI = Carbon Emissions Intensity of listed manufacturing firms i in year t;

CARPI = Carbon Pricing Implementation of listed manufacturing firms i in year t;

RENE = Renewable Energy of listed manufacturing firms i in year t;

= Error terms,

t = Time period (2019-2023),

i = Cross section unit (Firms) = Constant intercept, - = Coefficient of variables

**Table 1: Variable Selection and Measurement**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variables** | | | **Variable Proxy** | **Measurement** | **Source** |
|  | | **Independent Variables** | | | |
| Carbon management (CMGT) | | | Carbon Emissions Intensity  Carbon Pricing Implementation  Renewable Energy Adoption | CO2 emissions per unit of gross domestic product (GDP)  Carbon taxes to total tax payable/paid  % of energy consumption from renewable sources to total environmental costs | Garcia and Martinez (2019); World Bank (2023)  World Bank report (2023)  Garcia and Martinez (2019); Agency (IEA) Statistics (2023) |
|  | Dependent Variable | | | | |
| Performance | | | Profit margin | Net income divided by total assets | Ganda and Milondzo (2018) |

**Sources: Data Generated by Author, 2025**

**4. Results and Discussion**

**Table 2: Descriptive Analysis:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | PFM | CARI | CARPI | RENE |
| Mean | 0.321800 | 0.866200 | 0.655800 | 0.567400 |
| Median | 0.150000 | 0.940000 | 0.010000 | 0.040000 |
| Maximum | 0.170000 | 0.970000 | 0.210000 | 0.470000 |
| Minimum | 0.030000 | 0.360000 | 0.010000 | 0.030000 |
| Std. Dev. | 0.056773 | 0.181230 | 0.053417 | 0.082234 |
| Skewness | -0.908252 | -1.952877 | 2.385612 | 3.171047 |
| Kurtosis | 2.026479 | 5.339923 | 7.642975 | 13.57389 |
| Jarque-Bera | 8.848809 | 43.18781 | 92.33707 | 316.7277 |
| Probability | 0.011981 | 0.000000 | 0.000000 | 0.000000 |
| Sum | 6.090000 | 43.31000 | 1.790000 | 3.370000 |
| Sum Sq. Dev. | 0.157938 | 1.609378 | 0.139818 | 0.331362 |
| Observations | 50 | 50 | 50 | 50 |

**Source: Data Analysis, 2025**

Table 2 discloses the are summarized results of the descriptive analysis showing the primary statistical characteristics of the variables being examined which include Performance (PFM), Carbon Accounting for Renewable Energy (CARI), Carbon Pricing Implementation (CARPI), and Renewable Energy (RENE),. The dataset's central tendencies are indicated by the mean values for these variables, which are 0.3218 for FPM, 0.8662 for CARI, 0.6558 for CARPI, and 0.5674 for RENE. A considerable number of enterprises have lower values in these indicators, as evidenced by the median values, which vary somewhat, especially in CARPI and RENE, where the values are 0.01 and 0.04 respectively.

The range of dataset may be seen in the highest and minimum values, which range from 0.03 to 0.17 for FPM, 0.36 to 0.97 for CARI, 0.01 to 0.21 for CARPI, and 0.03 to 0.47 for RENE. The standard deviations exhibit variation; the biggest standard deviation, 0.1812, is displayed by CARI, indicating a greater dispersion among enterprises with regard to carbon accounting for renewable energy. According to skewness values, CARPI (2.3856) and RENE (3.1710) show positive skewness, indicating a rightward tail, whereas FPM and CARI are negatively skewed (-0.9082 and -1.9529, respectively), implying a leftward distribution. Leptokurtic distributions, which have notable peaks in contrast to normal distributions, are indicated by the kurtosis values for RENE (13.5739) and CARPI (7.6430).

According to the statistics of the Jarque-Bera test and the associated p-values (p < 0.05), every variable exhibits a substantial deviation from normalcy. Overall, our findings imply that accounting variables related to performance and carbon management show different degrees of dispersion, with some displaying notable departures from normalcy. In further analysis, this supports the use of non-parametric methods or transformations.

**Table 3: Panel Unit Root Test**

|  |  |  |
| --- | --- | --- |
| Variable | t-statistics | P-value |
| FPM | 8.709151 | 0.000 |
| **CARI** | 4.909137 | 0.000 |
| CARPI | 5.279062 | 0.000 |
| RENE | 5.870436 | 0.0002 |

**Source: Data Analysis, 2025**

The results of the panel unit root test in Table 3 verify that every variable is stationary. With p-values of 0.000 and 0.0002, respectively, the t-statistics for FPM (8.7092), CARI (4.9091), CARPI (5.2791), and RENE (5.8704) are all significant, suggesting that all series are stationary at the level. This eliminates the need for additional differencing, allowing regression analysis to be performed on the dataset without worrying about erroneous findings.

**Table 4: Models Selection Tests**

|  |  |  |
| --- | --- | --- |
| Tests | Statistics | Probability |
| Breusch-Pagan test | 1.52850 | 0.03710 |
| Hausman test | 0.89342 | 0.06286 |

**Source: Data Analysis, 2025**

The results of post data selection test in Table 4 among the pooled least square (PLS) method, fixed effect (FE) and random effect (RE) models conducted show that the Breusch-Pagan test statistic (1.5285) and its p-value (0.0371) between PLS and FE supports fixed effect . Then, since the null hypothesis that RE is superior to the FE cannot be rejected, the Hausman test statistic (0.8934) and p-value (0.0629) show that the Random Effects Model is suitable for this investigation. As a result, the Random Effects Model is used in the analysis.

**Table 5: Regression Analysis: Random Effect**

SERIES: PFM, **CARI**, CARPI, RENE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Method: REM-Random Effect Model  Sample: 2019 2068  Include 10 Cross-sectional Units  Included observations: 50  Dependent Variable: Performance | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| Constant | 2.241655 | 0.520293 | 4.308448 | 0.0001 |
| CARI | 2.354010 | 0.517754 | 4.546583 | 0.0000 |
| CARPI | 7.091007 | 1.564551 | 4.532297 | 0.0000 |
| RENE | 1.046788 | 0.255018 | 4.104762 | 0.0002 |
| R2 = 0.711192, Adjusted R2- = 0.666270  F-statistic = 6.927339, Prob (F-statistic) = 0.000605  Durbin-Watson stat = 2.571788 | | | | |

**Source: Data Analysis, 2025**

Table 5 shows that the regression random effect model results reveals all the independent variables have substantial impact on performance (FPM). A strong model fit is confirmed by the R2 value (0.7112), which indicates that the independent variables account for 71.12% of the variation in performance. Even after controlling for the number of predictors, the model is still able to explain a significant amount of the variances in performance, according to the modified R2 (0.6663).

A large and significant positive impact on is indicated by the carbon accounting for Renewable Energy (CARI) positive coefficient of 2.3540, t-statistic of 4.5466, and p-value of 0.0000. This shows that financial results are improved by greater investment in carbon accounting based on renewable energy. A t-statistic of 4.5323 and a p-value of 0.0000 are also found for the carbon pricing implementation (CARPI), which has the highest coefficient (7.0910). Accordingly, the imposition of carbon pricing greatly improves performance, perhaps through the promotion of sustainability and efficiency incentives.

Also, with a coefficient of 1.0468, a t-statistic of 4.1048, and a p-value of 0.0002, renewable energy (RENE) significantly improves performance. This demonstrates that businesses who incorporate renewable energy into their operations see improved financial results. The model as a whole is statistically significant, as shown by the F-statistic (6.9273) and its probability (0.0006), which validate that the independent variables have an overall effect on performance. The trustworthiness of the regression estimations is ensured by the Durbin-Watson statistic (2.5718), which indicates the lack of autocorrelation. The statistical significance of the constant term (p = 0.0001) indicates that there is a baseline level of performance of 2.2417 even in the absence of the independent factors.

**4.1 Discussion of Findings**

The finding from this study showed that the performance of Nigerian listed industrial companies and carbon management accounting procedures are significantly positively correlated. In particular, the study finds that the implementation of carbon pricing, the intensity of carbon emissions, and the use of renewable energy are important variables impacting financial success. All three variables have statistically significant beneficial effects on performance, according to the regression results, with the installation of carbon pricing having the biggest influence.

These results are consistent with other research, including that of Egbunike and Afodigbueokwu (2021), who discovered that disclosure of greenhouse gases (GHGs) has a favorable impact on Tobin's Q, a metric used to assess the performance. In a similar vein, Garcia and Chen (2020) stressed how carbon pricing schemes can maximize business wealth. Furthermore, the study backs up the findings of Ganda and Milondzo (2018), who found that businesses who incorporate renewable energy into their operations get better financial results. The claim that carbon management techniques support financial sustainability is strengthened by the results' agreement with earlier studies. These findings have significant ramifications. First, they emphasize how important it is for businesses to incorporate sustainable carbon management techniques into their operational plans. Second, they recommend that in order to promote environmental and financial sustainability, regulatory agencies should implement carbon pricing schemes. Finally, the findings suggest that in order to achieve long-term profitability, corporate stakeholders should consider sustainability investments as strategic objectives rather than extra expenses.

**5. Conclusion**

The study concludes that the performance of Nigerian listed manufacturing enterprises is highly impacted by carbon management accounting techniques, namely carbon emissions accounting, the use of renewable energy, and the application of carbon price. According to the findings, performance is positively and significantly impacted by all three independent variables, with the implementation of carbon pricing having the biggest influence. Both the panel unit root test and the model selection tests verify that the Random Effects Model is appropriate and that the dataset is stationary. By implementing strong carbon management accounting procedures, Nigerian manufacturing companies may improve their performance, according to the research. Future studies should include other elements like corporate governance and regulatory compliance to give a more thorough picture of sustainability-driven performance.

A notable vacuum in the literature that previously concentrated more on corporate social responsibility and sustainability disclosures has been filled by this study, which offers empirical insights into the effect of carbon management accounting on financial performance within the Nigerian manufacturing industry. This research offers a comprehensive model for assessing the financial impact of CMA by integrating carbon emissions intensity, renewable energy uptake, and carbon price implementation, in contrast to earlier studies that looked at individual parts of CMA. The results have important policy implications because they show how carbon pricing and incentives for the use of renewable energy can improve environmental sustainability and business financial success.

**5.1 Recommendations**

This study suggests that in order to guarantee consistency and openness in business sustainability disclosures and boost investor confidence, regulatory agencies should create standardized carbon management reporting frameworks. Tax incentives and subsidies should be offered by the government and financial institutions to businesses that use renewable energy sources in order to promote sustainability without sacrificing financial success. Businesses should incorporate carbon pricing into their strategic financial planning in order to take advantage of cost-cutting opportunities and preserve a competitive edge while adhering to environmental requirements.

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**COMPETING INTERESTS DISCLAIMER:**

**Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.**

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