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Evaluating the Impact of National Energy Policy on Environmental Sustainability in the Niger Delta, Nigeria

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Abstract **Original Research Article**

Environmental sustainability represents a multidimensional construct encompassing the conservation, protection, and responsible management of natural resources and ecosystems. Rooted in ecological preservation, biodiversity conservation, environmental degradation, and pollution mitigation, sustainability is shaped by both intrinsic and extrinsic factors. Yet, despite their significant contributions, environmental sustainability in the Niger Delta region of Nigeria has become a subject of concern as most of the communities are faced with high uncertainty and business failure rates. Therefore, this study examined the impact of national energy policy on environmental sustainability in the Niger Delta region of Nigeria. This study was conducted with the aid of an integrated theoretical framework derived from environmental justice and ecological modernisation theories, among others, and a survey research method for data collection. The study found that hydrocarbon exploration and gas flaring have a statistically significant impact on environmental sustainability in the Niger Delta region of Nigeria at 5% level of significance. The regulatory framework has a positive but insignificant impact on environmental sustainability in the Niger Delta region of Nigeria at 5% level of significance. The study concluded that national energy policy influences environmental sustainability in the Niger Delta region of Nigeria. The study thus recommended, among others that reviews and strengthen existing environmental regulations to address all potential environmental impacts of hydrocarbon exploration comprehensively. This may require updating legislation, closing loopholes and incorporating stricter environmental standards.

Keywords: Hydrocarbon Exploration policies, Gas flaring policies, Regulatory frameworks, Environmental sustainability.

INTRODUCTION

The energy sector is one of the most critical pillars of Nigeria's economy, accounting for over 65% of government revenue and 90% of foreign exchange earnings (Central Bank of Nigeria, 2022). It drives national development and international trade, but also presents significant environmental challenges. With growing demand for both fossil fuels and renewable sources, Nigeria faces the urgent task of balancing economic growth with environmental sustainability (Odenu et al., 2025; World Bank, 2023). The International Energy Agency (2023) has observed that poorly managed extraction activities in oil-producing nations, particularly Nigeria, are major drivers of ecological degradation. Similarly, the African Development Bank (2023) projects a 45% increase in Nigeria's energy demand by 2040, underscoring the need for robust policy reforms to prevent further environmental decline.

The Niger Delta region illustrates the severity of this dilemma. Since the start of oil production in 1958, more than 546 million gallons of oil have been spilt, destroying 65% of wetlands, degrading 70% of arable land, and contaminating drinking water for over 30 million people (NOSDRA, 2023; NCF, 2021; UNEP, 2021). Fisheries have declined by 60%, while mangrove loss has accelerated at 12% annually since 2010 (UNDP, 2022). Nigeria is also among the world's largest gas-flaring nations, with 7.4 billion cubic feet of gas emitted in 2018 alone (PwC, 2019). This practice releases 35 million tons of CO_2 annually (World Bank, 2022), increases climate vulnerability (Al-Amin et al., 2025), and costs the economy over ₦233 billion in lost value (PwC, 2019). The consequences extend beyond the environment, with respiratory diseases in oil-producing communities rising by 40% (UNDP, 2022).

Despite numerous interventions, environmental deterioration persists. Oil spill frequency rose by 28% between 2015 and

2023, mainly due to ageing infrastructure and sabotage (NOSDRA, 2023). While gas flaring in Nigeria has dropped from 53% in 2001 to about 10% in 2018, the country has achieved only 20% progress toward its 2030 zero-flaring target (PwC, 2019). Deforestation around inland basins has tripled as oil exploration expands, threatening to replicate Niger Delta–like crises in new regions (Sabiu & Magaji, 2024). These patterns undermine Nigeria's commitments to the Sustainable Development Goals (SDGs) and the Paris Climate Agreement (Dickson et al., 2025).

Underlying these outcomes are structural weaknesses in energy governance. Nigeria's petroleum sector suffers from fragmented policies, weak institutions, overlapping responsibilities, and limited accountability, which have institutionalised patterns of neglect (Ambituuni et al., 2014; Nwankwo, 2015; Abubakar et al., 2025a). The regulatory framework remains weak, with agencies such as NOSDRA, DPR, and NMDPRA operating in silos, resulting in uncoordinated enforcement (Edomah et al., 2017; Ite et al., 2013). Meanwhile, technological disparities exacerbate sustainability challenges, as some firms adopt modern technologies while others rely on outdated infrastructure with higher ecological footprints (Olanrewaju et al., 2022). Illegal refining and pipeline vandalism further complicate the governance landscape (Nigerian Navy, 2023).

Although existing studies have examined policy frameworks (Akpan et al., 2025) and specific environmental impacts (Mukhtar et al., 2025), few have investigated how national energy policy shapes sustainability outcomes through hydrocarbon exploration, gas flaring practices, and regulatory mechanisms in the Niger Delta. This study seeks to fill this gap by assessing the relationship between Nigeria's energy policies and environmental sustainability in the region.

The study's specific objectives are: (i) to examine the effect of hydrocarbon exploration policies on environmental sustainability; (ii) to determine the impact of regulatory frameworks; and (iii) to evaluate the role of gas flaring policies. The null hypotheses tested are that hydrocarbon exploration, regulatory frameworks, and gas flaring policies do not significantly affect environmental sustainability in the Niger Delta.

This investigation is timely given Nigeria's dual challenge of sustaining economic growth while safeguarding its fragile ecosystems. By evaluating the interplay between energy policies and environmental outcomes, the study contributes to understanding how national policy reform can advance sustainability in one of the world's most resource-endowed yet ecologically threatened regions.

LITERATURE REVIEW

Conceptual Definitions

Environmental Sustainability: Environmental sustainability refers to the responsible use and management of natural resources in ways that ensure ecological integrity, biodiversity conservation, and ecosystem resilience for present and future generations (World Commission on Environment and Development, 1987; Elliott, 2013). It deals with maintaining ecological balance, reducing pollution, preventing land degradation (Tanko et al., 2025), and ensuring that economic development does not compromise environmental quality (Yakubu et al., 2015). In the Niger Delta context, environmental sustainability involves protecting fragile ecosystems such as mangroves, wetlands, and rivers from oil spills, gas flaring, and deforestation, which have severely impacted livelihoods and human health (NOSDRA, 2023; UNDP, 2022).

National Energy Policy: A national energy policy outlines a country's strategies for ensuring a reliable, affordable, and sustainable energy supply while balancing socio-economic growth and environmental protection (Edomah, 2017). Nigeria's energy policy framework, first launched in 2003 and revised in 2013, focuses on diversifying the energy mix, reducing gas flaring, enhancing renewable energy integration, and improving energy efficiency (Federal Government of Nigeria, 2013). However, critics argue that weak enforcement mechanisms, fragmented institutional arrangements, and persistent overreliance on hydrocarbons undermine its effectiveness in promoting sustainability (Ambituuni et al., 2014; Akpan et al., 2025).

Hydrocarbon Exploration Policies: Hydrocarbon exploration policies regulate oil and gas drilling, extraction, and transportation activities. While they are intended to balance revenue generation with environmental protection, in practice, weak enforcement in Nigeria has led to extensive oil spills, soil degradation, and water contamination in the Niger Delta (Ite et al., 2013; Abubakar et al., 2025b).

Gas Flaring Policies: Gas flaring, the burning of associated natural gas during oil production, remains a major contributor to greenhouse gas emissions in Nigeria. Despite policies such as the Associated Gas Re-Injection Act (1979) and the Nigerian Gas Flare Commercialisation Programme (2016), implementation remains weak. Nigeria continues to rank among the top ten global gas-flaring nations (PwC, 2019; World Bank, 2022).

Regulatory Frameworks: Regulatory frameworks refer to institutional structures and legal mechanisms designed to ensure compliance with environmental and energy policies. In Nigeria, multiple agencies such as the Department of Petroleum Resources (DPR), National Oil Spill Detection and Response Agency (NOSDRA), and Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA) exercise overlapping functions, resulting in policy conflicts and weak accountability (Nwankwo, 2015; Olanrewaju et al., 2022).

Theoretical Framework

This study is anchored on two complementary theories:

1. Environmental Justice Theory: Environmental justice emphasizes fair treatment and equitable distribution of environmental benefits and burdens across communities, regardless of ethnicity, socio-economic class, or location (Bullard, 1990). In the Niger Delta, oil-producing communities bear the disproportionate burden of environmental degradation without corresponding socio-economic benefits.

Environmental justice theory highlights how exclusion from decision-making processes and inequitable access to resources aggravate poverty and conflict (Aigbedion, 2020). This framework is critical for analysing how Nigeria's national energy policy addresses or fails to address the social equity dimension of environmental sustainability.

2. Ecological Modernization Theory (EMT): Ecological modernisation posits that environmental protection can be reconciled with economic development through technological innovation, institutional reform, and regulatory modernisation (Mol & Spaargaren, 2000). EMT is particularly relevant to this study because it emphasises how policy-driven technological changes—such as gas re-injection systems, cleaner extraction technologies, and renewable energy integration—can reduce environmental harm while maintaining energy production. However, in Nigeria, outdated infrastructure and corruption limit the effectiveness of ecological modernisation, making this valuable theory for highlighting both potential and limitations (Edomah et al., 2017).

Empirical Review

Emeseh (2021) analysed environmental policy frameworks across 12 developing petroleum-producing countries to assess Nigeria's position within the comparative landscape. The research utilised a mixed-methods approach combining legal document analysis, expert surveys, and case study evaluations to develop a comprehensive policy effectiveness index. The study found that Nigeria's Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) ranked in the middle tier for policy comprehensiveness (scoring 6.8/10) but in the bottom quartile for implementation effectiveness (scoring 3.2/10), with particularly significant gaps in enforcement mechanisms and technical capacity. While methodologically robust, the study's reliance on expert assessments introduces potential subjective bias, and the aggregation of scores into composite indices may obscure important nuances in specific policy domains.

Ambituuni et al. (2014) investigated the implementation challenges in Nigeria's petroleum sector regulatory system. The study used a mixed-methods approach combining legal analysis, compliance data from 112 facilities, and key informant interviews. The research found that jurisdictional overlaps resulted in substantial enforcement gaps, with 41% of documented environmental violations receiving no enforcement response due to unclear agency responsibilities. Environmental inspectors were responsible for areas approximately 300% larger than recommended by international best practices, and only 42% of the required monitoring technologies were available to enforcement personnel. Political interference was documented in 68% of major enforcement cases, undermining regulatory independence and effectiveness. The study's focus on downstream operations limits its applicability to upstream exploration activities, and it does not adequately distinguish between different types of regulatory violations.

Giwa et al. (2019) quantified the environmental and health impacts of gas flaring in the Niger Delta region. The research employed a quantitative methodology combining remote sensing data, atmospheric sampling, and dispersion modeling. The study documented approximately 35 million tons of CO_2 and other pollutants emitted annually through gas flaring, with black carbon concentrations exceeding World Health Organisation guidelines in 83% of sampled locations around flaring sites. Communities within 5km of active flaring sites experienced 42% higher incidence of respiratory conditions compared to demographically similar communities beyond this range. The focus on atmospheric emissions addresses only one dimension of gas flaring impacts, overlooking effects on soil acidification, water quality, and vegetation, and the study provides limited temporal analysis to assess policy effectiveness over time.

Theoretical Framework

Sachs and Warner (1995) established the Resource Curse Theory through econometric analysis of growth patterns across resource-rich and resource-poor countries. The study employed cross-national statistical analysis, economic modelling, and comparative case assessment. The research identified a paradoxical negative relationship between natural resource abundance and economic growth, with resource-rich countries growing more slowly than resource-poor countries despite their apparent advantage. Sachs and Warner demonstrated that this relationship remained robust even when controlling for various economic, geographic, and policy factors. While groundbreaking in establishing statistical relationships, the study's primary economic focus did not fully address the institutional and political mechanisms through which the resource curse operates.

Ross (2015) expanded the Resource Curse Theory to examine political and institutional dimensions beyond economic effects. The research employed a multi-method analysis, combining statistical assessments of 170 countries, process tracing in selected cases, and theoretical development. The study identified three primary causal mechanisms through which the resource curse operates: (1) the rentier effect, where governments derive sufficient revenue from resources to reduce accountability to citizens; (2) the repression effect, where resource revenues fund internal security apparatuses that suppress dissent; and (3) the modernization effect, where resource dependence impedes social and institutional changes associated with development. Ross demonstrated that these mechanisms operate with particular intensity in petroleum-dependent states, with oil-rich countries 50% more likely to be authoritarian and significantly more prone to weakened institutional quality. While providing valuable theoretical refinement, the study's broad comparative approach may obscure important contextual variations in how the resource curse manifests in specific countries like Nigeria.

The Resource Curse Theory provides this study with analytical tools for understanding how Nigeria's heavy dependence on oil revenues has shaped governance incentives, institutional capabilities, and policy implementation patterns in ways that systematically undermine environmental sustainability objectives. The theory helps explain persistent implementation gaps across Nigeria's environmental policy landscape, where well-crafted policies frequently fail to translate into effective protection measures. Furthermore, its attention to how resource extraction creates opportunities for corruption and patronage politics illuminates the political-economic.

METHODOLOGY

This study adopts a descriptive survey research design. Descriptive research aims to describe the characteristics of a population or phenomenon by collecting data through surveys, interviews, or observations. Survey research involves the use of standardised questionnaires or interviews to collect data from a sample of respondents that is representative of the target population (Fowler Jr, 2013).

The population of this study comprised five hundred and fifty (550) representatives of the selected stakeholders with knowledge, experience, or direct involvement in Nigeria's energy policy, oil exploration, and environmental management, particularly in the Niger Delta region. According to Chandan et al (2020), the sample size is the number of sampling units selected from the population for investigation.

This study employed Taro Yamane's sample formula (1968) to determine sample size.

$$n = \frac{N}{1+N(e)2}$$

Where n = sample size

N = Population

e = rate of error

N= 550

e= 0.05

$$n = \frac{550}{1+550(0.05)^2}$$

$$n = \frac{550}{1+550(0.0025)}$$

$$n = \frac{550}{1+1.375}, n=$$

n = 232

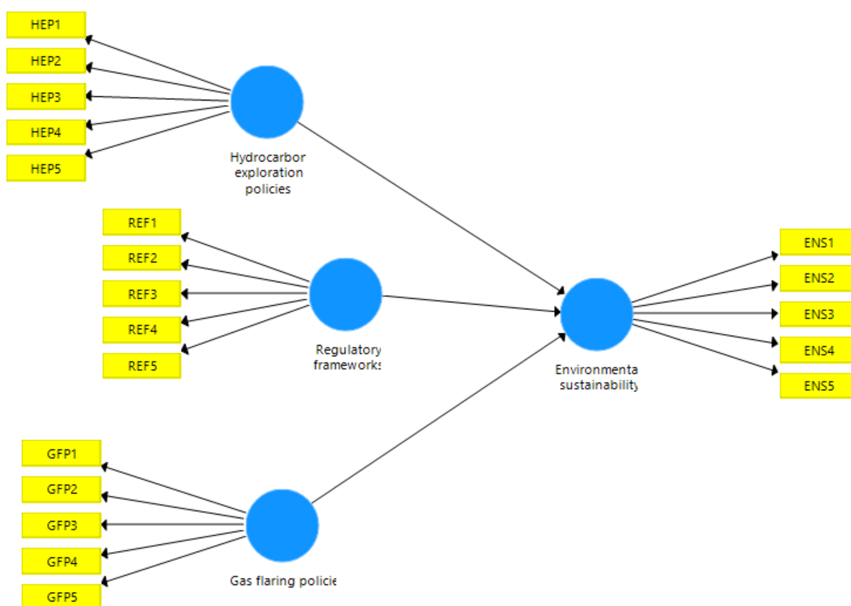

Fig. 1 the Model of the Study

The PLS-SEM analysis was conducted using the Smart PLS software, following a two-step approach. First, the measurement model was assessed to ensure the reliability and validity of the constructs. This step verified the accuracy of the measurement items for entrepreneurial leadership, strategic resource management, and business networking. Second, the structural model was evaluated to test the hypothesized relationships between energy policies and environmental sustainability. This method enabled a comprehensive examination of both direct and indirect effects, providing a deeper understanding of how various components of energy policies impact the environmental sustainability of the region.

However, the research process adhered to strict ethical standards. Informed consent was obtained from all participants, ensuring they were aware of the study's purpose and their right to withdraw at any time without repercussion. Confidentiality of the participants' responses was guaranteed, and all data was anonymized and securely stored to protect the privacy of the respondents. This approach ensured the integrity and ethical soundness of the research process.

RESULTS AND DISCUSSIONS

Assessment of Measurement Model

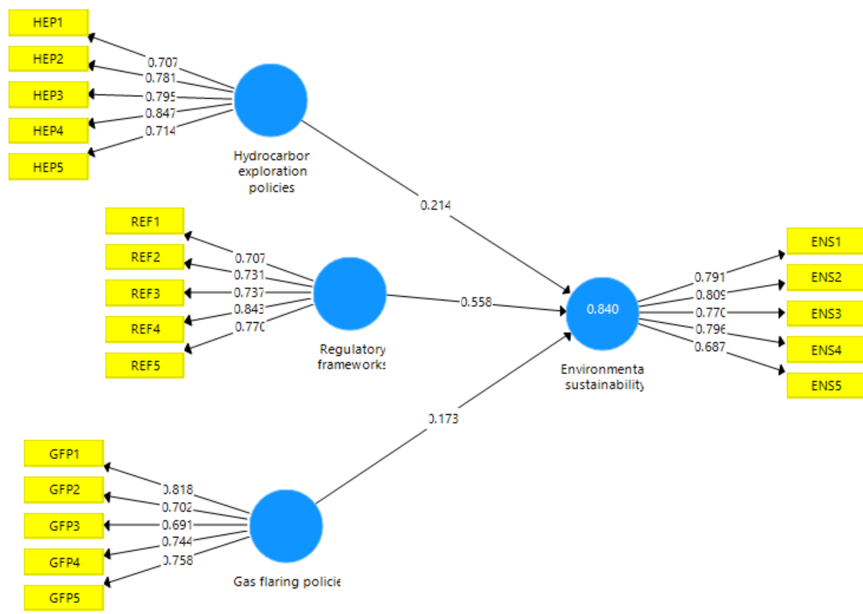

Fig. 2: Measurement model of the study constructs and indicators.

Source: Smart PLS Output, 2025

Table 1: Convergent validity

Variables	Indicators	Factor Loadings	Cronbach's alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Environmental sustainability	ENS1	0.932	0.915	0.934	0.936	0.745
	ENS2	0.809				
	ENS3	0.838				
	ENS4	0.799				
	ENS5	0.927				
Hydrocarbon Exploration	HEP1	0.939	0.896	0.912	0.924	0.708
	HEP2	0.791				
	HEP3	0.821				
	HEP4	0.809				
	HEP5	0.934				
Regulatory Framework	SRM1	0.864	0.880	0.897	0.912	0.677
	REF2	0.887				
	REF3	0.742				
	REE4	0.742				
	REF5	0.866				
Gas Flaring Policies	GFP1	0.843	0.939	0.955	0.953	0.804
	GEP2	0.900				
	GEF3	0.883				
	GEP4	0.918				
	GEP5	0.937				

Source: Smart PLS Output, 2025

The Environmental sustainability variable shows strong internal consistency and reliability, with a Cronbach's alpha of 0.915, indicating excellent reliability. The Composite Reliability (CR) is 0.936, further confirming that the construct is reliable. The Average Variance Extracted (AVE) is 0.745, indicating that 74.5% of the variance in the performance indicators is accounted for by the latent construct, which suggests good convergent validity. Each indicator, such as ENS1 (0.932) and ENS5 (0.927), has high factor loadings, further validating that these items strongly represent the underlying performance construct. These results suggest that the measurement of environmental sustainability is robust and reliable, providing confidence that this variable accurately captures the intended performance-related aspects within the Niger Delta.

For the Hydrocarbon exploration policies construct, the Cronbach's alpha of 0.896 shows strong internal consistency. With a Composite Reliability (CR) of 0.924 and an AVE of 0.708, the construct demonstrates good reliability and convergent validity. The AVE indicates that the hydrocarbon exploration policies explain 70.8% of the variance in the construct. Factor loadings, such as HEP1 (0.939) and HEP5 (0.934), are high, reinforcing the validity of the indicators in measuring hydrocarbon exploration policies. These findings suggest that hydrocarbon exploration is a well-measured variable in this context, providing a reliable assessment of leadership affecting environmental sustainability.

The regulatory framework variable displays a Cronbach's alpha of 0.880, indicating high reliability. The Composite Reliability is 0.912, confirming the construct's consistency, while the AVE is 0.677, suggesting that the latent construct captures 67.7% of the variance in the regulatory framework. Factor loadings, such as REF1 (0.864) and REF2 (0.887), show that these indicators strongly represent the construct, while REF3 and REF4 (both 0.742) show slightly lower but still acceptable loadings. These results imply that the construct of regulatory framework is measured reliably, although some indicators could potentially be refined for even stronger representation.

The gas flaring variable demonstrates the highest internal consistency, with a Cronbach's alpha of 0.939 and an extremely high Composite Reliability of 0.953. The AVE of 0.804 indicates that 80.4% of the variance is explained by the construct, confirming strong convergent validity. Factor loadings such as GEP5 (0.937) and GEP4 (0.918) are particularly high, indicating that these items are excellent indicators of the business networking construct. These results suggest that gas flaring is a well-defined and reliably measured construct in this study, playing a significant role in explaining sustainability in the Niger Delta. The above results are shown in Fig. 2 and Table 1

Discriminant Validity

Table 2: Heterotrait-Monotrait Ratio (HTMT)

	Gas flaring policies	Hydrocarbon exploration policies	Environmental sustainability	Regulatory framework
Gas flaring policies				
Hydrocarbon exploration	0.596			
Environmental sustainability	0.329	0.416		
Regulatory framework	0.290	0.318	0.205	

Source: Smart PLS Output, 2025

Table 3 presents the Heterotrait-Monotrait Ratio (HTMT) results, which are crucial for assessing the discriminant validity of the constructs in the study. The Heterotrait-Monotrait Ratio (HTMT) values in the table are all well below the standard threshold of 0.85, indicating good discriminant validity between the constructs. Discriminant validity ensures that each latent variable in the model represents a unique concept. For example, the HTMT value between gas flaring and Strategic hydrocarbon exploration is 0.596, confirming that these two constructs are perceived as distinct by the respondents. Similarly, the Regulstory framework and Environmental sustainability have an HTMT value of 0.205, showing a clear distinction between the regulatory framework and sustainability outcomes. This distinction is critical because it implies that the variables are independent enough to study how each uniquely affects the performance of the environment without overlap.

The low HTMT values for all constructs suggest that the model can effectively differentiate between the constructs of Regulatory Framework, Hydrocarbon Exploration, Gas Flaring, and Environmental Sustainability. For example, Environmental Sustainability shows values of 0.329 and 0.416 in relation to the regulatory framework and Hydrocarbon exploration, respectively, indicating that while there are relationships between these factors, they are distinct and can be evaluated separately. This distinction enables a more precise understanding of how various energy policies contribute to Environmental sustainability. The findings ensure that the model is reliable and that any conclusions drawn from the relationships between these variables are based on well-defined and separate constructs, enhancing the robustness of the study’s outcomes.

Path Coefficients

Table3: Path Coefficient

	Original Sample (O)	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
REF -> ENS	0.282	0.285	0.065	4.330	0.000
HEP -> ENS	0.079	0.087	0.051	1.531	0.126
GEP-> ENS	0.148	0.150	0.067	2.209	0.028

Source: Smart PLS Output, 2025

Figure 3 and Table 2 show that standard beta and the corresponding t-values were used in assessing the structural model in this study. It was done through the bootstrapping procedure.

H$_{O1}$: Hydrocarbon exploration has no significant effect on the environmental sustainability in the Niger Delta region of Nigeria.

The bootstrapping result from the Smart PLS reveals that the path coefficient of hydrocarbon exploration and environmental sustainability (HEP->ENS) is positive and statistically significant at 5% level of significance. The path coefficient from Hydrocarbon exploration (HEP) to Environmental sustainability (ENS) is 0.282, with a T-statistic of 4.330 and a P-value of 0.000. These results indicate that Hydrocarbon exploration has a statistically significant and positive effect on Environmental sustainability, as the P-value is less than 0.05, and the T-statistic is well above the critical value of 1.96. This means that effective Hydrocarbon exploration significantly enhances the environmental sustainability in the region. Organisations that demonstrate strong hydrocarbon skills can guide their teams more effectively, foster innovation, and make strategic decisions that improve their overall relationship with the host communities. The implication here is that Hydrocarbon exploration is a crucial factor in driving environmental sustainability success, and efforts to develop long-term sustainability capabilities within the Niger Delta region that can lead to improved business outcomes. The finding is in line with the finding of Sawaean et al. (2021) who investigated the relationship between hydrocarbon exploration and environmental sustainability in Kuwait and found that Hydrocarbon exploration had a significant positive impact on environmental sustainability. The finding is also in agreement with the findings of Tsetim et al. (2020), who examined the impact of Hydrocarbon exploration on environmental sustainability in Bayelsa State, Nigeria and significant relationships between all aspects of Hydrocarbon exploration (miner, explorer, accelerator, and integrator behaviours) and environmental sustainability.

H$_{O2}$: Regulatory frameworks have no significant effect on the environmental sustainability in the Niger Delta region of Nigeria

For the second hypothesis, the result from the Smart PLS reveals that the path coefficient of regulatory frameworks (REF) and environmental sustainability (REF->ENS) is positive but statistically insignificant at 5% level of significance. The path coefficient from regulatory frameworks (REF) to Environmental sustainability (ENS) is 0.079, with a T-statistic of 1.531 and a P-value of 0.126. Since the P-value is greater than 0.05, the relationship between Regulatory frameworks and Environmental Sustainability is not statistically significant in this model. The T-statistic being below the critical threshold of 1.96 further confirms that the impact of regulatory frameworks on environmental sustainability is weak or insignificant in this context. This implies that while regulatory frameworks are important, they may not be the sole driver of sustainability improvements for the Niger Delta region, or that other factors (such as host communities' engagement) may be moderating this relationship. The finding is in disagreement with the finding of Riana et al. (2020), who investigated the influence of regulatory frameworks and competitive strategy on the environmental sustainability in Bali, Indonesia and found that regulatory frameworks and strategic competitive strategies have a positive and significant effect on the environmental sustainability in Bali, Indonesia

H$_{03}$: Gas flaring has no significant effect on the environmental sustainability in the Niger Delta region of Nigeria

The bootstrapping result from the Smart PLS reveals that the path coefficient of gas flaring (GEP) and environmental sustainability (GEP->ENS) is positive and statistically significant at 5% level of significance. The gas flaring (GEP) to Environmental sustainability (ENS) is 0.148, with a T-statistic of 2.209 and a P-value of 0.028. This shows that gas flaring has statistically significant and environmental sustainability, as the P-value is below the 0.05 threshold. The T-statistics further confirm this significance by exceeding the critical value of 1.96. This finding suggests that effective gas flaring contributes positively to environmental sustainability, potentially by providing access to valuable resources, market information, and partnerships. For the host community in the Niger Delta, fostering strong networks with oil companies and other stakeholders can be a key strategy to enhance performance and seize business opportunities. The finding is in tending with the finding of Adudu et al. (2021) who assessed the impact of gas flaring on the environmental sustainability in Rivers State, Nigeria and found that all three network factors positively and significantly impacted environmental sustainability Specifically, network structure had the highest influence on sustainability, followed by network governance and content.

Multicollinearity Test

Table 5: Inner VIF Values

	Performance of SMES
Hydrocarbon exploration	1.448
Regulatory frameworks policies	1.109
Gas flaring policies	1.434

Source: Smart PLS Output, 2025

Table 5 presents the Inner Variance Inflation Factor (VIF) values for the structural model of the study, and it shows the VIF values for the three predictor constructs. The Inner VIF (Variance Inflation Factor) values in the table measure the level of multicollinearity between the independent variables, with values above five indicating potential multicollinearity issues. In this case, the VIF values for Hydrocarbon exploration (1.448), Regulatory frameworks (1.109), and Gas flaring policies (1.434) are all well below the threshold of 5, indicating low multicollinearity among the variables. This means that the independent variables Hydrocarbon exploration, regulatory frameworks and gas flaring policies are not highly correlated with each other and are providing unique contributions to explaining environmental sustainability. The implication is that the model is stable, and each variable's effect on environmental sustainability can be interpreted independently, which strengthens the validity of the results.

R Square

Table 6: R Square

	R Square	**R Square Adjusted**
Environmental sustainability	0.172	0.165

Source: Smart PLS Output, 2025

Table 6 presents the R Square values for the structural model, explicitly focusing on the endogenous variable, environmental sustainability. These values show the explanatory power of the model in the context of environmental sustainability in Niger Delta. The R Square (R^2) value of 0.172 indicates that the independent variables hydrocarbon exploration, regulatory frameworks and gas flaring policies explain 17.2% of the variance in environmental sustainability. The R Square Adjusted value of 0.165 accounts for the number of predictors in the model, slightly adjusting for potential overfitting. This suggests that, after accounting for the number of predictors, about 16.5% of the variation in environmental sustainability can still be explained by these factors.

While the R^2 value indicates that the model has some explanatory power, the relatively low value suggests that other factors not included in the model may also significantly influence environmental sustainability. In other words, hydrocarbon exploration, regulatory frameworks and gas flaring policies are important, but they do not fully capture all the drivers of environmental sustainability. Future research or models could incorporate additional variables better to explain the remaining 82.8% of variance in performance.

Effect Size

Table 7: F Square

	Environmental sustainability
Hydrocarbon exploration	0.167
Regulatory frameworks policies	0.007
Gas flaring policies	0.018

Source: Smart PLS Output, 2025

Table 7 presents the f-square values, which are essential for assessing the effect size of the predictor variables (Hydrocarbon exploration) on the endogenous variable (environmental sustainability) in Niger Delta. The F Square values in the table assess the effect size of the independent variables (Hydrocarbon exploration, regulatory frameworks and gas flaring) on environmental sustainability. The value for Hydrocarbon exploration is 0.167, indicating a moderate effect size, meaning that hydrocarbon exploration has a meaningful impact on environmental sustainability. Regulatory frameworks have an F Square value of 0.018, suggesting a small effect size, which means it has a minor but positive influence on environmental sustainability. On the other hand, gas flaring shows an F Square value of 0.007, indicating a negligible effect size, suggesting that flaring has little to no significant impact on environmental sustainability within this model.

Model Fit

Table 8: Fit Summary

	Saturated Model	Estimated Model
SRMR	0.068	0.068
d_ULS	0.980	0.980
d_G	3.156	3.156
Chi-Square	3,050.737	3,050.737
NFI	0.584	0.584

Source: Smart PLS Output, 202

Table 8 presents the Fit Summary for both the saturated and estimated models in the study. The Fit Summary table presents various fit indices for the structural model. The SRMR (Standardized Root Mean Square Residual) value is 0.068 for both the saturated and estimated models, which is below the acceptable threshold of 0.08, indicating a good model fit. The d_ULS and d_G values, which represent the squared Euclidean distance and geodesic distance, respectively, are 0.980 and 3.156, showing the consistency between the models. The Chi-Square value of 3,050.737 suggests that, although there is some discrepancy between the observed and expected covariance matrices, it is common for large samples; therefore, this alone does not invalidate the model. The NFI (Normed Fit Index) value of 0.584 is relatively low, implying that while the model fits, there may be room for improvement in the overall fit when compared to the null mode.

CONCLUSION AND RECOMMENDATIONS

The study, an assessment of the impact of national energy policies on environmental sustainability in the Niger Delta, Nigeria, concludes that hydrocarbon exploration and gas flaring policies have a significant and positive influence on environmental sustainability in the region. This implies that authority concerns with hydrocarbon activities and gas flaring are prevalent, necessitating stringent regulations, effective enforcement, the adoption of best environmental practices, and a decisive transition towards cleaner energy sources to mitigate the severe ecological consequences of hydrocarbon extraction in the Niger Delta region of Nigeria. On the other hand, regulatory framework policies, while showing a positive relationship with environmental sustainability, were found to have an insignificant effect. This suggests that these frameworks supposed to have introduces essential safeguards and pollution control measures, their impact is limited by factors such as weak enforcement, inadequate scope, economic pressures, and the inherent risks of the industry. To achieve a substantial positive influence in areas like the Niger Delta

Based on the findings and conclusion made in this study, the following recommendations are proposed:

i. Implement and rigorously enforce comprehensive environmental regulations specific to hydrocarbon exploration and extraction activities. This includes stringent standards for waste management, emissions control, water discharge, and land rehabilitation.

ii. Review and strengthen existing environmental regulations to address all potential environmental impacts of hydrocarbon exploration comprehensively. This may require updating legislation, closing loopholes, and incorporating stricter environmental standards.

Implement comprehensive health monitoring programs in communities affected by gas flaring and provide appropriate medical support and mitigation measures for respiratory and other health issues linked to air pollution.

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