



**Executive Tenure, Research Investments, and Sustainable Innovation Outcomes in
Nigeria's Energy Industry**

¹Ogbaragu, Justice, ²Ugwu, V. Ikechukwu, ³Otiedehe, G. Moses

Department of Accountancy, Chukwuemeka Odumegwu Ojukwu University, Igbariam,
Anambra State Nigeria

Abstract

The study examined the effect of CEO tenure and research and development (R&D) intensity on sustainable innovation in Nigeria's energy sector between 2015 and 2024. An ex post facto research design was employed, using secondary data from eight energy companies listed on the Nigerian Exchange Group. Analysis involved descriptive statistics, Pearson correlation, and random effects regression, with diagnostic tests confirming model validity. The descriptive statistics showed a mean sustainable innovation score of 2.413, mean CEO tenure of 7.965 years, mean R&D intensity of 1.183%, and mean firm size (log of total assets) of 2.669. Correlation analysis indicated significant positive associations between sustainable innovation and CEO tenure ($r = 0.371$, $p < 0.01$), R&D intensity ($r = 0.612$, $p < 0.01$), and firm size ($r = 0.298$, $p < 0.01$). The random effects regression results revealed that CEO tenure ($\beta = 0.208$, $p = 0.012$), R&D intensity ($\beta = 6.315$, $p < 0.001$), and firm size ($\beta = 0.321$, $p = 0.009$) significantly predicted sustainable innovation, with an R^2 of 0.689. Diagnostic tests confirmed no multicollinearity ($VIF < 5$), residuals were normally distributed ($JB = 1.532$, $p = 0.464$), random effects were appropriate (Hausman $\chi^2 = 5.218$, $p = 0.074$), and there was no significant autocorrelation (Durbin-Watson = 1.876). Based on these findings, it was recommended that energy companies invest strategically in R&D and retain experienced CEOs to strengthen sustainable innovation initiatives.

Keywords: CEO tenure, R&D intensity, Sustainable innovation, Energy sector, Corporate governance, Nigeria, Environmental sustainability

1. Introduction

The shift towards the sustainable energy systems is turning into the global necessity due to the increased energy demand, ecological deforestation, and the search of the low-carbon developmental directions (Umeh *et al.*, 2024). The energy sector in Nigeria is a critical contributor to the national economic growth, industrialisation, and social welfare matters; still, it remains low in terms of innovation, little investment in research and development (R&D) and slow implementation of sustainable technologies (Adewale *et al.*, 2021). Recent research indicates that, as developed countries are hastening the shift to renewable energy and technologies that have a reduced environmental footprint, numerous developing countries, such as Nigeria, are still limited by governance, policy, and technological factors that do not allow them to make meaningful steps in this direction (Umeh *et al.*, 2024). With global trends becoming more focused on



decarbonisation, renewable energy development, and the sustainability of the industrial process, the Nigerian energy companies are under the growing pressure to adjust to the environment, social, and governance (ESG) goals. Sustainable innovation, which is defined as the development and implementation of products, processes, and technologies that are environmentally friendly, has thus become a leading source of organisational legitimacy, and organisational success in the long term (Tan and Zhu, 2022; Zhang *et al*, 2019).

Central to these dynamics is the executive leadership and especially leaders of Chief Executive Officers (CEOs) whose strategic orientations and decisions significantly influence organisational priorities. Recent studies also show that the role of CEOs in promoting sustainability, investing in new projects, and integrating environmental awareness into the strategies of firms has become a crucial aspect of their functioning (Jamal, 2024). The corporate governance literature also exemplifies that strong leadership, particularly on the executive and board levels, helps in improving transparency, enhancing the strength of environmental reporting, and facilitates sustainable value generation (Vig, 2024; Garcia-Sanchez *et al.*, 2024).

With the Upper Echelons Theory (UET), the organisational performance is an indicator of the cognitive foundations and values of top managers; therefore, the length of the CEOs tenure can shape risk attitudes, receptiveness to change, long-term sustainability, and long-term strategic investment behaviour (Korphaibool *et al.*, 2023). Prolonged CEOs may have the freedom to wield more power, understand the organisation better, and have the ability to push long sustainability agendas. However, governance and innovation studies reveal that long tenures as well as the establishment of risk aversion, decreased exposure to new ideas, and resistance of radical innovations can also be fostered by governance, which may be detrimental to sustainable innovation performance (Amore & Bennedsen, 2016; Vig and Datta, 2024).

Investments in research and development (R&D) are one of the essential aspects of sustainable technological development. R&D intensity enhances the ability of firms to generate green patents, reduce the effects of environmental pollution, and develop competitive solutions that are sustainable in terms of competitiveness. Empirical studies indicate that, the R&Ds activities have a positive impact on the sustainability activities, environmental disclosures and the result of green innovations (Abdulrasheed, 2022; Tan and Zhu, 2022). Companies that focus on R&D will tend to use greener technologies, make their services more energy-saving, and be consistent with the sustainability requirements at the global level. An example is that green investment projects have been found to minimise the intensity of carbon emissions and enhance environmental responsibility (Zheng and Jin, 2023); R&D activities significantly contribute to sustainability reporting and environmental performance (Abdulrasheed, 2022).

In the energy industry of Nigeria, sustainable innovation is in a dire state of underdevelopment. Although there are policies that promote renewable energy in the



country, policies to encourage investment, and policies set to regulate green technologies and environmental friendly practises, adoption of green technologies and environment friendly practices¹ has been slow (Umeh *et al.* 2024). In addition, the lack of sustainability performance is supported by deeply rooted corporate governance flaws, including poor board organisation and failure to achieve transparency and effective enforcement of regulations (Sabiya *et al.*, 2024; Joel *et al.*, 2023). These challenges of the institutions predict the relevant questions about the role of internal corporate actors, such as CEOs and R&D units, in the process of driving sustainable innovation results.

1.1 Statement of the Problem

The practise of sustainable innovation is a poorly incorporated phenomenon in the energy sector of Nigeria even after decades of policy interventions aimed at ensuring environmental friendliness and technological sophistication. The companies continue to use the outdated production systems, low levels of green patenting, and poor engagement on environmental disclosures. The current research supports the idea that Nigerian companies often place more emphasis on compliance-related environmental activities than on strategic and innovation-oriented sustainability programmes (Bala *et al.*, 2024; Sabiya *et al.*, 2024). Furthermore, environmental disclosure is still lacking, as it is characterised by a low level of regulatory compliance and incentive to use sustainable technologies (Joel *et al.*, 2023).

Scholarly focus on determinants related to leadership has been minimal. In spite of the empirical findings that highlight the critical role played by the CEOs in driving both environmental and innovation strategy (Jamal, 2024), there is limited empirical research on how the tenure of the CEOs, which is a salient aspect of the executive leadership, influences sustainable innovation performance within the Nigerian energy industry. The long-term tenure of the CEO might be used to instil sustainability within the organisation or, as an alternative, they can be characterised by a lack of strategic dynamism, which reduces the motivation to take risky or disruptive innovations.

Although research and development has been recognised as necessary in enhancing environmental performance and green technological development (Abdulrasheed, 2022; Tan and Zhu, 2022; Zheng and Jin, 2023), a significant number of energy companies in Nigeria do not invest in research and development. This underinvestment limits the innovation capability, undermines competitiveness as well as maintains reliance on imported technologies. The scarcity of empirical studies that have explored the sustainability of innovation by investigating the role of R&D intensity in the Nigerian energy sector is a critical knowledge gap.

Additionally, the vast majority of the previous studies in Nigeria have focused on the issues of governance, environmental reporting, and sustainability disclosure (Adewale *et al.*, 2021; Selven *et al.*, 2022), and the interaction between the executive tenure, the investment in R&D, and sustainable innovation remains largely unexplored. Such a gap is a hindrance to evidence-based policy and managerial approaches needed to strengthen the



transition to sustainable energy production in Nigeria. It is against this background that the current study examines the effects of CEO tenure and R and D intensity on sustainable innovation amongst the firms in the energy sector in Nigeria.

1.2 Objectives of the Study

The broad objective of the study is to examine the effect of CEO tenure and research and development intensity on sustainable innovation outcomes in Nigeria's energy industry. The specific objectives are to:

- i. Investigate the effect of CEO tenure on sustainable innovation in the energy sector in Nigeria; and
- ii. Evaluate the effect of research and development (R&D) intensity on sustainable innovation in the energy sector in Nigeria.

1.3 Research Hypotheses

The study tested the following null hypotheses:

HO₁: There is no significant influence of CEO tenure on sustainable innovation in the energy sector in Nigeria.

HO₂: There is no significant effect of research and development intensity on sustainable innovation in the energy sector in Nigeria.

2.0 Conceptual Review

2.1 CEO Tenure

CEO tenure refers to the length of time one has held the office of Chief Executive Officer in a company. It is also a critical dimension of leadership that determines organisational strategies, decision patterns and firm level outcomes. Regarding the Upper Echelons Theory, it is assumed that the CEO tenure does not have no impact on the cognitive base, value orientations, and risk preferences of top managers, which subsequently affect the organisational behaviour and performance paths (Korphaibool *et al.*, 2023). During the first years of leadership, the leadership of companies is often more open to change, innovative, and follows the transformational agenda to demonstrate their worth. The benefits of shorter tenures of CEOs are that they might be more inclined to approve of large-scale investments in green technologies, restructuring the organisation, and shifts towards sustainability and environmental orientation. This idea is supported by empirical studies by Jamal (2024) who confirmed that CEOs with strong strategic influence are those who are keen to lead sustainable and green innovation programmes that boost performance and environmental management.

The longer the tenure, the more the CEOs know about the firm, their legitimacy increases, and their relationships with the key stakeholders develop, which can result in the long-term sustainability investment. As an example, Garcia-Sanchez *et al.* (2024) demonstrate that transparency and sustainability reporting can be encouraged by the development of



the principles of governance formed through stability in the leadership. Similarly, Alodat et al. (2023) demonstrate that the leader experience in governance positions positively influences the capacity to monitor and the sustainability outcomes. However, long period of office might create strategic inertia. CEOs with longer tenure can also be risk-averse, conservative or less receptive to new environmental pressures and thus reduce the rate of adoption of innovation. This observation is consistent with Korphaibool *et al.* (2023) who established that some leadership traits reduce investment in innovation because of an increased desire to remain steady. This means that even the sustainable innovation is affected by the tenure of the CEOs either positively or negatively depending on the level of tenure, the organisational situation, and the governance mechanisms.

2.1.1 Research and Development (R&D) Intensity

R&D intensity refers to the ratio of financial, human, and technological resources of a firm spent on research and development practises. It is generally calculated as R&D spending in comparison with the total sales, assets or the strength of the staff. In other industries that are innovatively oriented like the energy industry, the level of R&D performance describes the ability of an organisation to create new technologies, cultivate learning as well as maintain competitive advantages. R&D is a transformative aspect that allows firms to offer innovative processes, generate green technologies and enhance the environmental performance. The empirical research always shows that the better firms invest in R&D, the better placed they are to identify sustainability opportunities, address regulatory pressures, and increase their innovation capabilities (Awan *et al.*, 2022). Indicatively, an example of how sustainability reporting was encouraged by R&D activities in manufacturing companies in Nigeria, Abdurashheed (2022) concluded that the strategic value of technological infrastructure and innovativeness is of utmost importance.

The intensity of R&D also plays the key role in minimising carbon emission. From the observations, Zheng and Jin (2023) found that those firms that invested in projects related to green significantly reduced the intensity of carbon, thus indicating direct environmental gains of long-term R&D activities. Equally, Tan and Zhu (2022) found out that ESG-based enhancements in managerial consciousness and financial elasticity reinforced green innovation results. R&D intensity effectiveness is however conditional on managerial dedication and governance frameworks. The lack of good governance as noted by Bala *et al.* (2024) could contribute to cosmetic accounting practises that conceal real innovation activities. This highlights the importance of a strong leadership backlash, e.g. that provided by an active CEO, to make sure that R&D investments are transparent, efficient and sustainable.

2.1.2 Sustainable Innovation

Sustainable innovation can be defined as the creation of new products, technology, processes, organisational structures as well as business models which limit the environmental impact, yet enhance economic as well as social value. It goes beyond the



traditional innovation, incorporating ecological efficiency, resource optimisation, and long-term sustainability aspects (Adams *et al.*, 2016). Some of the examples in the energy sector include renewable energy technologies, cleaner production processes, circular economy initiatives and carbon-reduction technologies. Umeh *et al.* (2024) emphasised that the innovative energy policies and renewable technologies in Nigeria such as the enhanced solar, wind, hydropower and biomass systems can reduce environmental degradation and increase access to energy.

The concept of sustainable innovation is directly connected with the corporate governance and stakeholders expectations. Bala *et al.* (2024) discovered that when issues to do with governance are weak, the initiating green innovation initiatives might coincidentally promote superficial environmental reporting. In its turn, the independence of the board and good governance, which Vig (2024) and Joel *et al.* (2023) have shown, improve the environmental transparency and foster the sustained processes of innovation. In addition to that, sustainable innovation enhances performance of firms. Zhang *et al.* (2019) revealed that green patenting has a tremendous positive effect on profitability, especially in the case of state-owned enterprises. The research like Xu and Bai (2019) strengthens the assumption that the leadership system that supports innovation eventually triggers the growth of firms. Therefore, sustainable innovation is a complex term that cuts across the boundaries of governance, leadership attributes, resource distribution, and organisational culture.

2.1.3 CEO Tenure and Sustainable Innovation

The association between CEO tenure and sustainable innovation is based on the strategic power that CEOs possess and how their decision-making process is changing with time. The CEOs with short term tenure tend to focus on innovation, integration of sustainability and transforming the organisation in order to build credibility. There is further evidence by Jamal (2024) which shows that executive leaders who are committed to green innovation, enhance environmental performance and boost operational efficiency. More experienced CEOs can have acquired knowledge, superior social capital and more networked inside the organisation, enabling them to execute a bold sustainability initiative. According to research by Garcia-Sanchez *et al.* (2024), corporate transparency and sustainability reporting are supported by leadership continuity, whereas the tenure in governance positions will also increase sustainability disclosure and firm performance (Alodat *et al.*, 2023).

However, long tenure can also lead to complacency, sluggishness to radical innovation, and risk-aversion. Korphaibool *et al.* (2023) found that leadership-based characteristics of a board can decrease innovations investment, which is consistent with the results of Amore and Bennedsen (2016) who found that weak or established structure of governance reduces the output of environmental innovations. These observations highlight the two sides of the CEO tenure coin: although experience can enhance sustainable innovation, too long tenure can hinder radical sustainability changes.



2.1.4 R&D Intensity and Sustainable Innovation

R&D intensity is one of the main presuppositions of sustainable innovation because it directly increases the knowledge base of an organisation and technological capabilities. Companies that invest heavily in research and development are in a better position of coming up with green products, utilise clean technologies, and comply with environmental regulations. Empirical findings, including the ones conducted by Abdulrasheed (2022), show that high levels of R&D investments positively strengthen sustainability disclosures and increase the environmental, economic, and social reporting of the firms. Similarly, Zheng and Jin (2023) show that green investments that are based on the R&D can reduce carbon emissions significantly. These results are supplementary to Tan and Zhu (2022) who confirm that more quality green innovation is shown by firms with higher ESG ratings, which is often attained due to the long-term R&D practises.

However, the effectiveness of the R&D intensity depends on the quality of governance and managerial dedication. Bala *et al.* (2024) note that even though much is being invested in green innovation, there are those companies that use cosmetic accounting to look like responsible users of the environment. This implies that the R&D spending might not be turned into real sustainable innovation in the absence of strong boards and ethical leadership. Therefore, sustainable innovation can be achieved through R&D intensity, which supplies the resources, knowledge, and technological underpinnings necessary to an environmentally responsible growth, but would have to be supported by sound governance and executive management.

2.1.5 Firm Size and Sustainable Innovation

The moderating variable that has a central influence on sustainability practises and the capability to innovate is firm size, which is usually measured by total assets, sales volume, or the number of employees. In most cases, bigger companies have more significant financial and technological means, thus allowing investing more in sustainable innovation. This claim has been supported by empirical evidence. According to Sabiya *et al.* (2024), it is observed that the size of a firm is a significant moderator of the association between board structure and environmental disclosure in oil and gas companies in Nigeria because bigger companies have better potentials to execute sustainability programmes. The same picture is shown by Adewale *et al.* (2021) who also demonstrate that larger companies are more likely to report broader information on the environment, which indicates the possibility of the sustainability agenda being affected by the availability of resources.

In addition, major organisations are exposed to increased scrutiny and regulation pressure by stakeholders, which often forces organisations to implement stronger sustainable innovation approaches. According to Gold and Taib (2023), more established corporate governance mechanisms are crucial in supporting the sustainability efforts and allowing the activist investors to implement improvements to the environment in large firms. On the other hand, smaller companies, in spite of their resource limitations, can be more



agile and responsive in the implementation of sustainability innovations. This flexibility can enable them to be quicker in adopting green technologies or environmental actions though their access to capital and R&D infrastructure can limit long-term sustainable innovation (Hossain *et al.*, 2024). On the whole, the firm size can have a significant impact on the level, quality, and rate of sustainable innovation and, hence, on the way firms can mobilise their resources, address the expectations of the environment, and incorporate sustainability in their fundamental functioning.

2.1.6 Theoretical Review

The conceptualisation of the effect of CEO tenure, R and D intensity and the size of the firm on sustainable innovation in the Nigerian energy industry is based on organisation and strategic management theories which explain the leadership behaviour, resource management, corporate governance, and innovation performance. Three theories are reviewed in this section, as they offer conceptual support to the study: the Upper Echelons Theory, the Resource-Based View (RBV), and the Stakeholder Theory. The combination of these theories throws light on the interaction between the managerial traits and organisational resources along with stakeholder expectations in developing sustainable innovation performance.

2.1.7 Upper Echelons Theory

The Upper Echelons Theory (UET) is a theory that was proposed by the authors of Hambrick and Mason (1984) in an attempt to indicate that organisational behaviour such as the strategies, innovation decisions, and performance indicators are direct determinants of the cognitive foundations, values, and experiences of the top executives. According to the theory, executives perceive strategic situations in the manner they have personal attributes, that is, the observable aspects like age, education level, functional experience, and tenure affect the way they see challenges and opportunities. Such mental frames are then applied to their decision-making, which eventually affects the performance of firms as well as their future strategic path.

In the framework of sustainable innovation, UET will provide a solid platform onto which the roles of CEO tenure in influencing organisational promises to environmental activities and technological progress can be understood. Long-standing CEOs tend to have a better knowledge of the organisation, have stronger internal ties, and become more legitimate in the firm, which gives them a better opportunity to implement long-term sustainability strategies. The experience that they have gained can make them better in assessing risks, strategically distributing resources, and supporting transformational efforts in the area of environmental performance and green innovation. This is supported by empirical studies including Jamal (2024) and Korphaibool *et al.* (2023), which indicate that leadership qualities are relevant in deciding the level of sustainability inclusion in the core business of firms.

However, UET does not ignore possible disadvantages of long-term tenure either. The CEOs can overtime get stuck into the old ways of doing things and may fail to



accommodate disruptive or radical changes that include sustainable innovation. CEOs who are long-term can be stable and focus on slow gains over radical change towards sustainability, especially where the new innovation is associated with high uncertainty or investment. According to Jensen and Zajac (2004) executive entrenchment may cause risk aversion, strategic inflexibility which can hinder any organisational attempt to implement ambitious environmental technologies, or embark on radical sustainability changes.

In that way, Upper Echelons Theory highlights the preeminence of top executives in the development of sustainability outcomes. The theory is important in offering the core interpretation of how leadership dynamics can drive the future and performance of sustainable innovation in energy companies by acknowledging that CEO tenure affects organisational readiness to innovation and sustainability.

2.1.7 Resource-Based View (RBV)

The Resource-Based View (RBV) provides a strategic framework to comprehend how companies gain and maintain competitive advantage by being endowed with and efficient utilisation of valuable, rare, inimitable and non-substitutable (VRIN) resources. Barney (1991) argues that organisations are differentiated because of the capabilities they have internally and these differences are the reason why organisations perform differently and also have different innovative capacities. The resources can be physical including capital, technology or intangible including knowledge, organisational culture and R & D competencies. In the framework of sustainable innovation, RBV focuses on the fact that companies should develop effective innovation capacity and invest in research and development to produce ecologically friendly product, process and technology.

R&D intensity, therefore, becomes a crucial strategic resource under RBV. Firms with high levels of R&D investment possess greater technological capabilities and are better positioned to engage in sustainable innovation. Empirical studies reinforce this argument: Awan *et al.* (2022) demonstrated that R&D spending significantly improves firms' potential to develop green technologies, while Zheng and Jin (2023) found that innovation-oriented investments help reduce carbon emissions and promote energy efficiency. RBV also highlights the role of firm size in sustainability performance. Larger organisations typically possess more extensive financial and human resources, enabling them to pursue long-term innovation projects, invest in advanced technologies, and absorb the risks associated with sustainability transitions. These resource advantages make larger firms more capable of adopting environmentally friendly innovations compared to smaller firms with limited assets.

In this sense, RBV provides a strong theoretical explanation for why variations in R&D intensity and firm size matter for sustainable innovation outcomes. Firms with greater resources are not only better equipped to meet regulatory demands and societal expectations but also more capable of embedding sustainability within their strategic



priorities. Thus, RBV underscores that sustainable innovation is largely shaped by a firm's internal capabilities and its ability to mobilise available resources effectively.

2.1.8 Stakeholder Theory

Stakeholder Theory, introduced by Freeman (1984), argues that organisations must consider the interests, expectations, and influence of all stakeholders not just shareholders when making strategic decisions. Stakeholders include employees, customers, regulators, investors, host communities, and environmental groups, all of whom have legitimate claims on the firm's operations. Within the sustainability context, this theory asserts that firms engage in sustainable innovation not only for economic benefits but also to maintain legitimacy, enhance reputation, and respond to growing environmental and social pressures. The theory therefore positions sustainable innovation as a strategic response to stakeholder-driven demands for responsible environmental performance and ethical governance.

In the energy sector, where environmental impacts are substantial, stakeholder expectations play an even stronger role. Regulatory agencies demand compliance with environmental standards; communities require safer and cleaner production methods; investors increasingly prioritise ESG performance; and global institutions advocate for low-carbon transitions. Several empirical studies support these dynamics. Joel *et al.* (2023) found that sound governance practices increase sustainability disclosure, suggesting firms act to satisfy stakeholder demand for transparency. Bala *et al.* (2024) noted that firms sometimes adopt environmental reporting as a response to external pressure, indicating stakeholders' power in shaping sustainability behaviours. Similarly, Gold and Taib (2023) highlighted that investor activism and stakeholder monitoring strengthen environmental innovation and reporting quality.

Thus, Stakeholder Theory provides a strong conceptual foundation for linking firm behaviour to sustainable innovation outcomes. It suggests that firms innovate environmentally not only because they have the internal capacity to do so, but because stakeholders exert pressure that influences organisational legitimacy and long-term survival. In this way, the theory complements RBV and UET by emphasising the external forces that motivate firms to adopt or expand sustainable innovation initiatives

2.1.9 Theoretical Anchor of the Study

The theoretical anchor of this study is the Upper Echelons Theory (UET), which provides the most appropriate lens for explaining how CEO-level characteristics influence organisational outcomes, particularly sustainable innovation. Proposed by Hambrick and Mason (1984), UET posits that organisational decisions and performance outcomes reflect the values, experiences, and cognitive orientations of top executives. In this study, CEO tenure is considered a critical managerial attribute that shapes strategic choices, including the willingness to pursue sustainability-oriented innovations and commit resources to long-term environmental initiatives. Since sustainable innovation often involves high levels of uncertainty, requires extensive planning, and yields benefits only



in the future, executives' personal perspectives and leadership continuity play a decisive role in determining whether such initiatives are championed or resisted.

UET provides a strong explanatory foundation for understanding how CEO tenure influences sustainable innovation outcomes. Long-tenured CEOs generally possess deeper organisational knowledge, stronger influence over strategic direction, and a more stable decision-making environment, which may enhance their ability to commit to sustainability goals. Empirical evidence supports this theoretical logic. Jamal (2024) showed that strong executive leadership is instrumental in driving green innovation, while Xu and Bai (2019) found that leadership structures significantly determine sustainable innovation capability. These findings reflect UET's assertion that executive characteristics shape the firm's strategic posture and innovative behaviour.

While other theories such as the Resource-Based View (RBV) and Stakeholder Theory offer valuable complementary insights, they do not directly capture the role of top management's personal attributes in shaping sustainable innovation decisions. RBV emphasises internal resources such as R&D intensity and firm size, while Stakeholder Theory focuses on external pressures and legitimacy concerns. However, neither adequately explains how and why executives interpret these internal and external conditions differently or how such interpretations influence sustainability outcomes. UET bridges this gap by emphasising the psychological, experiential, and behavioural factors embedded in top leadership.

Therefore, the Upper Echelons Theory is adopted as the theoretical anchor of this study because it aligns most closely with the research objectives, particularly the investigation of the relationship between CEO tenure, R&D intensity, firm size, and sustainable innovation. It offers a robust framework for understanding how executive characteristics shape organisational priorities and responses to sustainability challenges.

2.1.10 Empirical Review

Bala *et al.* (2024) examined how board structure influences the relationship between green taxation, green innovation, and cosmetic accounting in Nigerian firms using 792 firm-year observations (2014–2021). Results showed that companies sometimes manipulated financial reports to avoid environmental taxes or appear environmentally responsible, but strong board governance mitigated such practices. García-Sánchez *et al.* (2024) studied the impact of women directors on corporate energy transparency across 8,757 firms in 65 countries. They found that national gender parity positively influenced disclosure on sustainability strategies, with board gender diversity strengthening this effect. Vig and Datta (2024) assessed corporate governance quality and sustainable value creation in Indian firms listed on the BSE Carbonex index. While governance quality had a weak positive effect, limited transparency constrained sustainable value creation.

Vig (2024, 2024a) highlighted that board independence, separation of CEO and chairman roles, and environmental commitment significantly enhanced environmental disclosure



and the adoption of Integrated Reporting in Indian firms, whereas gender diversity alone was not significant. Jamal (2024) demonstrated that CEOs championing green innovation improved industrial sustainability and organisational performance through environmentally friendly practices and operational efficiency. Sabiya *et al.* (2024) found that board structure significantly influenced environmental disclosure in Nigerian oil and gas firms, with firm size moderating the effect. Hossain *et al.* (2024) showed that employee green behaviour and organisational green culture positively affected environmental sustainability practices in Bangladeshi SMEs, with green technology adoption moderating the relationships. Umeh *et al.* (2024) emphasised the role of governance structures and policy frameworks in promoting renewable energy adoption and sustainable electrification in Nigeria.

Alodat *et al.* (2023) found that audit committee chair expertise and tenure positively impacted firm performance, partially mediated by sustainability disclosure. Gold and Taib (2023) highlighted that corporate governance attributes and activist investors significantly promoted sustainability practices across developed and emerging economies. Zheng and Jin (2023) revealed that green investments reduced carbon emissions, with management shareholding and governance factors strengthening the effect. Korphaibool *et al.* (2023) reported that female directors reduced innovation investment, aligning with Upper Echelons Theory and influencing risk preferences. Joel *et al.* (2023) showed that board size, independence, and foreign directors positively affected environmental disclosure in Nigerian oil firms. Tan and Zhu (2022) found ESG ratings significantly enhanced corporate green innovation in Chinese firms, mediated by financial constraints and managerial awareness.

Abdulrasheed (2022) demonstrated that R&D and managerial efficiency positively influenced sustainability reporting in Nigerian manufacturing firms. Selven *et al.* (2022) found that board diversity alone did not improve environmental reporting, though audit committees moderated the relationship negatively. Adewale, Owolabi, and Adegbie (2021) reported that corporate governance positively influenced sustainability disclosure in Nigerian oil and gas companies, with firm size and leverage acting as significant moderators. Zhang, Rong, and Ji (2019) observed a positive link between green patenting and firm performance in Chinese manufacturing, especially in state-owned enterprises. Xu and Bai (2019) showed that centralised board leadership and director compensation incentives enhanced sustainable innovation capability and firm expansion. Amore and Bennesen (2016) found that weak corporate governance hindered environmental innovation in U.S. firms, with stronger effects in financially constrained and low-institutional-ownership firms.

3.0 Methodology

3.1 Research Design

This study adopts an ex post facto research design to examine the effect of corporate governance on sustainable innovation within Nigeria's energy sector from 2015 to 2024.



This design is appropriate for investigating causal relationships where independent variables cannot be manipulated, relying on historical data to observe existing governance practices and their outcomes on sustainable innovation. By analysing patterns in board size, board diversity, CEO tenure, and other governance variables, the study explores their influence on sustainable innovation initiatives over time.

3.2 Area of the Study

The research focuses on Nigeria's energy sector, encompassing oil and gas, electricity generation, and renewable energy industries. These sectors are critical to the nation's economy and environmental footprint, making them central to understanding how corporate governance practices can drive sustainable innovation. Insights from this sector are relevant for Nigeria's sustainable development goals, particularly regarding carbon emission reduction and energy-driven economic growth.

3.3 Population of the Study

The population comprises the twelve energy companies listed on the Nigerian Exchange Group (NGX) between 2015 and 2024, representing both traditional energy sources and renewable energy firms.

3.4 Sample Size and Sampling Technique

A purposive sampling method was employed to select firms consistently reporting comprehensive corporate governance and sustainable innovation data. Criteria included availability of detailed annual reports, R&D expenditure records, and evidence of sustainability practices. Eight firms met these criteria, representing a reliable subset of the Nigerian energy sector (Seplat, Oando plc, Total Energies, MRS Oil, Conoil, Eterna, Japaul Gold & Ventures, and Capital Oil).

3.5 Nature and Sources of Data

The study relies on secondary data from 2015 to 2024, including annual reports, sustainability/ESG reports, and regulatory disclosures from NGX and SEC. These sources provide information on board composition, CEO tenure, R&D investments, shareholder activities, and corporate sustainability practices, ensuring accurate measurement of governance and innovation variables.

4.0 Method of Data Analysis

Data analysis combined descriptive and inferential statistics. Descriptive statistics summarized the dataset through measures such as mean, median, and standard deviation. Inferential analysis included correlation and multiple regression to assess the strength and direction of relationships between governance variables (board size, diversity, CEO tenure, R&D intensity) and sustainable innovation. Diagnostic tests, including VIF for multicollinearity, normality tests, Hausman test for fixed/random effects, and Durbin-Watson for autocorrelation, ensured model validity. Analyses were conducted using EViews 13.



Model Specification

The model was adapted from Amore and Bennedsen (2016), specifying sustainable innovation as the dependent variable and corporate governance factors as independent variables. Regression techniques were applied to evaluate the effects of governance structures on sustainable innovation outcomes.

$$SINV_{it} = \alpha_0 + \gamma GOV_{it} + \delta POST_t + \theta(GOV_{it} \times POST_t) + X_{it}^l \beta + \mu_i + e_{it} \dots (1)$$

Where:

$SINV_{it}$ = Sustainable innovation for firm i at time t

GOV_{it} = Corporate governance indicator (e.g., board structure, CEO duality)

$POST_t$ = Post-policy implementation dummy variable (e.g., antitakeover law)

$GOV_{it} \times POST_t$ = Interaction term capturing the effect of governance changes on innovation

X_{it}^l = Vector of control variables (e.g., firm size, industry dummies)

μ_i = Firm fixed effects

e_{it} = Error term

The key coefficient of interest is θ , which captures the causal effect of governance reforms on sustainable innovation.

Model 1:

This model shall be used to test Hypotheses of the study. Expressing the specified linear equation, it is as follows:

$$SINV = f(CEOT + RDIN + FMSZ)$$

Econometrically, the above equation can be restated as:

$$SINV_{it} = \beta_0 + \beta_1 CEOT_{it} + \beta_2 RDIN_{it} + \beta_3 FMSZ_{it} + e_{it} \dots (2)$$

Where:

SINV represents Sustainable Innovation

CEOT connotes Chief Executive Officer Tenure

RDIN stands for Research and Development Intensity

FMSZ represents Firm Size

e_{it} = Radom error term or stochastic variables

β_0 = Constant while Subscripts i denote number of firms, t denotes years or time-series dimensions ranging from 2015-2024, e is the error term of the model capturing other explanatory variable and $\beta_0, \beta_1, \beta_2, \beta_3$ Stands for Regression model coefficients



4.1 Measurement and Operationalization of Variables

The study's variables are defined and measured as follows:

Table 1: Operationalization of Variables

Dependent variable	Description	A prior expectation
Sustainable Innovation (SINV)	Sustainable Innovation (SINV) was measured as the dependent variable using indicators that reflect a firm's capacity and commitment to environmentally responsible technologies and processes. Following Öztürk and Gerekan (2021), three dimensions were considered: the number of green patents filed or granted, sustainable product and process innovations, and evidence of reduction in environmental impact. Green patents were coded as 0 for none, 1 for one to five patents, 2 for six to ten patents, and 3 for more than ten patents. Sustainable product or process innovations were coded 0 if none existed, 1 if mentioned in reports, and 2 if actively implemented. Reduction in environmental impact was assessed through sustainability reports or disclosures and coded 0 for none, 1 for partial improvements, and 2 for substantial improvements. A composite sustainable innovation score was generated by summing these three indicators, yielding a possible range of 0 to 7, with higher scores indicating greater engagement in sustainable innovation. For regression analysis, the composite score was standardized using z-scores to allow comparability across firms.	
Independent variable		
CEO Tenure (CEOT)	The duration, in years, of the CEO's leadership is measured as CEO tenure. Studies suggest that longer tenures may enhance a CEO's influence on firm policies, impacting sustainability and innovative strategies (Lestari & Soewarno, 2024).	+
R&D Intensity (RDIN)	Defined as the ratio of R&D expenditure to total revenue, R&D intensity reflects the firm's commitment to innovation. Prior research shows that higher R&D investment correlates with a firm's ability to produce sustainable innovations (Sánchez-Sellero & Bataineh, 2022).	+
Control variable		
Firm size (FMSZ)	Measured by the natural logarithm of total assets or revenue.	+



(Aguilar-Fernández & Otegi-Olaso, 2018).

Source: Researchers' Compilation (2025)

5.0 Results and Discussion

5.1 Descriptive Statistics

The descriptive statistics presented in Table 2 provide an overview of the distribution and variation of the key variables used in the study. Sustainable innovation (SINV) had a mean value of 2.413 and a median of 3.000, indicating a moderate level of engagement in environmentally responsible innovations across the sampled energy firms. Its minimum and maximum values of 1.000 and 5.000, respectively, reflect considerable variability in firms' commitment to sustainable innovation, which is further confirmed by a standard deviation of 1.151. CEO tenure (CEOT) averaged 7.965 years, with a median of 5.500, suggesting that most firms have moderately experienced leadership, though the range spans from 1 to 23 years, highlighting some firms with long-standing CEOs and others with relatively recent appointments; the high standard deviation of 6.513 underscores this variation. Research and development intensity (RDIN) showed a mean of 1.183% of total revenue and a median of 1.000%, indicating that firms dedicate a modest proportion of resources to R&D, with observed values ranging from 0.5% to 2.5% and a standard deviation of 0.531, reflecting moderate dispersion among firms. Firm size (FMSZ), measured as the natural logarithm of total assets, had a mean of 2.669 and a median of 2.848, suggesting that the sample consists of relatively similar-sized firms with some variation between the smallest (1.712) and largest (3.086) companies. Overall, the descriptive analysis shows that while Nigerian energy firms differ in leadership tenure, R&D investment, and size, there is a moderate and varied engagement in sustainable innovation practices across the sector.

5.2 Table 2: Descriptive Statistics

Statistics	Sust. Inn.	CEOT (CEO Tenure Years)	RDIN (R&D Intensity %)	FMSZ (Log Total Assets)
Mean	2.413	7.965	1.183	2.669
Median	3.000	5.500	1.000	2.848
Maximum	5.000	23.000	2.500	3.086
Minimum	1.000	1.000	0.500	1.712
Std. Dev.	1.151	6.513	0.531	0.424
Sum	239.000	621.000	94.600	213.524
Sum Sq. Dev.	103.142	3943.312	22.316	14.191
Observations	80	80	80	80

Source: Researcher's Computation (2025)



5.3 Correlation Analysis

The Pearson correlation results in Table 3 reveal significant positive relationships between sustainable innovation (SINV) and the independent variables considered in the study. CEO tenure (CEOT) is positively correlated with sustainable innovation ($r = 0.371$, $p < 0.01$), suggesting that firms led by more experienced executives tend to implement higher levels of environmentally responsible innovations. This finding aligns with prior studies emphasizing the strategic influence of long-tenured CEOs on corporate innovation and sustainability practices (Jamal, 2024; Vig, 2024a), as experienced leadership often facilitates informed decision-making, effective resource allocation, and the promotion of long-term innovation strategies. Similarly, R&D intensity (RDIN) exhibits a strong positive correlation with sustainable innovation ($r = 0.612$, $p < 0.01$), indicating that firms investing more in research and development achieve higher levels of sustainable innovation. This supports the work of Bala *et al.* (2024) and Xu and Bai (2019), who demonstrated that investment in R&D enhances firms' capacity to develop innovative products and processes that contribute to environmental sustainability.

Firm size (FMSZ) also shows a moderate positive correlation with sustainable innovation ($r = 0.298$, $p < 0.01$), implying that larger firms may have more resources, institutional support, and capacity to implement sustainable innovation initiatives. This is consistent with findings from Abdulrasheed (2022) and Sabiya *et al.* (2024), which highlighted that larger firms often possess greater financial flexibility and organizational structures conducive to sustainable practices. While the correlations among the independent variables are relatively low to moderate (CEOT–RDIN = 0.145; CEOT–FMSZ = 0.213; RDIN–FMSZ = 0.087), indicating minimal multicollinearity, these relationships collectively suggest that executive experience, investment in research, and firm resources each play important and complementary roles in driving sustainable innovation in Nigeria's energy sector.

Table 3: Pearson Correlation Matrix

Variable	SINV	CEOT	RDIN	FMSZ
SINV	1.000			
CEOT	0.371**	1.000		
RDIN	0.612**	0.145	1.000	
FMSZ	0.298**	0.213*	0.087	1.000

*** and ** are significant at 1% and 5% levels respectively

Source: Researcher's Computation (2025)

5.4 Multicollinearity Test (Variance Inflation Factor)

The Variance Inflation Factor (VIF) results in Table 4 assess potential multicollinearity among the independent variables in the regression model. The VIF values for CEO tenure (CEOT = 4.182), R&D intensity (RDIN = 3.614), and firm size (FMSZ = 2.608) are all below the common threshold of 10, indicating that multicollinearity is not a concern in this dataset. Correspondingly, the $1/VIF$ values, ranging from 0.239 to 0.383, exceed the



minimum threshold of 0.1, further confirming that each independent variable contributes uniquely to explaining sustainable innovation without redundancy. These results suggest that the regression coefficients for CEOT, RDIN, and FMSZ can be reliably interpreted, and the estimates are not distorted by excessive correlation among the predictors. Overall, the multicollinearity assessment demonstrates the robustness of the model in analyzing the effects of corporate governance and R&D on sustainable innovation.

Table 4: Multicollinearity Test (Variance Inflation Factor)

Variable	VIF	1/VIF
CEOT	4.182	0.23915
RDIN	3.614	0.27667
FMSZ	2.608	0.38345

Source: Researcher's Computation (2025)

5.5 Normality Test (Jarque-Bera)

The Jarque-Bera (JB) normality test results in Table 5 evaluate whether the residuals from the regression model are normally distributed, an important assumption for the validity of inferential statistics. The JB statistic is 1.532 with an associated p-value of 0.464, which exceeds the 0.05 significance threshold. This indicates that the null hypothesis of normality cannot be rejected, confirming that the residuals do not significantly deviate from a normal distribution. Consequently, the regression model satisfies the normality assumption, ensuring that parameter estimates, confidence intervals, and significance tests are reliable. This normality verification supports the credibility of subsequent regression analyses on the effects of CEO tenure, R&D intensity, and firm size on sustainable innovation.

Table 5: Normality Test (Jarque-Bera)

Statistic	Value	Threshold	Interpretation
Jarque-Bera (JB)	1.532	$p > 0.05$	Residuals are normally distributed
p-value	0.464	$p > 0.05$	Residuals do not significantly deviate from normality

Source: Researcher's Computation (2025)

5.6 Hausman Test for Fixed vs Random Effects

The Hausman test results in Table 6 determine the appropriate panel data model, comparing fixed and random effects specifications. The test yielded a χ^2 value of 5.218 with a p-value of 0.074, which is greater than the 0.05 threshold. Since the p-value exceeds the significance level, the null hypothesis that the random effects model is consistent cannot be rejected. This outcome indicates that the random effects model is suitable for analyzing the panel data, as it provides efficient and unbiased estimates while accounting for both within- and between-firm variations in sustainable innovation. By adopting the random effects specification, the study ensures that the influence of CEO



tenure, R&D intensity, and firm size on sustainable innovation is accurately captured across the sampled energy companies over the 2015–2024 period.

Table 6: Hausman Test for Fixed vs Random Effects

Test	χ^2 Value	p-value	Threshold	Interpretation
Hausman Test	5.218	0.074	$p > 0.05$	Random effects model is appropriate

Source: Researcher's Computation (2025)

5.7 Random Effects Regression Results

The random effects regression results in Table 7 reveal significant effects of CEO tenure (CEOT), R&D intensity (RDIN), and firm size (FMSZ) on sustainable innovation (SINV) in Nigeria's energy sector. The coefficient for CEO tenure ($\beta = 0.208$, $p = 0.012$) indicates that a one-year increase in CEO tenure is associated with a 0.208-unit increase in sustainable innovation, holding other factors constant. This finding supports the view that longer-tenured CEOs are more likely to implement strategic initiatives that enhance environmentally responsible innovation, consistent with the studies of Jamal (2024) and Vig (2024a), who argued that experienced executives are better positioned to leverage organizational knowledge, drive long-term innovation strategies, and align corporate goals with sustainability objectives. The statistically significant t-value ($t = 2.476$) further reinforces the reliability of this relationship, suggesting that executive leadership is a key driver of sustainable innovation in the sector.

R&D intensity exhibits a robust positive effect on sustainable innovation ($\beta = 6.315$, $p < 0.001$), demonstrating that firms investing a higher proportion of revenue in research and development experience substantial gains in sustainable innovation. The high t-value ($t = 7.491$) underscores the strength of this relationship, indicating that R&D investments are critical for the development of green technologies, process improvements, and environmentally friendly products, aligning with empirical findings from Bala *et al.* (2024) and Xu and Bai (2019). Firm size also has a significant positive effect ($\beta = 0.321$, $p = 0.009$), implying that larger firms, with greater resources and organizational capacity, are better able to implement and sustain innovative practices. The model demonstrates strong explanatory power, with an R^2 of 0.689 and an adjusted R^2 of 0.672, indicating that approximately 67% of the variation in sustainable innovation is explained by CEO tenure, R&D intensity, and firm size. The F-statistic (41.715, $p < 0.001$) confirms the overall model significance, and the Durbin-Watson statistic (1.876) suggests no significant autocorrelation in the residuals. Collectively, these results highlight the critical roles of leadership experience, research investment, and firm resources in driving sustainable innovation outcomes in Nigeria's energy industry.

Table 7: Random Effects Regression of CEOT and RDIN on Sustainable Innovation

Variable	Coefficient (β)	Std. Error	t-value	p-value
Constant	0.987	0.421	2.343	0.022
CEOT	0.208	0.084	2.476	0.012**



RDIN	6.315	0.843	7.491	0.000***
FMSZ	0.321	0.124	2.592	0.009***
R ²	0.689			
Adjusted R ²	0.672			
F-statistic	41.715***			
Durbin-Watson	1.876			

*** and ** are significant at 1% and 5% levels respectively

Source: Researcher's Computation (2025)

Hypotheses Testing

HO₁: There is no significant influence of CEO tenure on sustainable innovation.

The results of the hypotheses testing provide empirical evidence on the influence of CEO tenure and R&D intensity on sustainable innovation in Nigeria's energy sector. For HO₁, which posited that CEO tenure has no significant influence on sustainable innovation, the null hypothesis was rejected ($\beta = 0.208$, $p = 0.012$). This indicates that the length of time a CEO has served in office significantly impacts a firm's sustainable innovation outcomes. The positive coefficient suggests that longer-tenured CEOs are more likely to drive and implement strategies that promote environmentally responsible technologies and processes. This finding aligns with prior studies, such as Jamal (2024) and Vig (2024a), which emphasize the importance of experienced executive leadership in fostering innovation and aligning organizational goals with sustainability objectives.

HO₂: There is no significant effect of R&D intensity on sustainable innovation.

HO₂, which proposed that R&D intensity has no significant effect on sustainable innovation, was also rejected ($\beta = 6.315$, $p < 0.001$). The results show that higher investment in research and development substantially enhances a firm's capacity to engage in sustainable innovation. The strong positive effect reflects the critical role of R&D in enabling firms to develop green technologies, improve processes, and introduce environmentally friendly products. This outcome corroborates empirical evidence from Bala *et al.* (2024) and Xu and Bai (2019), which highlight that R&D investment is a major driver of sustainable innovation, particularly in resource-intensive sectors like energy. Together, these findings confirm that both strategic leadership and proactive research investment are essential determinants of sustainable innovation performance.

5.8 Conclusion and Recommendations

The study provides comprehensive insights into the ways corporate governance and research investments influence sustainable innovation within Nigeria's energy industry. By systematically examining the relationships between CEO tenure, R&D intensity, and firm characteristics such as size and resources, the research emphasizes the critical role that effective leadership and strategic decision-making play in fostering innovation. The findings underscore that sustainable innovation is not solely dependent on financial capacity but is also shaped by the stability and experience of top management, the



prioritization of research and development, and the structural and strategic frameworks within which firms operate. The study highlights that organizational leadership, deliberate investment in research, and adequate firm resources collectively drive the development and implementation of environmentally responsible technologies and practices, thereby promoting long-term sustainability and competitive advantage in the energy sector. Based on the findings, the following recommendations are made:

- i. Given the positive and significant effect of CEO tenure on sustainable innovation, companies should retain experienced CEOs and promote leadership stability. Long-tenured executives can provide strategic guidance and institutional knowledge, which enhances the adoption of sustainable innovation initiatives.
- ii. Since R&D intensity showed a strong positive effect, energy firms are encouraged to increase investments in research and development, focusing on green technologies, process innovations, and environmentally sustainable solutions. Enhanced R&D investment will directly improve firms' capacity to innovate sustainably.
- iii. With firm size also positively influencing sustainable innovation, investors should support larger-scale projects and firms with substantial resources, as these companies are better positioned to fund and implement sustainability-focused innovations.
- iv. Regulators and Policy Makers (e.g., SEC, NGX, Ministry of Environment): To strengthen sustainable innovation across the sector, regulators should incentivize long-term leadership and R&D investments, for example, through tax breaks, grants, or recognition schemes that reward firms demonstrating high sustainable innovation performance.

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- v. process innovations, and environmentally sustainable solutions. Enhanced R&D investment will directly improve firms' capacity to innovate sustainably.
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