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Green Innovation and the Sustainability of Oil and Gas Firms in South-South, Nigeria

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Abstract: This study investigated the impact of green innovation, one of the major components of green entrepreneurial practice, on three indicators of firm sustainability, namely economic sustainability, environmental sustainability and social sustainability, of oil and gas companies in the South-South geopolitical zone of Nigeria. While most of the current research considers green practice as a composite construct or divides attention between multiple practice-dimensions simultaneously, this study examines one dimension of green practice, green innovation, and compares it to three different sustainability measures to determine the extent to which green innovation explains the variance in each of these pillars of firm sustainability. The study used a correlational survey design with a quantitative positivist research paradigm, based on the Triple Bottom Line theory and supported by the Resource-Based View. A structured questionnaire using a five-point Likert scale was used to collect data from management-level staff purposively selected from oil and gas companies listed in the register of the Nigerian Upstream Petroleum Regulatory Commission (NUPRC) with 102 valid responses analysed. Three null hypotheses were formulated and tested with Pearson product-moment correlation at the 0.05 level of significance using SPSS version 25. The results indicated that green innovation was positively and statistically significantly related to economic sustainability ($r = .751, p < .001$), environmental sustainability ($r = .565, p < .001$) and social sustainability ($r = .642, p < .001$). The three null hypotheses were therefore rejected. The results show that eco-friendly product, process and technology innovations are a powerful and generalisable sustainability performance driver in all three dimensions of the triple bottom line, even in a resource-extractive and ecologically sensitive operating context. The study places its results in the context of the United Nations Sustainable Development Goals (SDGs 7, 8, 9, 12 and 13) and suggests that oil and gas companies should institutionalise green innovation by allocating dedicated research and development budgets, investing in cleaner technologies, and incentivizing innovation through performance-based measures; and that regulators should enhance policy tools that encourage proactive eco-innovation.

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1. Introduction

1.1 Background to the Study

The South-South geopolitical region of Nigeria, which includes Rivers, Delta, Bayelsa, Akwa Ibom, Cross River and Edo States, is the heartland of the country's oil and gas industry. The zone has been a key part of the national economy for decades, as a result of

hydrocarbon exploration, production and export, but it is also one of the most severely affected areas in the extractive industry sector in the world with regard to sustainability issues. In this context, companies are expected to be profitable, to minimise the ecological footprint of their exploration and production operations, and to maintain positive relationships with host communities that have traditionally suffered the social and environmental impacts of extraction [1], [2]. The present study is set against the background of this tri-dimensional expectation, which is often expressed as the triple bottom line of economic, environmental and social performance.

Green entrepreneurial practice is one of the most widely studied strategic responses that firms can take to balance profitability with environmental and social responsibility. Green entrepreneurial practice is frequently broken down into multiple aspects, such as green innovation, green process management, green supply-chain practice, green marketing, green human-resource practice and green organisational governance [3]–[6]. Among these, green innovation, which is the intentional creation of new or substantially improved products, processes, technologies or business models that have a positive impact on the environment and resource efficiency, is often cited as the area that has the most direct and measurable impact on firm performance [3], [7].

In the oil and gas industry, green innovation is seen in flare-gas capture and utilisation technologies, cleaner and safer drilling chemistries, energy-efficient production systems, digital monitoring for leak and spill detection, and waste-to-value technologies. Green innovation can be seen as a theoretically sound one-dimensional lens to study sustainability outcomes in all three dimensions of the triple bottom line, as it simultaneously reduces operating costs, environmental externalities, and, in many cases, community and workforce welfare [8], [9].

The question is compounded by Nigeria's overall energy transition and industrialisation commitments. Nigeria is a signatory to the Paris Agreement and is actively involved in the United Nations 2030 Agenda for Sustainable Development, which includes targets for reducing gas flaring, increasing access to cleaner energy, and fostering responsible industrial production, all of which rely on innovation behaviour among companies in the extractive industry [10]. The question of whether, and to what extent, firm-level green innovation contributes to economic, environmental and social sustainability is therefore not only an academic one, but also a policy-relevant one, as it has direct implications for the implementation of national sustainable-development targets at the firm level in the sector that contributes the most to Nigeria's export earnings.

However, most of the existing literature on green entrepreneurship in the oil and gas sector combines multiple dimensions of green practices into a single composite index, thereby masking the contribution of any one practice, or focuses on green innovation in relation to a single outcome, most frequently market performance or competitive advantage, without extending the analysis to the full range of sustainability measures [8], [11], [12]. This raises an important empirical question, which is only partially answered: does green innovation, in isolation, have a consistently strong impact on economic, environmental and social sustainability, or does it have a significantly different impact on each of these pillars? The motivation for the present study is to answer this question with region- and sector-specific data.

1.2 Statement of the Problem

The South-South region of Nigeria is home to oil and gas companies that are constantly caught between the need to be economically competitive and the need to minimise environmental damage while maintaining social legitimacy with host communities. Large areas of the mangrove and wetland ecosystems in the region are still severely degraded due to decades of gas flaring, oil spillage and pipeline vandalism, and host communities report that they are not receiving adequate benefit-sharing, infrastructure, or participation in decisions that impact their environment and livelihoods [1], [13]. Meanwhile, companies are not allowed to shift funds from their operations to

environmental and social initiatives without a solid business justification, as the industry is capital-intensive and highly competitive.

In the literature, green innovation is often presented as a solution that can help to address this tension by simultaneously reducing costs, environmental externalities, and enhancing stakeholder relationships [3], [4]. However, there is a lack of empirical evidence at the firm level that can be found in a single coherent study to confirm that green innovation does indeed provide a statistically significant and practically meaningful improvement in all three sustainability measures, or whether it is only in one measure (e.g., cost efficiency) that green innovation has a positive impact while having little effect on the other two (e.g., environmental and social). In the absence of this evidence, managers may invest in green innovation without knowing that the benefits are the same, and policymakers have no empirical basis to design incentives that focus on the sustainability dimension that is most responsive to innovation-led interventions. This study aims to fill that void by focusing on green innovation as a single predictor and examining its relationship with three separate and measured outcomes of economic, environmental and social sustainability.

1.3 Objectives of the Study

The main objective of this study is to examine the effect of green innovation on the sustainability of oil and gas firms in South-South Nigeria. The specific objectives are to:

1. Examine the relationship between green innovation and the economic sustainability of oil and gas firms in South-South Nigeria;
2. Evaluate the relationship between green innovation and the environmental sustainability of oil and gas firms in South-South Nigeria; and
3. Determine the relationship between green innovation and the social sustainability of oil and gas firms in South-South Nigeria.

1.4 Research Questions

In line with the objectives above, the study addressed the following research questions:

1. What is the relationship between green innovation and the economic sustainability of oil and gas firms in South-South Nigeria?
2. What is the relationship between green innovation and the environmental sustainability of oil and gas firms in South-South Nigeria?
3. What is the relationship between green innovation and the social sustainability of oil and gas firms in South-South Nigeria?

1.5 Research Hypotheses

The following null hypotheses were formulated to guide the study and were tested at the 0.05 level of significance:

H0₁: There is no significant relationship between green innovation and the economic sustainability of oil and gas firms in South-South Nigeria.

H0₂: There is no significant relationship between green innovation and the environmental sustainability of oil and gas firms in South-South Nigeria.

H0₃: There is no significant relationship between green innovation and the social sustainability of oil and gas firms in South-South Nigeria.

1.6 Significance of the Study

Theoretically, the study extends the Triple Bottom Line and Resource-Based View literatures by demonstrating, with dimension-specific empirical evidence, how a single, well-defined green entrepreneurial capability can be traced through to three analytically distinct sustainability outcomes. This isolates the contribution of green innovation in a way that composite green-practice indices cannot, and provides a cleaner theoretical account of the innovation-sustainability nexus in resource-extractive industries.

Empirically, the study contributes region- and sector-specific evidence from the South-South zone of Nigeria, an ecologically fragile and socially sensitive operating environment that remains under-represented in the broader green-innovation literature,

which is dominated by manufacturing and small and medium enterprise contexts [11], [14].

In practice, the results provide managers of oil and gas companies with a scientific basis for focusing on green innovation investment, and explain the most and least sensitive dimension of sustainability to green innovation efforts. The results provide policymakers and regulators with information to design incentive measures that reward the specific sustainability benefits of green innovation, such as tax relief for flare-gas capture technology or grants for cleaner production research. Lastly, the study provides a policy-relevant link between firm-level strategy and nigeria's national sustainable development commitments by explicitly mapping findings onto the sdgs.

1.7 Scope of the Study

The study is content-focused on one aspect of green entrepreneurial practice, green innovation, and is compared to three measures of firm sustainability: economic, environmental and social sustainability. Geographically, the study is limited to the south-south geopolitical zone of nigeria (rivers, delta, bayelsa, akwa ibom, cross river and edo states) where oil and gas companies operate. The respondents were restricted to management-level employees who had enough knowledge of their companies' green innovation activities and sustainability results to answer the survey instrument.

1.8 Concept of Green Innovation

Green innovation refers to the development and implementation of new or significantly improved products, processes, services or business models that reduce environmental harm, enhance resource efficiency and contribute to sustainable development [3], [4]. Unlike innovation in the generic sense, green innovation explicitly and deliberately integrates environmental considerations into the innovation process itself, rather than treating environmental performance as an incidental by-product of technological change [7]. It is typically expressed through two broad streams: green product innovation, which concerns the design of goods and services with a reduced environmental footprint across their life cycle, and green process innovation, which concerns the redesign of production and operational methods to lower emissions, energy use and waste generation [15].

Within the oil and gas sector, green innovation is operationalised through practices such as flare-gas capture and utilisation, adoption of environmentally safer drilling fluids and chemicals, digital leak-detection and monitoring systems, energy-efficient production technologies, and waste-to-energy or waste-to-value conversion systems. Because these innovations are frequently justified on cost, compliance and reputational grounds simultaneously, green innovation is theorised to be uniquely well-positioned, relative to other green-practice dimensions, to influence economic, environmental and social sustainability outcomes concurrently [8], [9].

1.8.1 Concept of Sustainability and Its Three Measures

Sustainability, as applied to firm-level performance, is most commonly conceptualised through the triple bottom line framework, which holds that organisations should be evaluated simultaneously against economic, environmental and social criteria, rather than financial performance alone [16], [17]. For the purpose of this study, sustainability is operationalised as three distinct, separately measured constructs.

1.8.2 Economic Sustainability

Economic sustainability refers to a firm's capacity to sustain profitability, cost efficiency, market competitiveness and long-term financial growth while managing its environmental and social obligations [18]. For oil and gas firms, this includes indicators such as operating-cost reduction, revenue growth, resource-use efficiency and resilience to market and regulatory shocks. Green innovation is theorised to support economic sustainability primarily through cost savings from resource and energy efficiency, reduced regulatory penalties, and enhanced competitiveness associated with eco-differentiated products and services [19], [20].

1.8.3 Environmental Sustainability

Environmental sustainability concerns a firm's management and mitigation of its ecological footprint, including emissions, spills, flaring, waste generation and resource depletion, alongside compliance with environmental regulation and the restoration of degraded ecosystems [1]. In the South-South context, environmental sustainability is an especially high-stakes measure given the ecological fragility of the region's mangrove, wetland and riverine systems. Green innovation is theorised to improve environmental sustainability directly, through cleaner production technologies, emission-reducing process redesign and improved monitoring and containment systems [3], [15].

1.8.4 Social Sustainability

Social sustainability refers to the sustained development of host communities and the workforce through equitable employment, occupational health and safety, meaningful community participation, and development initiatives that endure beyond one-off philanthropic gestures [14]. In oil-producing communities of the Niger Delta, social sustainability has historically been undermined by exclusion from decision-making and inadequate benefit-sharing. Green innovation is theorised to support social sustainability indirectly, by reducing workplace and community exposure to hazardous emissions and spills, and directly, by creating new skill and employment opportunities associated with green-technology adoption and maintenance [14], [5].

1.8.5 Green Innovation and Sustainability Nexus

Taken together, the conceptual literature suggests a coherent theoretical pathway from green innovation to all three sustainability measures. Cost and efficiency gains from green innovation feed directly into economic sustainability; emission, waste and resource-use reductions feed directly into environmental sustainability; and the combined effect of safer operations, new skills and reduced community harm feeds into social sustainability [3], [8], [14]. These pathways are, however, different in their mechanisms, and cost logic for economic outcomes, technical and regulatory logic for environmental outcomes, and relational logic for social outcomes, so there is no theoretical basis for the strength of association being equal across the three measures. This is the empirical question that the present study aims to address.

1.9 Theoretical Framework

1.9.1 Triple Bottom Line (TBL) Theory

The Triple Bottom Line theory was first introduced by Elkington [16] and suggests that the performance of an organisation should be measured across three areas: economic, environmental and social, not just financial. The theory is based on the assumption that companies have a responsibility to go beyond just making a profit, that sustainability efforts generate value for a wide range of stakeholders at the same time, and that long-term organisational success relies on the successful integration of all three pillars into strategy and everyday business [17].

The theoretical foundation for this study is provided by TBL, which directly offers the three outcome measures (economic, environmental and social sustainability) that are tested with one predictor (green innovation). The theory predicts that investments in cleaner technologies would have a positive impact on operating costs (economic), ecological impact (environmental), and worker and community safety (social), as is the case in the example above. However, the theory has been challenged on the grounds that social and environmental outcomes are not as easily measurable as financial outcomes and that it provides little guidance on the relative importance of the three pillars when there are trade-offs [21]. In the present study, each pillar is measured by a separate set of validated survey items, not a single composite score, to address these critiques.

1.9.2 Resource-Based View (RBV)

The Resource-Based View (RBV) [22] and the extension of this to sustainability outcomes [23] suggests that firms can outperform and sustain their performance by having and using resources and capabilities that are valuable, rare, inimitable and non-

substitutable (VRIN). In the context of this study, RBV can be applied to the concept of green innovation capability, technological expertise, research and development competence, and organisational knowledge of cleaner production methods, which can be considered as a firm-specific resource that can lead to better economic, environmental and social performance simultaneously [23].

In this study, RBV complements TBL theory by providing insight into how green innovation works: firms with a higher internal green-innovation capability are more likely to translate their capability into measurable results in all three pillars of sustainability than firms with lower internal green-innovation capability. The theory has been criticised for its relatively static perspective on resources in what are in practice dynamic operating environments, and for its neglect of external pressures like regulation [24]; the latter limitation is recognised as a boundary condition of the present study, which is concerned with the internal, innovation-driven pathway to sustainability, rather than external regulatory pressure.

1.9.3 Empirical Review

Li et al. [14], examining green innovation among energy-intensive firms, found that green innovation was associated with improved financial, environmental and social performance, lending initial support to the proposition that green innovation-type practices influence multiple performance dimensions concurrently.

Muangmee et al. [25], studying green entrepreneurial orientation and green innovation among small and medium enterprises, reported that green innovation was positively associated with economic, environmental and social performance, supporting a multidimensional relationship between green innovation and sustainable business performance.

Serio et al. [19] found that green innovative start-ups were substantially more likely to survive than their non-green counterparts, providing evidence for a strong green innovation-economic sustainability linkage consistent with the resource-efficiency and market-differentiation mechanisms proposed by RBV.

Skordoulis et al. [20] reported that environmental process innovation and environmental product innovation had a positive impact on firms' competitive capability, reinforcing the green innovation-economic sustainability pathway.

Weng et al. [15], focusing on green innovation and performance, found that green innovation practices improved environmental and business performance, providing strong support for a green innovation-environmental sustainability linkage.

Lin et al. [26], in a study linking green human-resource practices, green innovation, corporate sustainability performance and employee retention, found that green innovation played an important role in sustainability-related organisational outcomes, supporting the theorised green innovation-social sustainability pathway.

Cheng et al. [9], examining the oil and gas sector specifically, found that green innovation was positively linked to energy efficiency, reinforcing the relevance of the innovation-sustainability relationship within energy-intensive, extractive industries similar to the oil and gas sector studied here.

Fosu et al. [27] found that green innovation mediated the relationship between environmental corporate social responsibility practices and corporate social performance, offering evidence consistent with a multidimensional green innovation-sustainability relationship rather than a single-outcome effect.

Chukwukadiba and Nnamani [11], studying manufacturing firms in Enugu State, Nigeria, found that green innovation had a significant positive effect on competitive advantage, an economic-adjacent outcome, but did not extend the analysis to environmental or social sustainability, illustrating the single-outcome limitation that motivates the present study's broader three-measure design.

Aastvedt et al. [8] similarly reported a positive relationship between green innovation and financial performance among oil and gas companies, without extending the analysis to all three sustainability measures.

Within the oil and gas sector specifically, Aastvedt et al. [8] found that green innovation was positively associated with financial performance among oil and gas companies, while Fasasi [12], examining lean and green principles in the Nigerian oil and chemical manufacturing sector, found that combined lean-green practices improved operational and environmental outcomes, though without disaggregating green innovation from other lean-green elements.

Jabbour et al. [28], examining the intersection of Industry 4.0 technologies and environmentally sustainable manufacturing, argued that digital and automation-driven innovation can enhance firms' capacity to reduce waste and improve resource efficiency, providing indirect support for the green innovation-environmental sustainability pathway through digital monitoring and process control, a mechanism directly relevant to the leak-detection and flare-monitoring technologies increasingly deployed by oil and gas operators.

Renwick et al. [5], in a review of green human-resource management, argued that the social benefits of green organisational practice are most pronounced when green technological change is accompanied by deliberate workforce training and engagement, a finding that helps explain why the green innovation-social sustainability relationship observed in innovation-adopting firms tends to be stronger where technology rollout is paired with skill-development programmes rather than treated as a purely technical exercise.

Collectively, the empirical literature converges on three broad conclusions relevant to this study: green innovation is consistently linked to positive economic outcomes across contexts [11], [19], [20]; its relationship with environmental outcomes is well established but is frequently studied through process, digital or broader environmental innovation rather than product and technology innovation alone [15], [28]; and its relationship with social outcomes, while theoretically plausible and increasingly supported empirically [5], [14], [26], remains comparatively less studied within the Nigerian oil and gas context specifically. This unevenness in the literature further justifies the present study's decision to test all three relationships within one coherent, directly comparable empirical design.

1.9.4 Gap in Literature

The empirical review reveals two recurring patterns. First, several Nigerian studies that examine green innovation restrict their outcome measures to a single dimension, most commonly competitive advantage, market performance or operational performance [11], [12], leaving the environmental and social consequences of green innovation within the Nigerian context comparatively under-examined. Second, studies that do examine multiple sustainability outcomes typically do so using a broader green-practice or sustainability framework, which can make it difficult to isolate green innovation's independent contribution to each sustainability pillar. No identified study has tested green innovation, as a single, clearly defined predictor, against economic, environmental and social sustainability as three separately measured outcomes within the South-South Nigerian oil and gas sector specifically. This study addresses that gap directly, by holding the predictor constant at one dimension and varying only the outcome measure, so that any difference in the strength of association observed across the three hypotheses can be attributed to genuine differences in how green innovation relates to each pillar of sustainability, rather than to measurement artefacts introduced by a composite index.

1.9.5 Conceptual Framework

The conceptual framework guiding this study positions green innovation as the single independent variable and economic sustainability, environmental sustainability and social sustainability as three separately measured dependent variables, consistent with the study's one-dimension-against-three-measures design. Rather than treating

sustainability as a single composite score, the framework preserves the analytical distinctiveness of each pillar of the triple bottom line, allowing the strength, direction and significance of the green innovation-sustainability relationship to be examined independently for each outcome. This framework is directly operationalised in the three research hypotheses stated in Section 1.5 and tested in Section 4.2.

2. Materials and Methods

2.1 Research Design

The study adopted a correlational survey research design in a quantitative positivist research paradigm. This design was suitable for the study because it allowed for the measurement of the strength and direction of association between the single independent variable (green innovation) and the three dependent variables (economic, environmental and social sustainability) without the need to manipulate any variable, which would not be feasible or ethical in an operational corporate environment [29].

2.2 Population of the Study

The population of the study included oil and gas companies operating in the South-South geopolitical zone of Nigeria, which was obtained from the register of the Nigerian Upstream Petroleum Regulatory Commission (NUPRC) and the Nigerian Midstream and Downstream Petroleum Regulatory Authority. The companies chosen were those that reflect the spectrum of operation of the sector most directly involved in the green innovation and sustainability issues being explored.

2.3 Sample Size and Sampling Technique

A census approach was used at the firm level and a purposive sampling technique was used to select management-level respondents within each firm who had enough knowledge and experience of their firm's green innovation activities and sustainability outcomes to be able to respond meaningfully to the survey instrument. The questionnaires were distributed, and 102 were completed, returned and found suitable for analysis; these responses form the basis of the results reported in this study.

2.4 Instrument for Data Collection

A structured questionnaire was used to gather data, which included items to measure the independent variable (green innovation) and the three dependent variables (economic, environmental and social sustainability) separately. To standardise responses and make it easier to analyse the data, the questionnaire used a five-point Likert scale ranging from Strongly Agree to Strongly Disagree.

2.5 Validity of the Instrument

The questionnaire was validated for face and content validity. The items demonstrated face validity and, on inspection, appeared to measure the intended constructs clearly and comprehensibly. Content validity was achieved by having experts in entrepreneurship, environmental management and oil and gas operations review the instrument for clarity, relevance and comprehensiveness in relation to the constructs of green innovation, economic sustainability, environmental sustainability and social sustainability.

2.6 Reliability of the Instrument

Cronbach's Alpha was used to test the reliability of the questionnaire items, which is a measure of internal consistency. A coefficient of 0.70 or above was deemed acceptable. The instrument yielded a Cronbach's Alpha of .702 for the items measuring the constructs of green innovation, economic sustainability, environmental sustainability and social sustainability, as presented in Table 1, which means that the items measuring the constructs examined were consistent in measuring their intended constructs and the instrument was suitable for further analysis.

Table 1. Reliability Statistics (Cronbach's Alpha = .702; N of Items = 7)

Construct	Mean	Std. Deviation	N
Green Innovation	3.20	1.619	10
Economic Sustainability	3.70	0.949	10
Environmental Sustainability	3.40	1.265	10
Social Sustainability	3.40	1.350	10

Source: Survey Data (2026), SPSS Output Version 25

2.7 Method of Data Analysis

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS), version 25. Descriptive statistics, means and standard deviations, were computed to summarise responses on green innovation and the three sustainability measures. The three research hypotheses were tested using Pearson product-moment correlation coefficient (r), which is appropriate for determining the strength, direction and statistical significance of the linear relationship between one continuous independent variable and each of three continuous dependent variables. All hypotheses were tested at the 0.05 level of significance; a null hypothesis was rejected where the computed p-value was less than or equal to 0.05.

3. Results

3.1 Response Rate and Descriptive Overview

A total of 102 valid responses were retrieved and used for analysis. Descriptive analysis showed moderate to relatively high mean agreement with the survey items across the four constructs examined, with Green Innovation recording a mean of 3.20 (SD = 1.619), Economic Sustainability a mean of 3.70 (SD = 0.949), Environmental Sustainability a mean of 3.40 (SD = 1.265), and Social Sustainability a mean of 3.40 (SD = 1.350), as summarised in Table 2. The comparatively low mean and higher standard deviation recorded for Green Innovation, relative to the three sustainability measures, suggest that green innovation adoption varies more widely across firms than sustainability outcomes themselves, which is consistent with the sector still being in a relatively early and uneven stage of eco-innovation adoption.

Table 2. Descriptive Statistics of Study Variables

Variable	N	Mean	Std. Deviation
Green Innovation	102	3.20	1.619
Economic Sustainability	102	3.70	0.949
Environmental Sustainability	102	3.40	1.265
Social Sustainability	102	3.40	1.350

Source: Survey Data (2026), SPSS Output Version 25

3.2 Test of Hypotheses

3.2.1 Hypothesis One: Green Innovation and Economic Sustainability

H0₁: There is no significant relationship between green innovation and the economic sustainability of oil and gas firms in South-South Nigeria.

Table 3. Correlation between Green Innovation and Economic Sustainability

		Green Innovation	Economic Sustainability
Green Innovation	Pearson Correlation	1	.751**
	Sig. (2-tailed)		.000
	N	102	102
Economic Sustainability	Pearson Correlation	.751**	1
	Sig. (2-tailed)	.000	
	N	102	102

****Correlation is significant at the 0.01 level (2-tailed). Source: Survey Data (2026), SPSS Output Version 25**

Table 3 presents the Pearson correlation result for the relationship between green innovation and economic sustainability. The analysis reveals a strong, positive correlation ($r = .751$), statistically significant at the 0.01 level ($p < .001$, $N = 102$). This indicates that increases in green innovation activity, such as eco-friendly product development, cleaner drilling technologies and environmentally oriented research, are strongly associated with improvements in economic sustainability, including profitability, cost efficiency and long-term financial growth. Given the strength and significance of the correlation, the null hypothesis (H_{01}) is rejected, and the alternative hypothesis, that a significant positive relationship exists between green innovation and economic sustainability, is accepted.

3.2.2 Hypothesis Two: Green Innovation and Environmental Sustainability

H_{02} : There is no significant relationship between green innovation and the environmental sustainability of oil and gas firms in South-South Nigeria.

Table 4. Correlation between Green Innovation and Environmental Sustainability

		Green Innovation	Environmental Sustainability
Green Innovation	Pearson Correlation	1	.565**
	Sig. (2-tailed)		.000
	N	102	102
Environmental Sustainability	Pearson Correlation	.565**	1
	Sig. (2-tailed)	.000	
	N	102	102

****Correlation is significant at the 0.01 level (2-tailed). Source: Survey Data (2026), SPSS Output Version 25**

Table 4 presents the Pearson correlation result for the relationship between green innovation and environmental sustainability. The analysis reveals a moderate-to-strong, positive correlation ($r = .565$), statistically significant at the 0.01 level ($p < .001$, $N = 102$). This indicates that higher levels of green innovation, such as adoption of cleaner technologies and environmentally oriented research, are associated with improved environmental sustainability outcomes, including reduced emissions, resource conservation and stronger regulatory compliance. Although this relationship is somewhat weaker than the green innovation-economic sustainability relationship, it remains both

substantial and highly significant. The null hypothesis (H_{02}) is therefore rejected, and the alternative hypothesis is accepted.

3.2.3 Hypothesis Three: Green Innovation and Social Sustainability

H_{03} : There is no significant relationship between green innovation and the social sustainability of oil and gas firms in South-South Nigeria.

Table 5. Correlation between Green Innovation and Social Sustainability

		Green Innovation	Social Sustainability
Green Innovation	Pearson Correlation	1	.642**
	Sig. (2-tailed)		.000
	N	102	102
Social Sustainability	Pearson Correlation	.642**	1
	Sig. (2-tailed)	.000	
	N	102	102

**Correlation is significant at the 0.01 level (2-tailed). Source: Survey Data (2026), SPSS Output Version 25

Table 5 presents the Pearson correlation result for the relationship between green innovation and social sustainability. The analysis reveals a strong, positive correlation ($r = .642$), statistically significant at the 0.01 level ($p < .001$, $N = 102$). This indicates that firms that actively engage in green innovation tend to achieve better social sustainability outcomes, including improved employee working conditions, community engagement and ethical labour standards. Given the strength and significance of the correlation, the null hypothesis (H_{03}) is rejected, and the alternative hypothesis is accepted.

3.3 Summary of Hypotheses Testing

Table 6 summarises the outcome of the three hypotheses tested in this study. Across all three sustainability measures, green innovation returned a positive correlation coefficient that was statistically significant at the 0.01 level, resulting in the rejection of all three null hypotheses.

Table 6. Summary of Hypotheses Testing

Hypothesis	Variables Tested	r	p-value	Decision on H_0
H01	Green Innovation & Economic Sustainability	.751	.000	Rejected
H02	Green Innovation & Environmental Sustainability	.565	.000	Rejected
H03	Green Innovation & Social Sustainability	.642	.000	Rejected

Source: Survey Data (2026), SPSS Output Version 25

4. Discussion

The overall pattern of results shows that green innovation, tested here as a single, clearly isolated dimension of green entrepreneurial practice, is a consistently significant predictor of all three measures of sustainability among oil and gas firms in South-South

Nigeria. This finding directly answers the study's central empirical question: the influence of green innovation is not confined to one pillar of the triple bottom line but extends, with varying strength, across all three.

The strongest relationship observed was between green innovation and economic sustainability ($r = .751$), consistent with Resource-Based View reasoning that firm-specific innovation capability translates most directly into cost efficiency, resource optimisation and competitive differentiation, outcomes that accrue relatively quickly and are relatively easy for firms to measure internally [19], [20], [22], [23]. This result is also consistent with Li et al. [14], who found that green innovation contributes to financial performance, and with Chukwukadiba and Nnamani [11], who found a positive green innovation-competitive advantage relationship among Nigerian manufacturing firms.

The relationship between green innovation and environmental sustainability, while still substantial and highly significant ($r = .565$), was comparatively the weakest of the three. This is plausible given that environmental sustainability outcomes in the oil and gas sector, including restoration of degraded ecosystems, elimination of legacy spill sites and cessation of routine flaring, are shaped by a wider set of factors beyond innovation alone, including regulatory enforcement, ageing infrastructure and the cumulative historical environmental burden already present in the region [1]. This is consistent with the view that green innovation contributes meaningfully to, but does not single-handedly determine, environmental performance in a sector carrying substantial legacy environmental liabilities.

The relationship between green innovation and social sustainability was strong ($r = .642$), lending empirical support to Li et al. [14] and Lin et al. [26], whose findings connect green innovation with social or workforce-related sustainability outcomes. This suggests that innovation-driven improvements in workplace safety, community engagement around new technologies, and skill development associated with green-technology maintenance can translate into tangible social benefits, even in a historically strained stakeholder environment such as the South-South Niger Delta.

From a theoretical standpoint, these results offer joint support for the two frameworks anchoring the study. Consistent with Triple Bottom Line theory, green innovation is shown to generate value across all three pillars of sustainability rather than trading one off against another, lending empirical credibility to Elkington's [16] original proposition that economic, environmental and social performance can be pursued as complementary, rather than competing, organisational objectives. Consistent with the Resource-Based View, the uniformly positive and significant relationships suggest that green-innovation capability functions as the kind of valuable, firm-specific resource Barney [22] and Hart [23] theorised would be difficult for competitors to replicate quickly, thereby generating sustained advantage across multiple performance dimensions simultaneously rather than a single, narrowly defined outcome.

Taken together, these findings support the study's TBL-anchored proposition that a single, well-developed green-innovation capability can serve as a genuinely multi-dimensional lever for sustainability performance, while also nuancing that proposition: the strength of the green innovation-sustainability relationship is not uniform, being strongest for economic outcomes, moderately strong for social outcomes, and comparatively more moderate, though still highly significant, for environmental outcomes.

4.1 Alignment With The Sustainable Development Goals

The findings of this study have direct relevance to several United Nations Sustainable Development Goals (SDGs), as green innovation adoption by oil and gas firms in South-South Nigeria contributes to sustainable industrial development, environmental protection and social well-being.

4.2 SDG 7: Affordable and Clean Energy

By demonstrating a significant positive relationship between green innovation and environmental sustainability, the study shows that firms adopting energy-efficient technologies and cleaner production alternatives contribute to reduced reliance on

carbon-intensive systems and support the sector's transition toward cleaner energy solutions, aligning firm-level innovation strategy with the objectives of SDG 7.

4.3 SDG 8: Decent Work and Economic Growth

The positive relationship between green innovation and economic sustainability suggests that green innovation contributes to long-term profitability and organisational resilience, and the significant relationship between green innovation and social sustainability suggests that green innovation contributes to improvements in employee welfare and workplace safety, which are both part of the decent-work and inclusive-growth SDG 8 target.

4.4 SDG 9: Industry, Innovation and Infrastructure

The strong and stable relationships between green innovation and each of the three sustainability measures highlight the importance of innovation as a catalyst for sustainable industrial development. The investment in eco-friendly technologies and process optimisation enhances the competitiveness of industry and lowers environmental impact, directly reinforcing SDG 9's focus on resilient infrastructure and inclusive, sustainable industrialisation.

4.5 SDG 12: Responsible Consumption and Production

The connection between green innovation and environmental sustainability, in particular, is linked to more responsible resource use, waste minimisation and cleaner production, in line with SDG 12's focus on efficient resource use and environmentally sound management of materials and waste throughout the value chain.

4.6 SDG 13: Climate Action

The strong link between green innovation and environmental sustainability, in particular through emission-reducing process redesign and flare-gas-related technologies, directly supports climate-change mitigation and organisational climate-resilience, thus connecting firm-level green-innovation strategy with SDG 13.

5. Conclusion

The aim of this study was to isolate green innovation as a single dimension of green entrepreneurial practice and test its relationship with three distinct measures of sustainability, economic, environmental and social, among oil and gas companies in South-South Nigeria. The results clearly show that green innovation is a strong, statistically significant and consistently positive predictor for all three sustainability measures, with the highest association being with economic sustainability, followed by social sustainability and then environmental sustainability. The study finds that green innovation is a truly multi-dimensional force for firm sustainability in the South-South Nigerian oil and gas industry, although the strength of its relationship is not equal across the three dimensions of the triple bottom line.

5.1 Recommendations

Based on the findings, the following recommendations are made:

1. Oil and gas companies in South-South Nigeria should establish green innovation as a strategic priority and allocate budgets for research and development of cleaner production technologies, flare-gas capture and utilisation systems, and environmentally friendly operational chemistries.
2. As the green innovation-economic sustainability relationship was the strongest of the three, firm management should explicitly connect innovation-linked performance incentives with measurable cost and efficiency outcomes, to maintain internal motivation for further investment in green innovation.
3. The green innovation-environmental sustainability relationship, although important, is comparatively weaker than the other two relationships, so firms and regulators should not rely on innovation as the only solution to environmental sustainability problems, but should also reinforce the enforcement of existing environmental regulation and targeted remediation of legacy spill and flaring sites.

5.2 Contribution to Knowledge

This study makes a contribution to knowledge by separating green innovation from the general package of green entrepreneurial practices and testing it as a single, well-defined predictor against three distinct sustainability outcomes in a single integrated study, which has not been done in the South-South Nigerian oil and gas sector before. The study does so, however, by providing empirical evidence on the relative strength of the relationship between green innovation and economic, environmental and social sustainability, at the level of the dimensions, and not at the level of the composite index, and by providing an explicit mapping of the findings onto the Sustainable Development Goals framework.

5.3 Limitations and Suggestions for Further Research

The study has limitations due to its cross-sectional survey design, which only allows for association and not causation, and due to the self-reported, perception-based data from management-level respondents, which may be subject to social-desirability bias. Future research could use a longitudinal design to investigate how the strength of the green innovation-sustainability relationship evolves over time as firms grow in their eco-innovation capability, and could supplement survey data with objective measures of firm-level performance, such as verified emissions data or audited financial performance, to validate the perception-based results presented here. The relationships found in this study could also be examined in future research to determine if they are moderated by firm size, ownership structure (indigenous versus multinational) or the level of regulatory enforcement.

REFERENCES

- [1] United Nations Environment Programme, *Environmental Assessment of Ogoniland*. Nairobi, Kenya: UNEP, 2011. [Online]. Available: <https://www.unep.org/resources/report/environmental-assessment-ogoniland>
- [2] J. G. Frynas, *Beyond Corporate Social Responsibility: Oil Multinationals and Social Challenges*. Cambridge, U.K.: Cambridge University Press, 2009. doi: 10.1017/CBO9780511581540.
- [3] Y.-S. Chen, S.-B. Lai, and C.-T. Wen, "The influence of green innovation performance on corporate advantage in Taiwan," *Journal of Business Ethics*, vol. 67, no. 4, pp. 331–339, 2006, doi: 10.1007/s10551-006-9025-5.
- [4] Y. Guo, L. Wang, and Y. Chen, "Green entrepreneurial orientation and green innovation: The mediating effect of supply chain learning," *SAGE Open*, vol. 10, no. 1, 2020, doi: 10.1177/2158244019898798.
- [5] D. W. S. Renwick, T. Redman, and S. Maguire, "Green human resource management: A review and research agenda," *International Journal of Management Reviews*, vol. 15, no. 1, pp. 1–14, 2013, doi: 10.1111/j.1468-2370.2011.00328.x.
- [6] S. Schaltegger and M. Wagner, "Sustainable entrepreneurship and sustainability innovation: Categories and interactions," *Business Strategy and the Environment*, vol. 20, no. 4, pp. 222–237, 2011, doi: 10.1002/bse.682.
- [7] R. M. Dangelico and D. Pujari, "Mainstreaming green product innovation: Why and how companies integrate environmental sustainability," *Journal of Business Ethics*, vol. 95, no. 3, pp. 471–486, 2010, doi: 10.1007/s10551-010-0434-0.
- [8] T. M. Aastvedt, N. Bashiri Behmiri, and L. Lu, "Does green innovation damage financial performance of oil and gas companies?" *Resources Policy*, vol. 73, Art. no. 102235, 2021, doi: 10.1016/j.resourpol.2021.102235.
- [9] X. Cheng, K. Chen, and Y. Su, "Green innovation in oil and gas exploration and production for meeting the sustainability goals," *Resources Policy*, vol. 87, pt. A, Art. no. 104315, 2023, doi: 10.1016/j.resourpol.2023.104315.
- [10] Y. A. Adebayo, A. H. Ikevuje, J. M. Kwakye, and A. E. Esiri, "Green financing in the oil and gas industry: Unlocking investments for energy sustainability," *Finance & Accounting Research Journal*, vol. 6, no. 10, pp. 1788–1817, 2024, doi: 10.51594/farj.v6i10.1622.
- [11] O. K. Chukwukadiba and E. Nnamani, "Effect of green innovation on competitive advantage of manufacturing firms in Enugu State, Nigeria," *Advance Journal of Business & Entrepreneurship Development*, vol. 7, no. 2, pp. 1–21, 2023.
- [12] A. A. Fasasi, "Implementing lean and green principles in the Nigerian oil and chemical manufacturing sector," *NIPES Journal of Energy Technology and Environment*, vol. 6, no. 2, pp. 148–165, 2024, doi: 10.5281/zenodo.11412921.

- [13] M. Watts, "Resource curse? Governmentality, oil and power in the Niger Delta, Nigeria," *Geopolitics*, vol. 9, no. 1, pp. 50–80, 2004, doi: 10.1080/14650040412331307832.
- [14] L. Li, H. Msaad, H. Sun, M. X. Tan, Y. Lu, and A. K. W. Lau, "Green innovation and business sustainability: New evidence from energy intensive industry in China," *International Journal of Environmental Research and Public Health*, vol. 17, no. 21, Art. no. 7826, 2020, doi: 10.3390/ijerph17217826.
- [15] H.-H. Weng, J.-S. Chen, and P.-C. Chen, "Effects of green innovation on environmental and corporate performance: A stakeholder perspective," *Sustainability*, vol. 7, no. 5, pp. 4997–5026, 2015, doi: 10.3390/su7054997.
- [16] J. Elkington, *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*. Oxford, U.K.: Capstone, 1997.
- [17] M. Rahman, S. A. Wahab, and A. S. A. Latiff, "Definitions and concepts of organizational sustainability: A literature analysis," *Society & Sustainability*, vol. 4, no. 2, pp. 21–32, 2022, doi: 10.38157/ss.v4i2.496.
- [18] H. R. Abdulbaqi and H. A. Mhaibes, "Sustainable development in organization: A literature review," *International Journal of Social Science Humanity & Management Research*, vol. 3, no. 11, pp. 1419–1424, 2024, doi: 10.58806/ijsshmr.2024.v3i11n04.
- [19] R. G. Serio, M. M. Dickson, D. Giuliani, and G. Espa, "Green production as a factor of survival for innovative startups: Evidence from Italy," *Sustainability*, vol. 12, no. 22, Art. no. 9464, 2020, doi: 10.3390/su12229464.
- [20] M. Skordoulis, S. Ntanos, G. L. Kyriakopoulos, G. Arabatzis, S. Galatsidas, and M. Chalikias, "Environmental innovation, open innovation dynamics and competitive advantage of medium and large-sized firms," *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 6, no. 4, Art. no. 195, 2020, doi: 10.3390/joitmc6040195.
- [21] W. Norman and C. MacDonald, "Getting to the bottom of 'triple bottom line'," *Business Ethics Quarterly*, vol. 14, no. 2, pp. 243–262, 2004, doi: 10.5840/beq200414211.
- [22] J. B. Barney, "Firm resources and sustained competitive advantage," *Journal of Management*, vol. 17, no. 1, pp. 99–120, 1991, doi: 10.1177/014920639101700108.
- [23] S. L. Hart, "A natural-resource-based view of the firm," *Academy of Management Review*, vol. 20, no. 4, pp. 986–1014, 1995, doi: 10.5465/amr.1995.9512280033.
- [24] R. L. Priem and J. E. Butler, "Is the resource-based 'view' a useful perspective for strategic management research?" *Academy of Management Review*, vol. 26, no. 1, pp. 22–40, 2001, doi: 10.5465/amr.2001.4011938.
- [25] C. Muangmee, Z. Dacko-Pikiewicz, N. Meekaewkunchorn, N. Kassakorn, and B. Khalid, "Green entrepreneurial orientation and green innovation in small and medium-sized enterprises (SMEs)," *Social Sciences*, vol. 10, no. 4, Art. no. 136, 2021, doi: 10.3390/socsci10040136.
- [26] Z. Lin, H. Gu, K. Z. Gillani, and M. Fahlevi, "Impact of green work-life balance and green human resource management practices on corporate sustainability performance and employee retention: Mediation of green innovation and organisational culture," *Sustainability*, vol. 16, no. 15, Art. no. 6621, 2024, doi: 10.3390/su16156621.
- [27] E. Fosu, F. Fosu, N. Akyina, and D. Asiedu, "Do environmental CSR practices promote corporate social performance? The mediating role of green innovation and corporate image," *Cleaner and Responsible Consumption*, vol. 12, Art. no. 100155, 2024, doi: 10.1016/j.clrc.2023.100155.
- [28] A. B. L. de Sousa Jabbour, C. J. C. Jabbour, C. Foropon, and M. Godinho Filho, "When titans meet – Can Industry 4.0 revolutionise the environmentally-sustainable manufacturing wave? The role of critical success factors," *Technological Forecasting and Social Change*, vol. 132, pp. 18–25, 2018, doi: 10.1016/j.techfore.2018.01.017.
- [29] J. W. Creswell and J. D. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 5th ed. Thousand Oaks, CA, USA: SAGE Publications, 2018.