Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.17, No.1, 2026

Green Innovation and Market Value of Listed Oil and Gas Firms in Nigeria. The Moderating Role of Quality Management System

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Abstract
The study examines the moderating role of quality management system on the relationship between green innovation and value of listed oil and gas firms in Nigeria. The study was anchored on the stakeholder's theory and adopted cross-sectional and longitudinal research designs. Data for the study was obtained using a census sampling of eight oil and gas firms listed on the Nigeria Exchange Group for the years 2015 to 2024. The study employed some descriptive and inferential statistics as data analytical techniques. Findings of the study revealed that green innovation, and quality management system have significant positive impact on market value of listed oil and gas firms in Nigeria, suggesting that expenditure on green technologies and quality management enhances corporate performance. Further, quality management system as a moderator, is also observed to strengthen the positive impact of green innovation on firm value. The study concludes that green innovation significantly influences value of listed oil and gas firms in Nigeria, and recommends that listed oil and gas companies should adopt a profit-oriented approach in quality management and green innovation so as to continue to enjoy customer patronage and improve firm value while meeting quality requirements.
KEYWORDS: Firm Value, Green Innovation, Quality Management, ISO 14001, Environmental Compliance Accounting.
DOI: 10.7176/JESD/17-1-02
Publication date: January 30th 2026

Introduction

Staying global and economically competitive in the market has become a constant challenge for organizations, given the intensification of changes in social, political, economic, and technological conditions that have resulted in different consumer demands. In addition, awareness about reducing impacts on the environment and preserving the planet has become a relevant topic in recent decades (Ofurum & Mmadubuobi, 2023; Etale & Otuya, 2018). Green innovation has become a popular concept in recent years as global warming and environmental deterioration continue to pose serious threats to the world population.

Green innovation is the development and dissemination of items, hardware, and frameworks used to safeguard normal living spaces and assets while lowering the negative environmental repercussions of human activities. With all of the concerns about the environment, the prosperity of the planet, global warming, and the reality that the earth's resources may one day be depleted, green innovation is a passionately contested subject around the world.

In Nigeria, oil slicks, gas spills, land grabs, and exploration activities by multinational oil organisations have resulted in community agitation, youth restiveness, and loss of manhours and profitability for organisations in the Niger Delta region of Nigeria (Opukri & Ibaba, 2008). Gas eruptions generate heat that kills vegetation around the flare region, obliterates mangrove swamps and salt marshes, smothers the development and flowering of certain plants. According to Deegan (2013), until managers are shown how much money they can save by employing cleaner manufacturing techniques and technologies, they will not be able to invest significant quantities of money. This has a significant effect on both the environment and companies that rely on natural capital.

Nigeria has a rich history and potential in oil and gas. With estimated known reserves of 37 billion barrels of oil and 5 trillion cubic meters of natural gas, it possesses the greatest natural gas deposits and second largest oil reserves in all of Africa. Around 70% of the nation's income comes from oil, which is now produced at 1.9 million barrels per day with a potential of 4 million barrels per day (IEA, 2023). The oil and gas companies operating in Nigeria have performed below the expectations of the stakeholders, and this has negative effects and implications on the firm value of the companies. Despite this, there are several other difficulties in effective firm

value attainment among environmentally sensitive companies in Nigeria (Aguguom & Salawu, 2022; Kurawa & Shuaibu, 2022). These include environmental problems in the Niger Delta that are mostly the result of the international oil companies' negligence to adequate environmental accounting and security challenges in the Niger Delta where these companies operate. A significant concern for the industry is the gradual pollution of the Niger Delta's waterways and the devastation of flora and agricultural land caused by oil spills that happen during petroleum exploration.

Considering the multifaceted interactions between corporate performance and different dimensions of green accounting, it is imperative to assess other factors that can mediate the interactions. Quality management (QM) is one of the factors in prior literatures that has been linked with green accounting, sustainability reporting, and environmental compliance accounting disclosures (Husnaini & Tjahjadi, 2021; Iqbal, 2019; Li et al., 2018; Wen et al., 2020). Quality management practices aim at creating an environment that motivates employees to think innovatively so that they affect innovation. In addition to influencing innovation, quality management is seen as the key determinant of corporate performance as a measure of good management practices. Companies that develop quality management can improve competitiveness by applying sustainable and eco-friendly management practices such as carbon emission management, environmental protection initiatives, energy and water saving so that they can support the process of continuous improvement, which ultimately affects firm value (Husnaini & Tjahjadi, 2021).

This study is motivated by the lack of consensus in the extant literature on the relationship between green accounting dimensions and firm value. Further, there is still much to learn about how different aspects of eco-system accounting might account for the noticeable variations in the corporate performance of oil and gas companies in Nigeria. In this regard, there is lack of empirical evidence in Nigeria and around the world about the degree to which quality management initiatives moderates the effect of green innovation on firm value. To close the gap and add to the body of existing research, it is necessary to examine the topic in the context of Nigerian oil and gas companies.
The remaining parts of the paper are organized as follows: section two provides the review of related literature, theoretical framework, and hypothesis development. Section three gives details of the empirical method adopted for the study and include the design and data, model specification, and measurement of the variables. Section four presents the data analysis and discussion of findings while the last section concludes the study.

2. Literature Review and Hypotheses Development

Value of the Firm

Market value of the firm is a benchmark for a company's value that measures shareholder wealth. It is the value that shareholders have in the company and it can also be referred to as shareholders' equity. As the company's market value rises, the wealth of shareholders increases (Otuya et al., 2023). A major purpose of corporate financial management is to maximize the wealth of shareholders. Adegbie (2022) noted that environmental accounting practice has a strong link with the possible economic value creation and firm value of a company. When there is clear evidence of environmental compliance, it provides the veritable ground for the economic growth and performance of such companies.

Tobin's Q is considered a measure of firm value in relation to financial performance from the market perspective. The market and financial performance of a company have a direct connection with the extent of image and reputation subsisting between the management of the company and the stakeholders, leveraging on the level of transparency and accountability attributable to the organization. Martinico et al. (2018) noted that Tobin's Q is closely related to measures in evaluating the financial performance of companies from the market perspective since the market participants' responses are the reflection of the performance of the companies. Consistent with prior studies, this study adopts the Tobin's Q as the measure of firm value.

Green Innovation

Green innovation, also known as eco-innovation, is a process that contributes to the creation of new production technologies and products with the aim of reducing environmental risks, pollution, and negative consequences of resource exploitation (Chukwukadiba & Nnamani, 2023). It involves the integration of environmental considerations into strategic planning, focusing on pollution prevention and sustainable development as key goals. By adopting green innovation, companies can drive technological advancements, mitigate adverse environmental impacts, and enhance their overall performance.
Green innovation generally aims at reducing pollution, energy productivity, reducing waste, substituting limited resources with sustainable resources and recycling. Mooney (2022) finds that green innovation institutions play a

key role in corporate environmental performance outcomes and the full realization of environmental sustainability. Green innovation is seen as a reflection of the theory of legitimacy. Legitimacy requires the actions taken by companies o be consistent with the values and norms in society.

Quality Management System

Nowadays, it is difficult for businesses to overlook the phrase "quality management," which describes a variety of management strategies and tactics used to boost productivity, cut expenses, and improve quality in addition to improving corporate performance and competitiveness (Dayuan et al., 2018). Quality management is the process of supervising all tasks and activities that need to be completed in order to maintain a desired level of perfection, according to Zhao et al. (2023). The establishment of a quality policy, the development and application of quality assurance and planning, quality control, and quality improvement are all included in this.

Generally speaking, quality management uses short-term projects to achieve long-term objectives. Quality management is a crucial aspect of any organization, ensuring that products or services meet customer and stakeholder expectations while continually improving processes. QM involves planning, coordinating, and controlling processes to ensure quality products or services. It encompasses various aspects, including quality planning, quality assurance, quality control, and continuous improvement (Adesete et al., 2022; Cuerva et al., 2014).

ISO 14001 is an international standard that outlines the requirements for an effective Environmental Management System (EMS). It provides a framework for organizations to manage environmental responsibilities, reduce waste, and promote sustainability. By integrating ISO 14001 with other management systems, such as ISO 9001 for quality management and ISO 45001 for occupational health and safety, organizations can streamline processes, enhance efficiency, and reduce compliance risks.

QM is a business philosophy that supports the notion that a company's long-term success is derived on the loyalty and happiness of its customers. To improve processes, goods, services, and the company culture, QM necessitates collaboration across all business stakeholders (Khalil & Muneenam, 2021). According to Zeng et al. (2017), QM is a crucial performance indicator in the oil and gas sector and has a direct impact on how quickly a firm introduces new products and innovations.

Green Innovation, Quality Management System, and Firm Value

Green innovation is an important intangible asset that affects the firm value, helping enterprises transform the environmental sustainability goal into a profitable investment opportunity. Griliches (1990) made a pioneering contribution to linking literature on innovation and market value with economic impacts of green innovation. Consistent with this idea, when green innovation is expected to influence the future cash flows of an enterprise by production, management, marketing, reputation and other aspects, it will affect the financial market in evaluating its value.

Oyerogba et al. (2024) also posit that green innovation is one of the tools to determine long-term sustainability which is useful for business facilities to increase sources of productivity, improve financial performance, profitability and competitive advantage. According to Li et al., (2018), quality management is negatively related to green innovation because quality management focuses more on the development of existing production and management systems rather than green innovation aimed at the company’s sustainable development. In contrast, Hamdoun et al., (2018) and Iqbal (2019) explained that quality management is positively related to innovation.

According to Escrig-Tena et al., (2018), quality management, both hard and soft, influences innovation. Hard QM is directly related to product and process innovation while soft QM is more concerned with infrastructure so that employees can be proactive and participate in the innovation process by providing new ideas. Song and Su (2015) expressed a different view, which stated that two opposite directions will show when quality management practices are divided into core QM practices and infrastructure. Core QM practice was found to negatively influence the process of new technology innovation, because it emphasizes more on control and stability and the existence of confidence, which is the method currently used, is the best innovation solution, which impedes the process of adoption of new technology.

In addition to influencing innovation, quality management is seen as the key to determining firm value (Llach et al., 2016). Companies that develop quality management can improve competitiveness by applying environmental management practices such as energy and water saving so that they can support the process of continuous improvement, which ultimately affects firm performance ((Pankratz et al. (2023).

Pipatprapa et al. (2017) differently explained that quality management does not directly affect innovation, but innovation mediates the relationship between quality management and green performance, and quality management directly affects green performance. The industry can achieve environmentally friendly performance by developing quality management and developing innovation. Against the backdrop of the foregoing, we propose the following hypotheses:

Ho_1: Green innovation has no significant positive effect on value of listed oil and gas firms in Nigeria

Ho_2: Quality management has no significant positive effect on value of listed oil and gas firms in Nigeria

Ho_3: The positive effect of Green innovation on value of listed oil and gas firms in Nigeria is not significantly moderated by Quality Management.

Theoretical Framework

The stakeholder theory forms the theoretical foundation for this study. The stakeholder theory was propounded and developed by Freeman (1984). Basically, stakeholder theory is based on proposition that a firm 's success or otherwise depends on a successful management of all the relationships that a firm has with its stakeholders. It is argued that stakeholder theory is one of the theories that seeks to explain the practice of presenting social information, focused on the role it can play in relations between organizations, governments, individuals, associations and societies in general. Nguyena and Trana (2019), reported that from an organizational point of view, stakeholders' theory is based on a model of accountability for all actors, be it normative, descriptive or the explanatory power they hold in the context of green and environmental accounting; and includes the responsibilities of the company and the transparent nature of its activities.

The study took stakeholder theory into consideration due to the connection between stakeholder expectations and the efforts of the corporations to achieve these expectations. A crucial element that the company can use to manage stakeholder relationships is precisely the information (financial, sustainability, or both) managed to gain the support and approval of corporate strategy from the stakeholders, without raising an objection. Against the backdrop of the review above, the conceptual model for the study is described as follows:

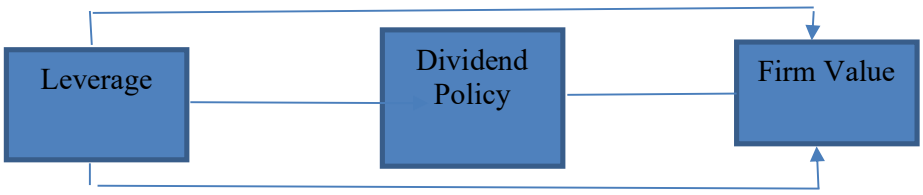

Figure 1: Conceptual Model for the Study

3. Methodology

Design and Data

This study adopted both cross-sectional and longitudinal research designs. The population of the study consisted of ten (10) listed Oil and Gas firms in the Nigerian Exchange Group as at 31st December, 2024. Two (2) firms were filtered out for not having the complete data useful for this study. Therefore, a census sample approach was used because of the small population. The study's data set included yearly reports from the eight (8) oil and gas firms that were selected after filtering which will provide data for the years 2015 through 2024. The study as a matter of procedure, adopted the panel regression technique by running the fixed effect panel regression and random effect panel regression after testing using the Hausman test to select the best suited technique between fixed effect panel regression and random effect panel regression.

Model Specification

Based on the theoretical literature and earlier empirical studies on green innovation and firm value, the model used by Chinanu and Folajimi (2024) was modified for the purpose of establishing the relationship between firm value and green innovation. The focus of the model is to examine to what extent green innovation affects value of the firm using market performance Tobin Q.

Succinctly, the models express a functional relationship between green innovation and firm value of the form:

$FMV_t = f(INV)$ ---------- (1)
Articulating equation (1) in econometric model and bearing in mind the panel nature of the regression data, equation (3) is converted as:

$FMV_{it} = \beta_0 + \beta_1 INV_{it} + \mu_{it}$ ---------- (3)

Considering the moderating effect of quality management on the relationship between green innovation which is the central aim of this research, we improved equation (3) to replicate the interface of the independent variable and mediating variable as:

$FMV_{it} = \beta_0 + \beta_1 INV_{it} + \beta_2 QMG_{it} + \beta_3 INV*QMG_{it} + \mu_{it}$ ---------- (4)

Where: FMV – Firm value; INV – Green innovation; QMG – Quality management; i = the number of companies (1,2, 3, ….. 8); t = time period (1,2, 3, …..10).
Presumptively, it is expected that β_1, β_2, to be >0 which signifies that these variables improve firm value.
Measurement of Variables

Table 1: Operationalization of the Variables

Variables	Proxy	Definition	References	A priori expectation
Dependent variable				
Market Performance	FMV	Tobin's Q: (aggregate value of listed stock + book value of total debt)/book value of total assets	Aguguom & Salawu (2022) Jimoh et al. (2023)	
Independent variable				
Green Innovation	INV	0 indicates there is no information on the energy accounting disclosure index in this subsection. 1 = Exclusive data regarding sustainability, environmental accounting information disclosure, environmental protection policy, and the GRI index A declaration on the energy accounting disclosure index. 2 = A description of the events and their noteworthy effects. 3 = A detailed explanation of the events and their major effects, accompanied by a recorded real number.	Agbo and Egbunike (2024) Dagar et al. (2022)	+
Moderating Variable				
Quality Management	QMG	Measurement using ISO 9001; dummy variable, 1: if the company passes ISO 9001 certification, and 0: for others	Husnaini and Tjahjadi (2021) Li et al. (2018)	+

Source: Researcher's compilation (2025)

4. Estimation Results and Discussion of Findings

Diagnostics Checks

In order to ascertain the fitness of the model specified in this study, the data obtained for the entire variables were further subjected to diagnostic tests for Normality, Autocorrelation, Hausman, and Heteroscedasticity. The results of the necessary diagnostic tests carried out in this study are discussed in the following sections

Table 2: Model Diagnostic Tests

Test	Model (TBQ)
Normality	JB 152.28, (P=0.332)
Serial Correlation	F (7,35 (=0.5291)
Heteroscedasticity	F(5,40) (P=0.185)
Hausman	X^2 = 10.85 (p>0211)

Source: Researcher's compilation (2025)

First, test for normality was conducted using the Jarque-Bera statistics. As observed in the analysis of the normality statistics, the variables did satisfy the normality criterion as the Jarque-Bera was positive and the p-values greater than the 5% significant level.

Second, the Breusch-Godfrey Serial Correlation LM Test was used to check for first-order serial correlation. For the study model, the serial correlation test statistics show Prob. F (7,35 (=0.5291) which also implies that there is no serial correlation in the model.

The study further employs *the* Breusch-Pagan Godfrey test to ascertain the presence or absence of heteroscedasticity in the regression result. The statistics also shows absence of heteroscedasticity given F(5,40) (P=0.185).

Finally, the Hausman test is used to determine whether fixed effects or random effects estimation is appropriate for panel data models. The Hausman test statistic X^2 = 10.85 (p>0211) indicates that the random effects estimator is appropriate.

The hypothesis testing results of the panel data estimation are reported in Table 3.

Table 3: Hypothesis Testing Results

Description	e	p	Decision
Ho_1: Green Innovation and Firm Value ($FMV\ \beta_0+\beta_1 INV_{it}$)	0.362	0.000	Rejected
Ho_2: Quality Management and Firm Value ($FMV_{it} = \beta_0+\beta_2 QMG_{it}$)	0.128	0.001	Rejected
Ho_3: Quality Management on Green Innovationa and Firm Value ($FMV_{it} = \beta_0+ \beta_3 INV*QMG_{it\ t}$)	0.191	0.000	Rejected

e = co-efficient; p = probability at 0.05 significant level
Source: Researcher's compilation (2025)

Results from the hypothesis testing and discussed thus:

First, the relationship between green innovation and firm value is found to be positive and significant at 5% significant level. The implication is that more expenditure on green production, marketing an products increases the market value of the firm. The result meets our *a priori* expectation and is consistent with prior studies such as Dubisz and Golinska-Dawson (2021), Chukwukadiba and Nnamani (2023) who found that green innovation improves profitability of firms.

In addition, the coefficient of the variable quality management is observed to be positive and significant suggesting that efforts on improving quality of goods and services also enhance the patronage, sales and by extension financial performance of the firm. The result meets our *a priori* expectation and is consistent with previous studies such as Dubisz and Golinska-Dawson (2021), and Mohammad et al. (2023) that highlighted that companies with quality management mechanism have superior performance in terms of profitability due to higher customer patronage. From the stakeholder's perspective, the public are more comfortable with firms that are perceived to maintain higher quality standard especially firms producing products with the ISO 9001 labels on their products.

As regards the moderating impact of quality management on the relationship between green innovation and firm value, the regression result shows a positive effect and statistically significant at 5%. The result gives enough evidence to accept the hypothesis that quality management using the ISO 9001 standards further strengthens the positive effect of green innovation on firm value of listed oil and gas firms in Nigeria. This position meets our *a priori* expectation and agrees with studies such as Mdasha et al. (2024) and Khatib et al. (2023) found evidence that quality management moderates the relationship between sustainability and green innovation and corporate performance of firms.

Conclusion and Recommendations

The study examines the quality management as a moderator on the relationship between green innovation and value of the firm. Findings of the study revealed that green innovation, and quality management using ISO 9001 have a significant positive effect on value of listed oil and gas firms in Nigeria suggesting that expenditure on green innovation technologies and quality management improve on corporate performance of listed oil and gas firms in Nigeria. Further, quality management is also observed to strengthen the positive impact of green innovation on firm value further validating implementation of green technology to improving corporate performacne. The study concludes that green innovation significantly influences value of listed oil and gas firms in Nigeria. Arising from the findings, the study recommends that listed oil and gas companies should adopt a profit-oriented approach in quality management and green innovation so as to continue to enjoy customer patronage while meeting quality requirements.

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