EXPLORING SUSTAINABLE INNOVATION AS A MITIGANT FOR ENVIRONMENTAL CHALLENGES IN NIGERIA

Abayomi Olusegun OGUNSANWO

Department of Business Administration and Management,
The Federal Polytechnic, Ilaro, Ogun State
abayomi.ogunsanwo@federalpolyilaro.edu.ng
+2348169464310

Abimbola Omolade ODUBANJO

Department of Marketing, The Federal Polytechnic, Ilaro, Ogun State
abimbola.odubanjo@federalpolyilaro.edu.ng
+2348076504122

Abstract

This study uses a thorough structural equation modelling (SEM) analysis to delve into the complex interactions between social innovation and environmental challenges. The study focuses on three crucial sustainable innovation facets: green management, circular economy, and green energy, and how they together affect environmental challenges in Nigeria. For model analysis, the study uses AMOS Graphics Version 26. The SEM framework clarifies the interactions between the latent dependent variable (Environmental Challenges) and the latent independent variables (Green Energy, Circular Economy, and Green Management). These links are clarified by careful statistical analyses, such as mean analysis, effect size estimation, and residual error assessment. The significance of each social innovation aspect in impacting environmental challenges is highlighted by the findings. Notably, the most powerful driver is green management, which is followed by green energy and circular economy. The favourable effects of green energy and green management on environmental challenges are confirmed by regression weight analysis, but the influence of circular economy is less pronounced. The Squared Multiple Correlations support these associations even more, showing that the combined influence of Social Innovation variables is responsible for about 80.7% of the variability in Environmental Challenges. The findings of this study support the development of social innovation practices, with a focus on green management programmes, as a potential means of solving environmental problems.

Keywords*: Green Energy, Circular Economy, Green Management*

Introduction

Nigeria, being the most populated nation in Africa and a rapidly expanding economy, is currently confronted with significant environmental issues (World Bank, 2021). The exponential expansion of industrial sectors, urban conglomerations, and energy utilisation has resulted in escalated levels of pollution and depletion of natural resources. The imperative to adopt sustainable practises is of utmost importance in order to ensure the preservation of the environment for future generations. Sustainable innovation, which entails the incorporation of clean energy, circular economy concepts, and green management, have the capacity to present feasible resolutions to these aforementioned difficulties. (Egbekun, A., Akinyeye, & Akinnuli, 2022). Technology is a comprehensive field of study encompassing a wide range of instruments, methodologies, and procedures that are capable of effectively and consistently fulfilling various human objectives. Simultaneously, innovation is indicative of the phase in which technology is strategically devised, developed, formalised, and put into practise. The process of innovation is implemented within complex structures that can be conceptualised as interconnected actors and institutional elements, which collectively shape the many stages of innovation. The enhancement of transparency in the various stages of innovation design and a comprehensive comprehension of the barriers to innovation are crucial. Achieving sustainable growth, particularly in relation to society and the environment, necessitates significant effort through a multitude of scientific studies and pragmatic practises. This endeavour also entails maintaining economic implications.

Environmental Challenges in Nigeria

Nigeria, a densely populated nation situated in the western region of Africa, is currently facing a multitude of environmental issues that pose significant risks to its ecological well-being, public health, and socio-economic equilibrium. (Iwegbue, 2018).

The difficulties at hand have been further intensified by rapid urbanisation, industrialization, deforestation, and inadequate waste management practises, hence amplifying the impacts of climate change and ecological degradation. This study examines the significant environmental difficulties confronting Nigeria and emphasises the imperative for immediate action to alleviate their detrimental effects.

The issue of deforestation and its impact on biodiversity is a matter of great urgency in Nigeria. The country has been experiencing substantial depletion of its forested areas as a result of irresponsible logging practises, growth of agricultural activities, and the spread of urbanisation (Adegun, 2018). The extensive deforestation that has occurred has had the consequence of causing the devastation of indigenous ecosystems, hence resulting in a significant decline in the variety of species present. The current state of several plant and animal species indigenous to Nigeria is more precarious as a result of habitat fragmentation and loss (Ola, 2019).

The issue of air and water pollution in Nigeria has been exacerbated by the country's industrial operations and the rising levels of emissions from vehicles. This has had a particularly pronounced impact on large urban centres such as Lagos and Port Harcourt (Omoregie, 2017). The escalation of particulate matter and harmful chemicals in the atmosphere has resulted in significant respiratory ailments and other health complications among the urban populace. Moreover, it is worth noting that water bodies in Nigeria suffer from significant pollution caused by untreated industrial effluents, agricultural runoff, and inappropriate waste management. This unfortunate situation has detrimental effects on both human health and the delicate balance of aquatic ecosystems (Iwegbue, 2018).

The vulnerability of Nigeria to climate change is a significant concern, as evidenced by the increasing frequency and intensity of extreme weather events, shifting weather patterns, and rising sea levels (Osuji et al., 2020). The repercussions of sea-level rise pose a significant threat to coastal regions, resulting in the loss of land, displacement of communities, and salinization of freshwater sources. The impact of climate change on agricultural productivity is a significant factor that contributes to the worsening of food insecurity and economic difficulties.

The phenomenon of desertification, which is characterised by the expansion of arid areas, is currently occurring in the northern regions of Nigeria. This process is primarily influenced by factors such as overgrazing, unsustainable land use practises, and the effects of climate change (Mustapha, 2016). Soil erosion and degradation are significant issues that have adverse impacts on agricultural productivity and contribute to the exacerbation of climate change.

Nigeria encounters substantial difficulties in effectively managing its solid waste, resulting in inadequate waste management practises. The phenomenon of rapid urbanisation has given rise to a notable escalation in the production of trash. However, the existing waste collection and disposal infrastructure has proven to be insufficient, leading to the undesirable practises of littering and open dumping. These activities have had detrimental effects on the environment, causing pollution and creating potential health hazards (Olawale, 2019).

Clean Energy as a Sustainable Innovation

Clean energy is defined as energy that is produced using renewable, non-polluting, zero-emission resources and includes energy that is conserved through energy-saving practises. To lessen climate change and stop environmental deterioration, we must switch from fossil fuels to clean energy sources (IEA, 2021). In Nigeria, there is a sizable chance to utilise renewable energy due to the abundance of solar, wind, and hydro resources. Recent years have seen a rise in the use of renewable energy, with both the public and private sectors investing in solar and wind generating plants. For instance, the construction of sizable wind farms in Katsina State and solar farms in Kano State show the nation's dedication to the use of sustainable energy.

In addition to lowering greenhouse gas emissions, clean energy also offers a dependable and sustainable energy source, particularly in rural areas with sparse access to electricity. Enhancing energy security and helping Nigeria meet its emission reduction targets under international climate agreements can both be accomplished through the integration of renewable energy into the national grid.

Circular Economy as a Sustainable Innovation

Resource depletion and significant waste generation are results of Nigeria's linear consumption and disposal patterns (Egbekun et al., 2022). Adopting circular economy principles can assist in severing the link between resource use and waste production and economic growth. Businesses can develop closed-loop systems that increase the lifespan of materials and products by designing goods with durability, repairability, and recycling in mind.

Several initiatives to develop circular practises have already surfaced in Nigeria. For instance, post-consumer textiles have been recycled into raw materials for new goods in textile recycling programmes in Lagos, lowering the demand on landfill space and natural resources (Egbekun, A., Akinyeye, & Akinnuli, 2022). The Lagos State Waste Management Agency has also put in place waste-to-wealth programmes that entail turning organic garbage into compost and biogas in order to encourage resource recovery and lower methane emissions.

Green Management as a Sustainable Innovation

At this point, a business makes every effort to cut back on environmentally harmful processes. This meant adopting environmentally responsible practises. Green management includes eco-friendly procedures used in a variety of industries, such as manufacturing, building, and transportation (Ibimilua et al., 2021). To lessen their influence on the environment, industries should use eco-friendly materials, energy-efficient procedures, and cleaner production methods. The usage of green building materials and renewable energy sources has increased in Nigeria, where sustainable construction methods have gained popularity (Ibimilua, Adeleye, & Adeleke, 2021).

Theoretical Review

The theoretical review gives the points presented in the article on investigating sustainable innovation as a mitigant for environmental concerns in Nigeria a foundation to build on. The study is strengthened by incorporating these ideas, which also demonstrate how important sustainable innovation strategies are for tackling environmental problems and building a more sustainable future in Nigeria.

Transition Theory

Sustainability According to the Sustainability Transition Theory (STT), communities must go through radical transition in order to accomplish sustainability objectives (Geels, 2002). This theory supports the idea of sustainable innovation as a means of addressing environmental problems, making it extremely pertinent to the subject. STT contends that adapting to sustainable practises, such as the use of clean energy and the concepts of the circular economy, calls for modifications to socio-technical systems as well as the creation of new, sustainable socio-technical configurations. In Nigeria's context, adopting circular economy principles and switching to clean energy sources is an essential step towards reaching a more sustainable future..

Triple Bottom Line (TBL)

Economic, social, and environmental sustainability are all taken into account by the Triple Bottom Line (TBL) paradigm (Elkington, 1998). It offers a comprehensive method for assessing the effectiveness of sustainable activities. TBL can be used in the article to evaluate the effects of sustainable innovation initiatives in Nigeria. Adoption of clean energy can enhance access to energy, spur economic growth, and create jobs while lowering greenhouse gas emissions and enhancing air quality (on an environmental level). By encouraging waste reduction and resource efficiency, circular economy practises can have a positive effect on the environment (environmental dimension) and open up new business prospects through material recovery and recycling (economic dimension). Sustainable procurement is one example of a green management strategy that can help firms cut costs (from an economic perspective) while also minimising their environmental impact..

Diffusion of Innovation Theory

The acceptance and diffusion of sustainable innovation practises in Nigeria can be understood in light of Rogers' (1962) Diffusion of Innovation Theory. According to the hypothesis, acceptance of innovations occurs in a pattern known as diffusion among various social groupings. The idea can be used to explain how sustainable practises like clean energy technology and circular economy initiatives have been adopted and spread in the context of the article. The availability of supportive policies and incentives, technological preparedness, and social acceptance are only a

few variables that may affect the rate of adoption. The adoption of sustainable innovation in Nigeria can be accelerated by taking into account these aspects.

RBV, or Resource-Based View

The competitive advantage that sustainable innovation can bring to enterprises in Nigeria can be understood through the Resource-Based View (RBV) of the organisation (Wernerfelt, 1984; Barney, 1991). According to RBV, a company's distinctive and priceless resources are what provide it a competitive advantage. By incorporating environmentally friendly technologies and procedures, adopting green management practises can, in the context of the article, improve a company's resource base. This can therefore result in better environmental performance, a better reputation, and higher levels of competition.

Establishment Theory

The role of institutions in forming sustainable innovation practises in Nigeria can be better understood via the lens of institutional theory (DiMaggio and Powell, 1983). According to the thesis, organisations must acquiesce to institutional constraints and established norms in order to be considered legitimate in society. Institutions, such as cultural norms, business associations, and government legislation, can have an impact on the adoption of clean energy and circular economy practises in the context of sustainable innovation. In the Nigerian context, an understanding of institutional issues might assist in identifying opportunities and challenges for sustainable innovation.

Methodology

This study used a survey research design and was carried out in Lagos State, Nigeria. Through the use of Monkey Survey, a total of 384 respondents were chosen for the online survey.From infinite population of Stakeholders. Two separate audience categories were the focus of the investigation. Employees from particular businesses and government organisations working in the energy, recycling, and green management sectors made up the first group. People who joined through links given by the aforementioned organisations and agencies fell under the second group. The Cochran algorithm for calculating an infinite sample size was used to determine the sample size. A four-point Likert scale questionnaire that was created to extract pertinent data was used to simplify data collection. Component factor analysis and Cronbach's alpha statistics were used to verify the validity and reliability of the study instrument.

The collected data underwent thorough analysis using Amos Graphic Version 26 and the Structural Equation Model (SEM). This method allowed for a thorough evaluation of the correlations between the variables, illuminating the complex dynamics of the adoption of clean energy, the circular economy, green management, and their impact on environmental concerns in Nigeria. The use of SEM made it possible to analyse and understand the collected data thoroughly, enabling defensible findings and insights into the research goals.

For ease of analysis, the model was structured as:

$EC=f(SOIN)$

$EC=f(CEN, CEC, GMA)$

$EC=\beta_o + \beta_l CEN + \beta_2 CEC + \beta_3 GMA + \mu_l$

Where EC= Environmental Challenges

CEN= Clean Energy

CEC= Circular Economy

GMA=Green Management

β_o= Constant

$\beta_l\ \beta_2\ \beta_3$=Coefficient of Correlation

μ_l= Error term.

Analysis

The analysis of this study is based on the results obtained from the structural equation model (SEM) analyzed using AMOS Graphics Version 26.

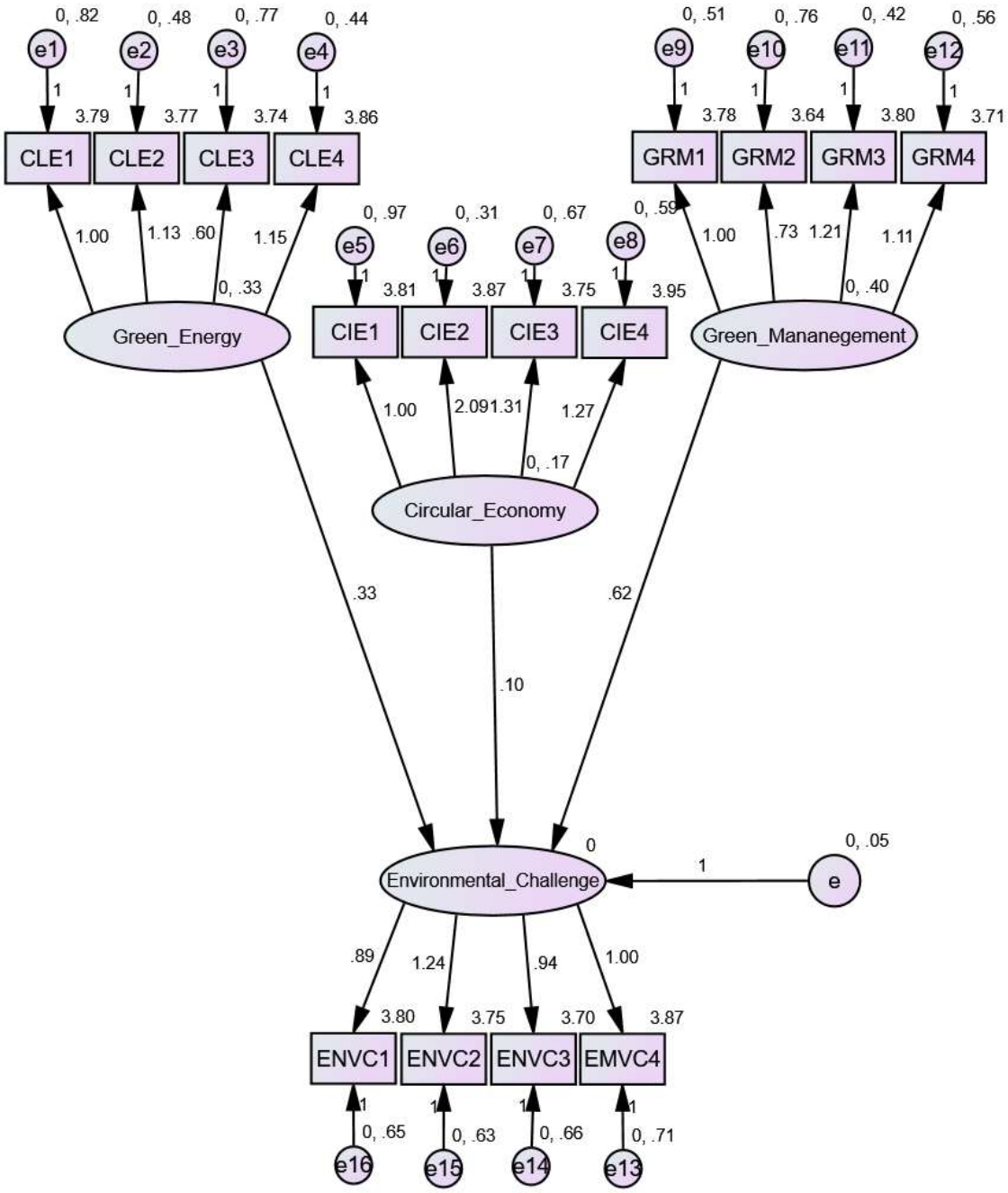

Figure 4.1: Structural Equation Model Specified for the Study

The structural equation model illustrates how social innovation proxies (green energy, circular economy, and green management) were used in this study to address environmental challenges in Nigeria. The latent independent variables (Green Energy, Circular Economy, and Green Management) and their effects on the latent dependent variable (Environmental Challenges) were determined from the model. Other statistics established from the model include the residual (error term), which represents the discrepancy between the values of the dependent variable and those predicted by the regression model. The study investigated the relationships between three latent independent

variables—Social Innovation factors Green Energy (CLE), Circular Economy (CIE), and Green Management (GRM)—and a latent dependent variable called Environmental Challenge (EMVC) using structural equation modelling (SEM) analysis.

The results show that the Environmental Challenge (EMVC) variable is positively influenced by each of the Social Innovation components (CLE, CIE, and GRM). These associations' estimated effect sizes are as follows: Green Management (GRM) has the largest estimated effect size of 0.62, followed by Circular Economy (CIE), with an effect size of 0.10, and Green Energy (CLE), with an effect size of 0.33. The magnitude and strength of each social innovation factor's impact on the environmental challenge are shown by the effect sizes.

The analysis also took into consideration the residual error, which was determined to be 0.05. The variability in the dependent variable (EMVC) that cannot be assigned to the independent variables (CLE, CIE, and GRM) is referred to as residual error. A smaller residual error indicates that the model adequately fits the data and can account for a sizable chunk of the environmental challenge's variability.

In conclusion, the study's structural equation modelling (SEM) research found favourable correlations between the environmental challenge and the social innovation elements (green energy, circular economy, and green management). Green Management, followed by Green Energy and Circular Economy, had the biggest influence. The comparatively small residual error suggests that the overall model fits the data well. These results imply that encouraging social innovation practises, especially green management efforts, may help to effectively solve environmental challenges. To fully comprehend the overall circumstance, though, it might be essential to conduct more research and consider more elements.

Table 1: Regression Weights

Variables	Estimate	S.E.	C.R.	P-Value	Decision
Environmental Challenge←Green Energy	.326	.078	4.201	***	Significant
Environmental Challenge ←Circular Economy	.102	.081	1.258	.208	Insignificant
Environmental Challenge ←Green Management	.622	.096	6.504	***	Significant

Source: Extracted from AMOS Text Output

The regression weights from the analysis, which evaluates the connections between the variables, are displayed in Table 1. The three independent variables are Green Energy (CLE), Circular Economy (CIE), and Green Management (GRM), while the dependent variable in the study is Environmental Challenge (EMVC). The estimates, standard errors, critical ratios, and p-values—which are used to assess the significance of the relationships—are all thoroughly described in the table.

The calculated regression weight for the association between environmental challenge and green energy is 0.326, starting with the first row. This estimate is accompanied by a 0.078 standard error. The estimate to standard error ratio, known as the crucial ratio, is calculated to be 4.201. The value of the critical ratio (C.R.) contributes to the evaluation of the relationship's significance. In this instance, the C.R. value above the cutoff point, which is normally 1.96 for a 5% level of significance, indicating that the association is statistically significant. Additionally, the relationship's p-value is indicated by *** (three asterisks), which denotes that it is less than 0.001 (very highly significant). So, it follows that Environmental Challenge and Green Energy have a statistically significant positive association.

The regression weight for the association between the environmental challenge and the circular economy is assessed to be 0.102 in the second row. This estimate's standard error is 0.081. It is determined that the critical ratio (C.R.) is 1.258. The p-value in this instance is denoted as 0.208, which is bigger than the conventional significance level of 0.05 because the C.R. value is below the threshold value of 1.96. The relationship between the environmental challenge and the circular economy is therefore regarded as statistically inconsequential. In this analysis, there is insufficient data to conclude that Circular Economy significantly affects Environmental Challenge.

The regression weight for the association between the environmental challenge and green management is assessed to be 0.622 when looking at the last row. The critical ratio (C.R.) is calculated to be 6.504 and has a standard error of

0.096. The C.R. value is far higher than the cutoff point, pointing to a very substantial association. The relationship's strong significance is further supported by the fact that the p-value is marked as *** (three asterisks), suggesting that it is less than 0.001. As a result, we may draw the conclusion that Environmental Challenge and Green Management have a statistically significant positive relationship.

In conclusion, the analysis shows that Green Energy and Green Management have a considerable positive influence on Environmental Challenge based on the regression weights and their associated statistical indicators. However, this study's findings on the circular economy's impact on environmental challenges were insignificant. These conclusions offer insightful understandings into the connections between these variables and could direct future investigation and decision-making in the context of resolving environmental issues.

Table 2: Environmental Challenge Social Innovation Squared Multiple Correlations Variables Estimate.807

Extrapolated from AMOS Input of Text

Table 2 displays the analysis's results for Squared Multiple Correlations, which evaluate the connections between the variables. One variable, represented by the latent variables Green Energy (CLE), Circular Economy (CIE), and Green Management (GRM) jointly, represents the association between Environmental Challenge (EMVC) and Social Innovation, as estimated using Squared Multiple Correlation.

It is estimated that there is a 0.807 Squared Multiple Correlation between environmental challenge and social innovation. The percentage of the environmental challenge variable's variance that can be accounted for by the combined impact of the social innovation variables (green energy, circular economy, and green management) is represented by this number.

In other words, the estimate of 0.807 shows that the combined impact of the Social Innovation variables can account for about 80.7% of the variability in the Environmental Challenge. With such a high value, it is possible that Social Innovation, as exemplified by Green Energy, Circular Economy, and Green Management, is a substantial factor in the variances in the Environmental Challenge.

Environmental challenges and social innovation (green energy, circular economy, and green management) are strongly correlated, as shown in Table 2's Squared Multiple Correlation. The estimate of 0.807 suggests that the combined influence of these Social Innovation elements can be used to explain a sizable amount of the variability in the Environmental Challenge. This research emphasises how critical it is to support social innovation practises in order to effectively manage and mitigate environmental challenges.

Conclusion

A viable solution to Nigeria's environmental problems is sustainable innovation, which includes the use of clean energy, the circular economy, and green management practises. Nigeria may create a future that is more durable and resilient while also promoting economic growth and development by adopting these practises. To make a country that is greener and more wealthy, sustainable innovation must be implemented successfully by the government, private sector, NGOs, and citizens.

The environmental issues in Nigeria are intricate and linked, necessitating a diversified strategy to properly address them. Sustainable forest management techniques and protected area conservation are essential to halt deforestation and prevent the loss of biodiversity. Adoption of renewable energy sources and creation of climate-resistant infrastructure are necessary for climate change mitigation.

Recommendations

The following suggestions for policymakers in Nigeria should be taken into account in order to promote sustainable innovation and lessen environmental challenges:

Implement measures like feed-in tariffs, tax breaks, and streamlined regulatory processes to stimulate private investment in renewable energy projects. This may include giving companies implementing green management practices financial and technical help, especially in industries with significant environmental effect.

Create a thorough circular economy strategy that includes measurable goals for waste reduction, resource efficiency, and sustainable production and consumption. To effectively address these environmental concerns, cooperation

across the public, commercial, and civil society sectors is crucial. Nigeria can maintain its natural resources, protect public health, and promote a resilient future for future generations by acting right away and placing a high priority on sustainable development.

Additionally, efforts to stop desertification and land degradation should concentrate on afforestation programmes and sustainable land use strategies. Last but not least, waste management programmes should be strengthened, with a focus on recycling and waste minimization initiatives.

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