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An Appraisal of Renewable Energy for Enhancement of Environmental Sustainability in Nigerian Public Procurement

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Abstract*—Over the years, the world is faced with environmental degradation, pollution from dangerous gas like carbon dioxide (CO2), bio-diversity lost, depletion of natural resources posed serious threat to climate change. These concerns impacted on our procurement processes to take into consideration how to limit or prevent these risk that impacted directly or indirectly on purchasing decisions. Another major concern, beyond CO2 emissions, is that the fossil fuels on which the world still depends on for getting over 80% of its energy, needs are finite and will be critically depleted within 50 years at current use levels. It was noted that pathways to net-zero emissions is through the shift towards renewable energy. Many countries, including Nigeria has made efforts to diversify its energy sources by investing in renewable energy, like solar, wind, geothermal, tidal, nuclear, hydro, bio-fuel and electric vehicles. This study appraised renewable energy towards enhancement of environmental sustainability in Nigerian public procurement. A quantitative survey was used and purposive sampling was adopted in getting the respondents. Data were collected with the aid of questionnaire. A sample size of 150 was drawn from population of 239 public procurement officers. 96 questionnaires were retrieved from respondents, analysis conducted highlights a well-educated workforce with substantial awareness of renewable energy but limited practical application was noted, particularly outside works. Five key barriers were assessed through ranking. The study emphasizes the need for enhanced regulatory frameworks, targeted training for procurement officials, and increased investment in renewable energy. It also revealed that lowest respondents are from the top management function, which may hinder policy decisions in public procurement activities.

***Keywords:** Public Procurement, Renewable Energy. Green Innovations, Emerging Technologies, Green Gas Emissions, Renewable Energy, Environmental Sustainability*

I. INTRODUCTION

1.1 Background of the Study

Globally, the world is concerned about climate change and the intensity of environmental degradation which makes countries to shift towards sustainable practices. Public Procurement can reduce greenhouse gas emissions directly if the public sector substitutes its purchases of polluting goods and services with more environmentally friendly alternatives, i.e. changing public consumption behaviour (Sapir et al., 2022).

In recent decades, society has faced difficult challenges with regards to environmental concerns and protection. These concerns include global warming and depletion of natural resources that directly or indirectly impact customer decisions about buying products and services. Promoting of green sustainability paved the way for ecological consequences such as depletion of ozone, loss of biodiversity, global warming, deforestation and erosion (Rusyaniet al., 2021)

Another major concern, beyond CO2 emissions, is that the fossil fuels on which the world still depends on for over 80% of its energy needs are finite and will be critically depleted within 50 years at current use levels (Dale, 2021; Friedemann, 2021; Ritchie et al., 2021).

In Nigeria, there exists an abundance of low-carbon energy resources that hold immense potential for fostering sustainable growth. Regrettably, Nigeria has yet to fully harness these resources to drive its economic expansion and bolster its power sector(Olujobiet al., 2023).

The over reliance on fossil fuels within Nigeria's energy sector has led to a substantial increase in carbon dioxide emissions, surpassing levels observed in developed countries with well-established low-carbon energy strategies(Olujobiet al., 2023)

However, despite the significant potential offered by low-carbon energy resources, their expansion in Nigeria has faced obstacles due to challenges such as;

shortage of skilled workforce, limited technical expertise and insufficient financial resources. Inefficiencies in governance and institutions, pricing policies, and insufficient awareness have hampered the effectiveness, investment, and returns of low-carbon energy projects in the country's power sector(Olujobiet al., 2023). Furthermore, the lack of commitment from the Federal Government to support the growth of low-carbon energy and issues of corruption impede the transition to low-carbon energy technologies in Nigeria. Recent research emphasizes that hydropower constitutes a significant 18% of Nigeria's electricity generation, whereas wind and solar energy sources contribute only a small fraction (Olujobiet al., 2023)

1.2 Statement of Research Problem

In Nigeria, the public procurement system has traditionally been characterised by inefficiencies and lack the implementation of environmentally sustainable practices (Udenchukwu& Ogbonna, 2020).

Nigeria, as a signatory to various international agreements and having committed to achieving the Sustainable Development Goals (SDGs) and the Paris Agreement, recognizes the importance of sustainable development. However, the effective implementation of these commitments has been hindered by issues such as limited financial resources, inadequate infrastructure, and a lack of awareness about sustainable practices (Edem, 2023). Despite the significance of renewable energy in achieving sustainable public procurement, the extent of the practitioners' awareness of the technologies and their utilisations in public procurement practice have not been uncovered. This knowledge gap hampers their effective integration into public procurement practices.

II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Public Procurement

The literature reviewed indicates that government intervention through environmental regulation can promote green innovation and encourage companies to adopt Renewable energy practices (Dong *et al.,* 2020). However, it is essential to address barriers such as lack of awareness, policies, regulations, financial constraints, and resistance to change in procurement procedures (Ayarkwa*et al.,* 2020; Lin *et al.,* 2024). Thus, our study proofs these propositions. Public Procurement is the acquisition of goods, services, and works by government institutions from private sector suppliers, with GPP aiming to reduce environmental impacts throughout the life cycle of products (Johnson & Klassen, 2022).

Study by Sapir*et al.,* (2022) emphasises that public procurement can directly reduce greenhouse gas emissions by substituting polluting goods with environmentally friendly alternatives. The literature also discusses the role of public procurement in driving innovation.

Also, another study by Liang *et al.,*(2023) Public Procurement generally promotes commercial innovation by supporting the formation of markets for products, technologies and services, which can be roughly divided into three aspects: product procurement, innovative procurement (new products, services, systems), and functional procurement (products with problem-solving functions).The climate plan argues that public procurement can play an essential role in reducing carbon dioxide (CO2) output and stimulating innovative green solutions. One action point is replacing fossil fuel cars with electric vehicles (EVs) by making it mandatory from 2022 for the public sector to buy EVs (Langseth & Tronstad, 2022).

The decisions made in public procurement (PP) have far-reaching implications, affecting areas as diverse as infrastructure development, healthcare delivery, education services, and national defense. Therefore, it is essential for governments and public organisations to continually evolve and improve their procurement practices to ensure transparency, efficiency, and sustainability (Hochstetter *et al.,* 2023).

2.2Renewable Energy

After environmental problems attracted widespread attention, scholars conducted extensive research on pollutant emissions and factors affecting pollution and carbon reduction efficiency. Some scholars proposed that energy consumption, especially the consumption of coal resources, is the main cause of pollutant emissions (Charfeddine, 2017; Wang *et al.,* 2022; Shahbaz *et al.,* 2019). They suggested that promoting energy transformation and upgrading is

the primary measure to reduce pollution and carbon (Belaïd & Massie, 2023; Lu *et al.,* 2022).

Renewable energy (RE) is the key element of sustainable, environmentally friendly, and cost-effective electricity generation. An official report by International Energy Agency (IEA) states that the demand on fossil fuel usage to generate electricity has started to decrease since year 2019, along with the rise of RE usage to supply global energy demands. Researches on RE technologies are continuously growing in order to enhance the performance of RE generation, especially in term of energy conversion efficiency (Ang *et al.,* 2022)

Renewable energy sources generate electricity without burning fuels and offer a clean alternative to fossil fuel consumption (Ghosh *et al.,* 2023). Hence, it reduces pollution and enhances the quality of life for humans, animals, and plants (Sultana *et al.,* 2023). Policymakers could be inspired by the improvement in living conditions to increase investment in the renewable sector (Islam *et al.,* 2023; Raihan & Bari, 2024). The United Nations has set the 2030 Agenda for Sustainable Development. That includes 17 SDGs, where goal 7 aims to significantly boost the proportion of renewable energy in the global energy mix for achieving a sustainable and environmentally friendly future (Rotondo *et al.,* 2022).

Table 2.1: Renewable energy identified with sources

S/No	Renewable energy identified from Literature	Sources
1	Hydropower	Azam*et al*., (2023); IEA, (2020); Bekun*et al*., (2022); Caglar *et al*., (2022); AlGhamdi, (2020); Ngubane, 2024
2	Electric Vehicle	Juliet, (2024); Li et al., (2023a); Rosales-Tristancho*et al*.,(2022)
3	Geothermal	Azam*et al*., (2023); Ali, (2023)
4	Tidal	Azam*et al*., (2023)
5	Nuclear	Azam*et al*., (2023); Ali, (2023); Ali *et al*., (2023)
6	Wind	Azam*et al*., (2023); IEA, (2020); Bekun*et al*., (2022); Caglar *et al*., (2022); Wang *et al*., (2023); AlGhamdi, (2020); Ali, (2023); Ngubane, 2024
7	Solar	Azam*et al*., (2023); IEA, (2020); Bekun*et al*., (2022); Caglar *et al*., (2022); Wang *et al*., (2023); SIDF, (2022); AlGhamdi, (2020); Ali, (2023); Singh *et al.,*(2023); Ngubane, 2024
8	Bio-fuel	IEA, (2020); AlGhamdi, (2020); Ngubane, 2024

Source: Literature

2.3 Renewable Energy in Nigeria

In Nigeria, public procurement accounts for a major share of government expenditures and therefore has the potentials to drive environmental innovations through adopting Renewable energy technologies. Despite these clear benefits, the implementation of Renewable energy technologies in Nigerian Public Procurement faces several challenges which includes inadequate infrastructure, limited awareness and regulatory barriers (Oyeyebi& Jimoh, 2022).

Wind Energy, Biomass Energy, Fuel-Cell Technology, Hydropower, Geothermal Energy, Nuclear Energy, Solar Energy. Nigeria possesses abundant and diverse low-carbon energy incomes, such as hydroelectric, lunar, wind, tidal, and biomass. These resources embrace great prospective for shaping ground-breaking energy impending in the country (Olujobi*et al.,* 2023).

2.4Environmental Sustainability

With increasing global concerns about environmental sustainability and energy security, the electric vehicle (EV) industry has emerged as a significant player in the green sector (Axsen and Uani, 2013; Bakker & Trip, 2013) Traditional fuel vehicles contribute to air

pollution and greenhouse gas emissions, driving a growing demand for cleaner and low-carbon transportation options (Jordaan *et al.,* 2017), EVs, known for their zero emissions and high energy efficiency, have become instrumental in achieving sustainable development goals (Lin & Zhu, 2020). To fully harness the potential of the EV industry, a comprehensive understanding of its relationship with sustainable economic growth (SEG) is essential. The rapid growth of the EV industry carries implications beyond economic development and job creation; it extends to technological innovation, adjustments in energy consumption structures, environmental protection, and energy security (Tang *et al.,* 2021; Xiong & Wang, 2020). Therefore, conducting in-depth research to elucidate the intricate link between the EV industry and SEG is paramount for the formulation and implementation of effective sustainable development strategies (Zhao *et al.,* 2024).

Environmental sustainability refers to the responsible consumption of natural resources and the maintenance of ecological balance to meet the needs of present and future generations. In developed economies like the USA, efforts towards environmental sustainability have shown significant trends. For example, between 2005 and 2019, the United States reduced its greenhouse gas emissions by approximately 12%, largely due to increased energy efficiency, renewable energy adoption, and shifts in industrial practices (U.S. Environmental Protection Agency, 2021).

One of the aims of SDGs is to make environmentally friendly product development easier for businesses through the notion of "green innovation" (Ahmed *et al.,* 2022). Companies must focus on both technological and management innovation for social sustainability (Sianturi*et al.,* 2022)

However, the ensuing environmental and resource deterioration has been a side effect of this prosperity (Abbas & Dogan, 2022). Natural resource and their vulnerability to global warming impact jeopardize emerging markets' economic progress (Alkaraan*et al.,* 2022). Over the years, authorities around the world have been eager to set standards and guidelines for products and services that are nearly environmentally safe (Kumar & Barua, 2022). Governments were encouraged to work on practical greenhouse gas emission reduction objectives by COP 26 (UNCOP26, 2021; Wyns & Beagley, 2021). United Nations also introduced Sustainable Development Goals (SDGs) to protect and improve the environment and society (UNDP, 2021). Consequently, organisationsstarted valuing the significance of a green environment, which motivated them to pay attention to redesigning their operations and management system (Ahmed *et al.,* 2022). Dynamic firms are taking knowledge, quality, and environment-friendly practices as valuable strategies for creating a competitive advantage in today's business world (Al-Qudah*et al.,* 2022).

The increase in population growth causes ecological problems, ozone depletion, biodiversity degradation, and natural resource scarcity, increasing concern among researchers, practitioners, and academics. These rising global environmental externalities are due to energy consumption, international trade, and urbanization (Geng *et al.,* 2022). The Organization for Economic Cooperation and Development (OECD) countries have advocated the parallel growth of population, trade, and technological development in conjunction with energy demand (Dogan *etal.,* 2021; Dogan *et al.,* 2020), further supported by anecdotal evidence. For instance, the energy demand of OECD countries is 60 % of total energy consumption. The annual trend in overall energy demand for G7 countries indicates that the United States (US) and Canada are the leading countries in total energy consumption per capital (Xing *et al.,* 2024).

The Earth is increasingly endangered by environmental impairments stemming from using conventional fuels. Nevertheless, solar energy is viewed as a leading solution to these problems (Singh *et al.,* 2023). Unlike fossil fuels, which are harmful to the environment through the gases they emit and contribute to climate change, solar energy harnesses the sun's power rather than clean electricity produced exclusively without pollutants. The shift in paradigm about energy to renewable resources fits in with international efforts to deal with the issue of climate change and to achieve sustainable development goals. Among all the benefits of solar energy, one of the noteworthy ones is that it decreases reliance on fossil fuels, hence reducing air and water pollution, saving many ecosystems, and reducing the adverse impacts of climate change on poorer communities (Tawalbeh*et al.,* 2021).

Over the past few decades, environmental issues on a global scale have increasingly come to the fore. Challenges such as climate change, air pollution, and water scarcity are exerting profound impacts on human society and ecosystems (Agovino *et al.,* 2021). In the face of these environmental challenges, the international community universally acknowledges the imperative action to safeguard and enhance the environment. Hence, the environmental regulations, green technological innovation, and the transition to the green economy stand as pivotal means to achieve the environmental conservation goals.

The environmental regulations are the catalyst for the development of the green economy. The environmental regulations could restrain environmental pollution and waste of resources and promote the green economy. At the same time, the environmental regulations could also achieve this transition by limiting emissions and reducing waste generation (Calle & Carrasco, 2022). In addition, these regulations could also promote the development of the green economy by limiting carbon emissions in the energy sector.

In response to these worries, the government has an Agenda 2030 to pursue sustainable development based on the Paris climate agreement, according to Tolliver *et al*., (2020). To increase sustainable development, the government and everyone involved in the built environment must be inventive and give greater attention to environmental preservation and economic growth (Guild, 2020).

2.5Implementation of Renewable Energy for Environmental Sustainability

Japan has implemented strict environmental regulations and promoted energy-saving technologies in various sectors, leading to a reduction in carbon dioxide emissions by 15% from 2005 to 2019 (Ministry of the Environment, Japan, 2020). Countries like Rwanda have made strides in promoting renewable energy, with initiatives such as the Scaling Up Renewable Energy Program supporting the development of solar and hydro-power projects to increase access to clean energy (World Bank, 2020). India has set ambitious renewable energy targets, with plans to achieve 450 gigawatts (GW) of renewable energy capacity by 2030, promoting solar, wind, and hydroelectric power generation (Ministry of Environment, Forest and Climate Change, India, 2021). Brazil has been investing in renewable energy, particularly hydro power and bio-fuels, to diversify its energy mix and reduce carbon emissions (Agência Nacional de Energia Elétrica, Brazil, 2021).

South Africa has also invested in renewable energy sources, particularly wind and solar power, to reduce reliance on fossil fuels and combat climate change (Department of Environment, Forestry and Fisheries, South Africa, 2021). Kenya has also made strides in renewable energy development, with projects such as the Lake Turkana Wind Power Project, one of the largest wind farms in Africa, contributing significantly to the country's renewable energy capacity (Ministry of Environment and Forestry, Kenya, 2020). Kenya has implemented policies to address plastic pollution, including bans on single-use plastics and initiatives to promote recycling and waste management practice (Ngubane, 2024).

Nigeria as one of the most populous countries in Africa, Nigeria faces environmental challenges such as deforestation, pollution, and soil degradation. In response, the Nigerian government has implemented policies and programs aimed at promoting environmental sustainability. For instance, the National Environmental Standards and Regulations Enforcement Agency (NESREA) enforces environmental regulations and standards to mitigate pollution and protect natural resources. Additionally, Nigeria has made efforts to diversify its energy sources by investing in renewable energy, including solar and hydroelectric power projects, to reduce reliance on fossil fuels and mitigate carbon emissions (Federal Ministry of Environment, Nigeria, 2020).

Ghana has also invested in renewable energy projects, such as the Bui Dam hydro-power plant and solar energy initiatives, to enhance energy security and reduce carbon emissions (Ministry of Environment, Science, Technology and Innovation, Ghana, 2015). Furthermore, Ghana has taken steps to address plastic pollution through policies such as the ban on single-use plastics and initiatives to promote recycling and waste management practices (Ngubane, 2024).

Ethiopia has invested in renewable energy projects, including hydro-power and wind power, to expand access to clean energy and reduce reliance on fossil fuels (Ministry of Water, Irrigation and Energy,

Ethiopia, 2020). Tanzania has made efforts to promote renewable energy, including solar and biomass, to increase energy access and reduce reliance on non-renewable sources (Tanzania Renewable Energy Association, 2020). Uganda has invested in renewable energy projects, including small scale hydro-power and solar energy, to increase energy access and reduce reliance on fossil fuels (Uganda Electricity Regulatory Authority, 2021).

Zambia has made efforts to promote renewable energy, including hydroelectric power and solar energy, to expand access to clean energy and reduce greenhouse gas emissions (Zambia Renewable Energy Authority, 2020). The DRC is investing in renewable energy projects, particularly hydro-power, to expand access to clean energy and reduce dependence on fossil fuels (Ministère de l'Énergie et RessourcesHydrauliques, DRC, 2020). Angola is exploring renewable energy options, including solar and wind power, to diversify its energy mix and reduce greenhouse gas emissions (Agência Nacional de Energia, Angola, 2021).

Ivory Coast is investing in renewable energy projects, particularly hydro-power and solar energy, to increase energy access and reduce reliance on fossil fuels (AgenceIvoirienne de l'Énergie, 2020).

Burkina Faso is exploring renewable energy options, including solar and biomass, to expand access to clean energy and reduce carbon emissions (Agence Nationale des Energies Renouvelables et de l'EfficacitéÉnergétique, Burkina Faso, 2020).

Also, the engagement of private end-users in the innovation process, particularly in energy efficiency and sustainability transitions, showcases the increasing active role of users in driving sustainable innovations (Peuckert& Kern, 2023; Nielsen *et al.,* 2016). The adoption of clean energy sources and energy-efficient practices plays a crucial role in reducing air, water, and solid pollutants, thereby enhancing environmental quality and sustainability (Chien *et al.,* 2021).

Again, studies have highlighted the importance of public funds in promoting eco-innovation, especially for smaller companies, and the role of government-university partnerships in accelerating the development of sustainable innovations (Filho *et al.,* 2022; Cecere *et al.,* 2020). Additionally, research has shown that environmental regulations can have a positive impact on green technological innovation, particularly for heavily polluting industries and regions (Shimshack& Ward, 2005).

2.6Barriers to Environmental Sustainability

According to Ayarkwa*el al*., 2020 in their article, Barriers to the implementation of environmentally sustainable procurement in public universities highlighted that Among the barriers to the implementation of environmentally SP reported in literature are the following:

a. Lack of awareness and knowledge, policies, regulations and incentives, insufficient/confusing guidance, tools and indicators.
b. Lack of improvement in organisations and management factors like financial issues, bid evaluation and analysis of the sustainable benefits were identified in Spain (Montalbán *et al.,* 2017);
c. Higher upfront capital cost of more environmentally sustainable products and services, poor choice of environmentally friendly products and services,
d. Lack of methods to compare environmental credentials of greener goods and services,
e. Resistance to change in procurement procedures were identified In the Netherlands (Butler & Keaveney, 2014);
f. Perceived cost or financial constraints, was identified as the most significant barrier to environmentally SP In the UK, Eastern and Western Europe, the USA and Canada (Blair & Wrigh, 2012; Brammer & Walker, 2011);
g. Higher costs, Insufficient or non-existent public policies and government incentives, inadequate legislation and procedures, need for training or technical guidance, ineffective and excessive controls and punishments, slowness in the analysis of licensing procedures and difficult access to technologies and more sustainable products to be the key barriers to the implementation of environmentally sustainable public procurement in Brazil (de Souza Dutra et al. (2017)

2.7 Public Procurement Practices That Needs to Be More Sustainable in Nigeria

Public procurement practices in Nigeria needs to be more sustainable for a reduction pose significant environmental risks, and these concerns are

increasingly recognized in both academic and policy circles. Here are some key fears associated with such practices;

Deforestation: particularly in the logging industry, contributes to widespread deforestation. This not only destroys habitats but also exacerbates climate change by reducing carbon sequestration. Studies highlight that the logging industry in Nigeria has led to significant forest loss, impacting biodiversity and ecosystem services (Akinbode *et al.,* 2020).

i. Pollution: practices in sectors like mining and oil extraction often lead to environmental pollution. For example, oil spills in the Niger Delta have caused extensive damage to aquatic ecosystems and local communities, leading to long-term ecological and health problems (Kujore& Olusola, 2021).

ii. Resource Depletion: The extraction of natural resources including minerals and water, leads to resource depletion. This impacts not only the environment but also the livelihoods of communities dependent on these resources. Over-exploitation of resources can diminish their availability and affect local economies (Ezeani *et al.,* 2022).

iii. Biodiversity Loss: Unregulated activities contribute to habitat destruction and biodiversity loss. The destruction of natural habitats due to unregulated land use and development activities leads to a decline in wildlife populations and loss of plant species (Nwachukwu *et al.,* 2019).

iv. Climate Change: Activities specially in industries with high carbon footprints, contributes to climate change. Such as uncontrolled burning of fossil fuels and deforestation increase greenhouse gas emissions, further aggravating climate-related issues (Okoro & Aliyu, 2021).

2.8 Regulations and Policies

The adoption of environmental standards and laws is another crucial issue. These regulations impose strict minimum criteria for environmental performance, such as those governing emissions or energy use. By establishing these criteria, governments may encourage firms to adopt more environmentally friendly practices and technology (Naruetharadhol *et al.,* 2024).

One of the causes of global warming is caused by human activities and natural damage that is harmful to environmental sustainability on an ongoing basis. The deteriorating environmental conditions encourage changes in people's behavior, especially the community to preserve the environment by using renewable energy and more sustainable energy management which has led to the trend of green governance and green policy. The implementation of the application of renewable energy with green policies by the public sector is carried out because of the public interest in their concern for the environment. These conditions change community behavior which encourages the government to actively implement and enforce a series of green rules based on environmental sustainability (Zhang *et al.,* 2020).

By addressing barriers and leveraging opportunities for innovation, Nigeria can make significant strides towards achieving its environmental goals and contributing to global efforts for a greener future.

III. RESEARCH METHODOLOGY

3.1 Research Design

The research was designed with structured and systematic approach to appraising renewable energy by analyzing quantitative data collected with statistical tools to provide inside for policy and decision makers on the challenges that hindered environmental sustainability in Nigerian Public Procurement.

3.2 Research Approach

A quantitative approach was employed to allow interviewees respond easily and efficiently. It enables the quantification of awareness and usage related renewable energy. This approach consists of standard closed questions that are worded in a specific way, asked in a set sequence and require respondents to choose from a set of predefined answers.

3.3 Sampling Technique

3.3.1 Sampling Method

A purposive sampling was used to administered questionnaire to public procurement processes. This was to ensure the data collected were relevant and reflective of professionals engaged in public procurement.

3.3.2 Sample Population

The population of the study is the procurement officers in Kaduna state, they consist of 76 procurement officers from state agencies and

163procurement officers from Federal agencies in the state, totaling 239 procurement officers.

3.3.3 Sample Size

Sample Size of 149 was determined by Taro Yamane's formula, because it helps to improve the accuracy level in determining the chunk of a population to sample at a reasonable margin of error. Taro Yamane Formula is expressed as $n = N/1+N (e)^2$

Where; n represents the sample size =?

N represents the total population = 239

e represents the level of significance = 0.05 at 95% confidence intervals

1 represents a constant value

Sample Size = $239/1+239(0.05)^2$

Sample Size = $239/1+239(0.0025)$

Sample Size =$239/1+0.5975$, = $239/1.5975$, = 149.6 approximately, 150 is our sample size.

3.4 Data Analysis

3.4.1 Type of Data

Primary data which contains information that can be measured and not simply observed were collected directly from source to calculate statistical values, such as mean, standard deviations and relationships.

3.4.2 Data Collection Instrument

Questionnaires were administrated to get information from procurement officers of public procuring entities in Kaduna State, Nigeria. The survey aimed to assess their awareness and usage of renewable energy. The questionnaire consists of seven sections; the first section is the demography of the respondents, the second is awareness of renewable energy, third section is familiarity of renewable energy, fourth is the challenges of renewable energy, fifth section is solution of overcoming challenges, the sixth section is the benefits to drive from renewable energy while the last section reveals unsustainable public procurement practices that hindered environmental sustainability.

3.5 Validity and Reliability

Table 3.1- Variability and reliability test

Variability Test		
Cases	No	%
Valid	95	99
Invalid	1	1
Total	96	100

Reliability Statistics	
Chronbach's alpha	No of items
0.853	24

Sources: SPSS

To ensure the validity and reliability of the research instrument, the questionnaire was pre-tested with a small group of procurement professionals. Feedback was incorporated to refine the questions and ensure clarity and relevance. Additionally, Cronbach's alpha was used to assess the internal consistency of the survey items, confirming their reliability.

3.6 Ethical Considerations

The research adhered to ethical standards by obtaining informed consent from all participants and ensuring confidentiality and anonymity of the data collected. Participants were informed about the purpose of the study, and their participation was entirely voluntary.

IV. DATA PRESENTATION AND ANALYSIS

4.1 Analysis, Presentation and Interpretation

This chapter contains the presentation of results obtained from respondents who are public procurement officers in Kaduna state, Nigeria. The

results were analysed with the aid of descriptive statistical tools (mean, standard deviation, correlation and frequency) and presented in tabular form in other to visualize information. Tabular presentation of data simplifies the data, makes it easy to view and provide comparison between variables

4.2 Data Presentation

4.2.1 Data response

Table 4.1 Data response rate

Data Response	No	%
Sample Size	150	100
Number of administered questionnaires	150+(10% of 150) = 165	110
Number of questionnaires retrieved	96	64

Source: field survey, 2024

Table 4.1 shows the sample size of 150 respondents which was drawn from population of 239 procurement officers in Kaduna State, Nigeria. 165 questionnaires were administered to procurement officers under the targeted population of which only 96 number of questionnaires were returned answer successfully. This represents 64% of our sample size.

Table 4.2: Demographic Characteristics of the Respondents

Category	Sub-Category	Frequency	%
Academic Qualification	B.Sc.	41	42.70%
	Masters	30	31.30%
	Doctorate	7	7.30%
	Others	18	18.70%
	Total	96	100%
Experience	0-5 Years	32	33.3%
	6-10 Years	20	20.8%
	11-15 Years	28	29.2%
	16-20 Years	4	4.2%
	21 Years and above	12	12.5%
	Total	96	100%
Position	Top Management Level	17	18%
	Middle management Level	28	29%
	Operational Level	51	53%
	Total	96	100%

Source: field survey, 2024

Table 4.2 Represents the demography of respondents which indicates a highly educated workforce of the respondents with 42.7% holding a Bachelor's degree, 31.3% have obtained a Master's degree and a proportion of 7.3% holds Doctorate degrees. This reflects a level of specialised expertise within the group. Meanwhile, 18.7% possess qualifications such as ND, HND, or PGD, highlighting a diversity in educational backgrounds that contributes to a well-rounded skill set in the workforce.

Also, the data revealed a broad distribution across different career stages with33.3% of respondents have between 0-5 years of experience, indicating a

significant presence of early-career professionals. Some with 20.8% falls within the 6-10-year range, suggesting a moderate level of experience. The largest segment of 29.2%, have accumulated 11-15 years of experience, indicating a solid mid-career workforce with considerable expertise. Smaller proportions are found in the more experienced brackets, with 4.2% having 16-20 years and 12.5% boasting over 20 years of experience, underscoring the presence of seasoned professionals who can provide leadership and mentorship. The distribution of respondents by organisational position reveals a workforce primarily engaged at the operational level, accounting for 53% of the total. This indicates that a majority of employees are involved in day-to-day tasks and front-line operations. Middle management positions represent 29% of the respondents, reflecting a moderate layer of leadership responsible for implementing strategies and supervising teams. Only 18% are in top management roles, suggesting limited participation in high-level decision-making processes. This distribution highlights potential opportunities for leadership development and succession planning to ensure a more balanced representation across all organisational levels.

Table 4.3: Renewable Energy identified

S/No	Renewable Energy Identify by Literature
1	Bio-fuel
2	Solar energy
3	Electric Vehicles (EV's)
4	Geothermal energy
5	Hydro-power
6	Wind energy
7	Nuclear energy
8	Tidal energy

Source: Literature

Table 4.3 Represents Renewable Energy identified by literatures. Research uncovered that countries across the globe have invested in renewable energy as a measure to the reduction of carbon dioxide emissions (CO2) which causes pollution and biodiversity loss to the entire ecosystem (Ngubane, 2024).

Study had identified Nuclear energy as the world's most environmentally friendly energy source and is considered to be a very clean source of energy (Irfan & Ali 2023). Natural replenishment of renewable resources is what constitutes sustainable energy. It includes sun, wind, rain, tides, waves, and geothermal heat. Other form of Renewable energy sources includes wind, solar, and hydropower (Bekun *et al*. 2022; Caglar *et al.* 2022).

Notable Countries like Brazil has been investing in renewable energy, particularly hydropower and biofuels, to diversify its energy mix and reduce carbon emissions (Agência Nacional de Energia Elétrica, Brazil, 2021). India has set ambitious renewable energy targets, with plans to achieve 450 gigawatts (GW) of renewable energy capacity by 2030, promoting solar, wind, and hydroelectric power generation (Ministry of Environment, Forest and Climate Change, India, 2021). Vehicle electrification represents one of the most prominent technological revolutions in the transportation sector in line with global goals on climate change (International Council on Clean Transportation, 2020; Jia *et al.,* 2023). Thus, zero-emission vehicles (ZEVs) are technological solutions that are inherently built to produce zero direct tailpipe emissions and minimize the negative environmental impacts that are associated with conventional fossil-fuel-powered vehicles (Li *et al.,* 2023a; Rosales-Tristancho*et al.,* 2022)

African countries like Tanzania have made efforts to promote renewable energy, including solar and biomass, to increase energy access and reduce reliance on non-renewable sources (Tanzania Renewable Energy Association, 2020 From (Juliet, 2024). Rwanda has made strides in promoting renewable energy, with initiatives such as the Scaling Up Renewable Energy Program supporting the development of solar and hydropower projects to increase access to clean energy (World Bank, 2020). South Africa has also invested in renewable energy sources, particularly wind and solar power, to reduce reliance on fossil fuels and combat climate change (Department of Environment, Forestry and Fisheries, South Africa, 2021)

Additionally, Nigeria has made efforts to diversify its energy sources by investing in renewable energy, including solar and hydroelectric power projects, to reduce reliance on fossil fuels and mitigate carbon emissions (Federal Ministry of Environment, Nigeria, 2020).

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Table 4.4 Knowledge of Renewable Energy

		Count	Mean	Std. Dev.
What is your level of awareness of Renewable Energy?	None	0	0	
	Low	14	0.15	
	Moderate	57	1.19	
	High	25	0.78	
	Total	96	2.11	.63
What is the level of acceptability of Renewable Energy in your organisation?	None	48	0	
	Low	20	0.21	
	Moderate	12	0.25	
	High	16	0.5	
	Total	96	.96	1.14
What type of Public Procurement activities have you used Renewable energy?	All	0	0	
	Goods	22	0.23	
	Works	62	1.29	
	Service	12	0.38	
	Total	96	1.90	.59
What is the level of effectiveness of the Renewable Energy product/service used?	None	0	0	
	Low	19	0.19	
	Moderate	53	1.10	
	High	24	0.75	
	Total	96	2.05	.67

Source: SPSS analysis of field survey, 2024

Awareness: The results shows that Most respondents report moderate (57) to high (25) awareness levels, with a mean score of 2.11 and a standard deviation of 0.63, indicating general awareness of renewable energy but with some variability.

Usage of renewable energy: Nearly half (48) respondents have not use renewable energy, while others report low (20) to moderate (12) involvement, with only 16 reporting high engagement. The mean score of 0.96 and a standard deviation of 1.14 reflect limited renewable energy adoption and high variability.

Acceptability of renewable energy in the Organization: Results revealed renewable energy is mostly applied to works (62), with fewer organizations applying it to goods (22) or services (12). The mean acceptability score is 1.90, with low variability (0.59), suggesting that renewable energy is more commonly accepted for specific types of projects, particularly works.

Effectiveness of renewable energy Products/Services: Most respondents rate the effectiveness as moderate (53) or high (24), with a mean of 2.05 and a standard deviation of 0.67, showing positive perceptions of renewable energy effectiveness. However, there is moderate awareness and acceptability of renewable energy, particularly for works, but actual usage is relatively low, highlighting opportunities for further integration and education on renewable energy into procurement practices.

Table 4.5: Assessment of Renewable Energy by Public Procurement Officers

	Questions	Responses	Percentage
Awareness of Renewable energy	Aware	82	85%

	Not aware	14	15%
	Total	96	100%
Acceptance of Renewable energy	Works	62	64.5%
	Goods	22	23%
	Service	12	12.5%
	Total	96	100%

Source: Field Survey, 2024

Table 4.4 informed of the awareness level of the respondents on renewable energy, which the results reveal an excellent number consisting 85% of procurement officers are aware of these energy with only 15% who respondents not aware. The results explored 64.5% of using this energy were for works type of procurement with only 45.5% were used for goods and services type of procurement,

Table 4.6: Usage of Renewable energy in Public Procurement Officers

S/No	Tech Used	Low	Moderate	High	Rate of Usage	Rank
1	Solar	2	30	18	50	1
2	Hydro & Solar	1	17	2	20	2
3	Bio-fuel & Solar	-	5	1	6	3
4	Electric vehicle, Hydro & Solar	-	5	-	5	4
5	Bio-fuel, Hydro & Solar	-	2	2	4	5
6	Hydro, Solar & Wind	-	3	1	4	5
7	Electric vehicle & Solar	-	1	2	3	7
8	Bio-fuel	1	-	-	1	8
9	Hydro-power	-	1	-	1	8
10	Solar & Wind	-	1	-	1	8
11	Wind	1	-	-	1	8
	Total	5	65	26	96	

Table 4.6. represent usage of the renewable energy by the procurement officers, showing solar alone dominating more than half of the usage with solar and hydro have used by twenty respondents, then Bio-fuel, Hydro-power, Solar & Wind and Wind alone with only one usage. Geothermal, Nuclear and Tidal have not been reported.

Table 4.7 Notable Barriers to Renewable energy in Public Procurement

Barriers of Renewable energy acceptability	Low	Moderate	High	Total	Mean	Std. Dev.	Rank
Poor Regulatory Framework	3	25	68	96	2.68	0.53	1
Inadequate Training of Procurement Officials	8	18	70	96	2.65	0.63	2
Insufficient Funding & Resources	9	18	69	96	2.63	0.65	3
Poor Environmental Conservation & Consideration	10	17	69	96	2.61	0.67	4
Limited Availability of Renewable Energy Products & Services	11	38	47	96	2.37	0.68	5
Administrative Inefficiency	10	50	35	95	2.26	0.64	6

Poor Regulatory Framework: the counts show 68 respondents rate this challenge as "High" and 25 as "Moderate" The mean score is 2.68 with a standard deviation of 0.53, indicating that respondents generally agree this is a notable challenge and ranked the highest challenge, show strong agreement on the importance of this challenge.
Inadequate Training of Procurement Officials: the counts show 70 respondents rate this challenge as "High" and 18 as "Moderate" The mean score is 2.65 with a standard deviation of 0.63, indicating that respondents also agree this is a notable challenge and ranked the second highest challenge, show strong agreement on the importance of this challenge.

Insufficient Funding & Resources: This challenge has "High" 69 respondents rated high and 18 suggesting it is perceived as the third most significant barrier. A mean of 2.63 and a standard deviation of 0.65 show strong agreement on the importance of this challenge, with slightly less spread in responses.

Poor Environmental Conservation & Consideration: This challenge has "High" 69 respondents rated high and 11 suggesting it is perceived as the fourth most significant barrier. A mean of 2.61 and a standard deviation of 0.67 show strong agreement on the importance of this challenge, with slightly less spread in responses.

Limited Availability of RE Products & Services: With a high count of 47 marking this as a "High" challenge, this issue is recognized as significant. The mean of 2.37 and standard deviation of 0.68 further support this agreement, showing slight variability around the mean but generally agreed challenge.

Administrative Inefficiency: the counts show 50 respondents rate this challenge as "Moderate" and 35 as "High." The mean score is 2.26 with a standard deviation of 0.64, indicating that respondents generally agree this is a notable challenge, with responses fairly consistent around the mean.

Table 4.8 Unsustainable Public Procurement Practices that affect environmental sustainability

	Low	Moderate	High	Total	Mean	Std. Dev.	Rank
Pollution of the eco-system	4	16	76	96	2.75	0.52	1
Resources depletion (un-sustainable extraction of natural resources)	2	22	72	96	2.73	0.49	2
Bio-diversity loss (poor procurement practice that resulted to habitat destruction)	4	18	74	96	2.73	0.53	3
Deforestation	4	19	73	96	2.72	0.54	4

The analysis explored unsustainable practice that harm and destroyed the environment as per below:
Pollution of the Ecosystem: This practice has the highest count of "High" ratings (76 respondents), suggesting it is viewed as a major issue in unsustainable procurement practices. With a mean of 2.75 and a standard deviation of 0.52, respondents consistently agree on the impact of pollution, with minimal variability in their responses.

Resource Depletion (Unsustainable Extraction of Natural Resources): Marked as a "High" concern by 72 respondents, resource depletion is recognized as another significant challenge. The mean score of 2.73 and a low standard deviation of 0.49 highlight strong agreement, showing that respondents view unsustainable resource extraction as highly impactful.

Biodiversity Loss (Habitat Destruction): With 74 "High" ratings, biodiversity loss is similarly seen as a critical issue. The mean of 2.73 and standard deviation of 0.53 indicate a high level of consensus, underscoring agreement on the negative impact of poor procurement practices on biodiversity. Overall (Ground Mean): The ground mean shows an "Agree" remark across all categories, confirming a general consensus among respondents that these unsustainable practices hinder environmental sustainability.

Deforestation: Rated as a "High" concern by 73 respondents, deforestation is seen as a significant unsustainable procurement practices. The mean score of 2.72 with a standard deviation of 0.54 suggests

broad agreement, with responses clustering closely around the mean, indicating consensus on its impact.

Table 4.9: How Renewable Energy enhance Environmental Sustainability

		Count	Mean	Std. Dev.
What should be the impact level for enhancing environmental sustainability?	None	0	0	
	Low	1	0.01	
	Moderate	30	0.63	
	High	65	2.03	
	Total	96	2.67	.50
What should be the level of environmental consideration in procurement activities?	None	0	0	
	Low	1	0.01	
	Moderate	29	0.60	
	High	66	2.06	
	Total	96	2.68	.49
what should be the level of Sustainable Practices by Procurement Entity?	None	0	0	
	Low	5	0.05	
	Moderate	23	0.48	
	High	68	2.12	
	Total	96	2.66	.58

Familiarity with Innovations: Respondents show strong familiarity with renewable energy, particularly solar energy (32) and all others (60), resulting in a mean score of 4.26 and a standard deviation of 1.00, indicating a high level of awareness but with some variability.

Usage of renewable energy: Actual usage is lower, with the majority using solar (32) energy, while bio-fuel (1) and hydro-power (1) are minimally utilized. The mean usage score is 3.96 with a standard deviation of 1.01, suggesting good familiarity but limited practical application.

Effectiveness of renewable energy: Perceptions of effectiveness are generally positive, with most rating the effectiveness as moderate (65) or high (26), leading to a mean effectiveness score of 2.22 and a standard deviation of 0.53, indicating confidence in the utility of these technologies. However, while there is high familiarity and perceived effectiveness of renewable energy, actual usage remains limited, particularly outside of solar energy, suggesting potential for increased implementation and further exploration of diverse technologies.

4.3 Data Analysis

Awareness of Renewable energy- The data reveals a high level of awareness of renewable energy among respondents, with 85% indicating they are aware of such energy, while only 15% are not. This suggests that the majority of the procurement officers handsome degree of understanding of renewable energy. However, acceptance levels vary depending on the type of procurement, with the result revealing usage of renewable energy is mostly application to infrastructural projects, with 65% of respondents indicating their usage in works, 23% for goods and 13% for services. This disparity highlights a need to promote and integrate adoption of renewable practices across all types of procurement, ensuring that awareness translates into broader acceptance and application beyond infrastructure projects.

Lastly, the analysis reveals a strong interdependence between renewable energy, procurement practices, benefits and environmental challenges. Addressing these challenges through targeted strategies can significantly enhance the effectiveness and sustainability of renewable energy.

V. CONCLUSION

The findings reveal a well-educated and experienced workforce, primarily in mid-career stages, but with limited representation in top management positions. This suggests a need for improved diversity and leadership opportunities to enhance decision-making and retention efforts.

Respondents acknowledged the challenges in adopting renewable energy in public procurement.

Funding emerged as a primary barrier, with limited availability and administrative inefficiencies also contributing to the slow adoption rate.

While awareness and knowledge of Renewable energy technologies are generally high, actual usage remains limited, particularly beyond solar energy. This indicates a gap between awareness and practical implementation that must be addressed.

The study highlights that environmental factors are often overlooked or not given sufficient priority in public procurement processes. To bridge this gap, enhancing regulatory frameworks, providing targeted training for procurement officials, and emphasizing environmental conservation are critical. These measures will strengthen the adoption of Renewable energy technologies and support the broader goal of promoting environmental sustainability within the public sector.

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