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Green Building Rating System and Mitigating Climate Change in Nigeria

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Abstract:
The rapid growth of urbanisation and construction activities in Nigeria has raised concerns about its environmental impact, especially in light of global warming. The paper investigates how Nigerian rating systems for green buildings can help to slow down global warming. It gives a summary of regional and global green building evaluation methods while stressing their advantages and applicability to the situation in Nigeria. The article focuses on how building construction affects the production and release of greenhouse gases while examining the difficulties brought on by attendant climate change in Nigeria. It also highlights how green construction evaluation systems, involving efficient use of energy, responsible site planning, water conservation, waste management, as well as quality of the indoor environment help to mitigate climate change. The adoption of grading systems for green buildings within Nigeria is assessed, including the current status, challenges, and government support. Case studies of effective green construction initiatives in Nigeria are presented in this article, showcasing their positive environmental and economic outcomes. It concludes with recommendations for policy enhancements, education and awareness programs, research and development, and collaboration to promote the widespread adoption of green construction methods. This paper highlights the value of grading systems for green buildings as a potent instrument for addressing the challenges of climate change in Nigeria and urges all stakeholders to work together to adopt ecologically sound construction methods for a future that is better for the environment.

Keywords: *Green Buildings, Climate Change, Rating Systems, Climate Change Mitigation, Nigeria*

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I. INTRODUCTION

Introduction

Global warming and a significant amount of emissions of greenhouse gases originate from the building industry. As countries worldwide grapple with the need to reduce their carbon footprint, green building techniques have become a crucial component of the fight against the effects of global warming impacts (United States Environmental Protection Agency (EPA), 2022). Nigeria, a rapidly developing nation with a booming construction industry, faces unique challenges in addressing climate change while meeting its growing infrastructure needs.

The chapter is about how urgent it is to address Global warming and human activity as well as their effect on the structure of buildings viz-a-vis ecological deterioration. Similarly, the impact of environmental effects on buildings, including energy consumption, resource depletion, and waste generation, is discussed, emphasising the necessity of using green construction techniques in Nigeria.

The importance of the study is then explained. Nigeria, with its expanding urban centres and rising energy demands, faces unique environmental crisis challenges. It has become imperative that we comprehend how environmentally friendly building grading systems might help Nigeria mitigate the consequences of climate change for sustainable development as well as environmental preservation (Okon, et al., 2021). The Nigerian construction industry could gain from using green building techniques by lowering emission levels of greenhouse gases and increasing the effectiveness of energy use, and enhancing indoor environmental quality, these are some of the issues highlighted.

Following the significance, the research objectives are outlined. This study's main goal is to examine how Nigerian green building rating systems contribute to climate change mitigation. Studying globally oriented and geographic regions' environmentally friendly construction rating systems, determining their applicability to the Nigerian context, analysing Nigeria's present level of green building practices, finding operational obstacles, and providing recommendations for promoting sustainable building practices.

Finally, a summary of the article's configuration is presented with the conclusion of this section. Well-thought-out discussions of environmentally friendly building assessment methods, global warming problems in Nigeria, the role of environmentally friendly construction methods in mitigating climate change, the adoption of rating systems for green buildings in Nigeria, case examples demonstrating effective projects, and suggestions for further action are covered in the following chapters.

By recognising the significance of environmentally sound building methods and their potential to reduce greenhouse gas emissions, this research seeks to advance the conversation on sustainable construction practices and resilient built environments in Nigeria and inspire action towards a greener and more environmentally conscious future.

1.B.1. Climate Change Mitigation in Nigeria

Nigeria, as a developing nation, faces many obstacles in the way of addressing sustainable growth and tackling global warming. Appropriate mitigation strategies are required due to both the nation's increasing production of greenhouse gases and their susceptibility to environmental consequences (Federal Ministry of Environment, Department of Climate Change, 2021). It is essential to comprehend how green building grading systems might help Nigeria mitigate the effects of global warming by aligning building practices with sustainable development goals.

1.B.2. Environmental Benefits of Green Building Grading Systems

Building evaluation systems offer some ecological advantages that are consistent with the objectives of reducing global warming. The effectiveness of these devices enhances the quality of the interior environment, greenhouse gas (GHG) emissions are decreased, water resources are conserved, ecological waste and material management are encouraged, and efficient use of energy is promoted (Labaran, Mathur, Muhammad, & Musa, 2022). This study analyses ways to reduce the negative environmental impacts of the construction industry and contribute to the mitigation of climate change by examining the possibility of green building grading systems in Nigeria.

1.B.3. Economic and Social Implications

Green construction standards and rating systems can assist Nigeria's economy and society. Buildings that use fewer fossil fuels have lower operating expenses, enhance property values, and contribute to job creation in the renewable energy sector. Additionally, improving the comfort of residents, wellness, and welfare are environmentally friendly construction strategies. (Oguntuase & Windapo, 2021) Investigating the economic and understanding social ramifications of green construction methods in Nigeria will help us better understand the conceivable benefits of environmentally friendly development.

1.B.4. Policy and Decision-Making Relevance

The results of this research directly affect Nigeria's decisions and policy procedures. The establishment of laws and regulations that encourage and impose sustainable building practices can be informed by an understanding of how to grade green buildings and their effectiveness. Additionally, insights from successful case studies can guide decision-makers in promoting and replicating sustainable building projects.

1.B.5. Knowledge Gap in Nigerian Context

While grading systems of green buildings have gained prominence globally, their specific applicability and effectiveness in the Nigerian context require further exploration (Onuoha, et al., 2023). This study addresses a knowledge gap by investigating the relevance, challenges, and opportunities for introducing rating systems and green building principles in Nigeria. The study contributes to our understanding of environmentally friendly development by bridging this knowledge gap with practices tailored to Nigeria's unique socio-economic and environmental conditions.

By pointing up the importance of this study, it underscores the importance of examining the role of grading systems for green buildings for climate change mitigation within Nigeria. The findings of this research can guide professionals in the construction industry, policymakers, as well as other interest groups and stakeholders towards adopting green building processes that contribute to environmental preservation and sustainable development goals.

II. LITERATURE REVIEW

Chapter Two provides an in-depth Literature Review of Environmentally friendly building grading systems globally, both internationally recognised and regionally relevant, to establish a comprehensive understanding of their key features, criteria, and benefits. This chapter serves as a foundation for evaluating the potential Green building grading methods' application in the context of Nigeria.

2.1 Introduction to Rating Systems for Green Buildings

The notion of rating systems for environmentally friendly buildings and their importance for advancing environmentally friendly construction methods are introduced at the beginning of the chapter. It emphasises the need for rating systems in evaluating and certifying structures according to ecological and environmentally friendly standards (Vierra, 2023). The chapter focuses on the possible advantages of using environmentally conscious construction rating systems, including energy efficiency, a smaller ecological footprint, improved quality of the interior environment, and satisfaction with the occupants.

2.2 Systems for International Green Building Rating

This section focuses on international techniques for evaluating green buildings that are widely accepted. Mechanisms like Green Star, Building Research Establishment Environmental Assessment Method (BREEAM), and Leadership in Energy and Environmental Design (LEED) are critically evaluated. This section discusses the key features, assessment criteria, certification levels, and success stories associated with each rating system. It emphasises their role in preventing global warming and promoting environmentally friendly growth (Li, Li, Skitmore, He, & Jiang, 2022).

2.3 Regional Green Building Rating Systems

In addition to international systems, this section explores Particularly applicable regional environmentally friendly construction grading methods for the Nigerian environment and the broader African region (Debra, Vidal, & Dinis, 2021). The Green Building Council of Nigeria (GBCN) and other regional rating systems in Africa are highlighted in this chapter. It examines their unique features, criteria, and objectives, and discusses their alignment with local climate conditions, socio-economic factors, and cultural considerations.

2.4 The Systems Comparison for Environmentally Friendly Building Ratings

To facilitate a comprehensive understanding, The international and regional green building rating systems are compared in this section. It looks at their parallels, discrepancies, and overlaps. The chapter explores the varying emphasis placed on different sustainability parameters like indoor environmental quality, water conservation, energy efficiency, site sustainability, and waste management. This analysis aims to identify common principles and best practices that can inform the development of environmentally friendly building techniques throughout Nigeria (Koko & Bello, 2020).

2.5 Relevance as well as Applicability to Nigerian Context

Building upon the comparative analysis, this section evaluates the usability and significance of green building grading methods within Nigeria. It considers factors such as local climate conditions, available resources, construction practices, and cultural considerations (Study Corgi , 2021). The section looks at both possibilities and challenges that come with introducing these systems of evaluation throughout Nigeria, highlighting the potential benefits they can bring to the local construction industry and environmental sustainability.

By providing a thorough analysis of regional as well as worldwide environmentally friendly construction rating systems, this chapter establishes the foundational knowledge necessary for evaluating their applicability in the Nigerian context. The analysis of key features, criteria, and benefits allows for a thorough knowledge of the possible roles that green building grading systems could play in Nigeria's environmentally friendly growth and fight against global warming.

A. Definition and Purpose

This section of Chapter 2 provides a clear definition and what green building rating systems are used for. It establishes the fundamental understanding of these systems, their objectives, and their part in encouraging environmentally friendly building methods.

2.A.1 Green Building Rating Systems Definition

The chapter begins by defining grading systems of green buildings as frameworks that assess as well as certify the environmental performance and sustainability of physical developments. The systems evaluate various aspects of a building's planning, design, operation, maintenance as well as construction, in order to determine its rank of sustainability (Vierra, 2023). Rating systems for green buildings operate on a standardised approach to measuring and recognising buildings that demonstrate exceptional levels of resource conservation, energy efficiency, as well as environmental responsibility.

2.A.2 Green Building Rating Systems' Objectives

Sustainable building rating schemes are used to encourage and incentivise sustainable building practices. These systems serve as guidelines and benchmarks for builders, designers, as well as developers to enhance buildings' ecological sustainability. By establishing specific criteria and performance standards, Sustainable

construction grading systems promote the use of environmentally friendly methods such as waste disposal plans, water-efficiency measures, energy from renewable sources, and technologies that are energy-efficient (Vierra, 2023). The main objectives are to lessen the negative effects of buildings on the ecosystem, slow global warming, and down the rate of climate change, and improve the quality of constructed spaces.

2.A.3 Green Building Rating Systems' Goals

This section outlines the key green building rating systems' goals. These objectives include:

i. **Environmental Preservation**: The goal of green building rating systems is to reduce a facility's adverse effects on the environment by reducing greenhouse gas emissions, promoting resource efficiency, minimising waste generation, and conserving water. These systems encourage the conservation of resources that are renewable and the use of ecologically friendly materials.

ii. **Energy Efficiency**: Enhancing the utilization of energy in buildings constitutes one of the main goals of green building grading systems. These systems aim to lower energy use and reliance on petroleum and natural gas by using energy-efficient design concepts, effective air conditioning and heating systems, insulating material, lighting innovations, and energy from renewable sources.

iii. **Indoor Environmental Quality**: Indoor settings that are relaxing and beneficial to health are prioritised by environmentally friendly construction rating systems. They emphasise elements like thermal comfort, acoustics, natural daylighting, and indoor air quality to ensure both the productivity and health of building inhabitants.

iv. **Water Conservation:** Another important goal of ecological construction is the preservation of water resources for future generations rating systems. These systems encourage the implementation of rainwater harvesting systems, water-efficient fixtures, as well as strategies for rational use of water to minimise and reduce water use and safeguard nearby water resources.

v. **Sustainable Site Development**: Green building rating systems promote sustainable site development practices, such as minimising the ecological footprint, preserving natural habitats, and reducing stormwater runoff. They encourage the use of permeable surfaces, green spaces, and native vegetation to improve ecological diversity and lessen the negative effects of building on the natural world.

vi. **Education and Awareness**: Green building rating systems seek to promote environmentally friendly building practices and inform qualified individuals, participants, and the public on the advantages associated with environmentally friendly buildings. These systems provide educational resources, training programs, and certification processes to enhance knowledge and skills related to sustainable construction.

By understanding the definition and what green building rating systems are used for, it becomes evident that These systems are essential for promoting the physical environment's growth that is environmentally friendly. They provide a framework for assessing and certifying buildings based on their environmental performance and promote the adoption of sustainable building practices to mitigate climate change and create more environmentally responsible structures (Ayarkwa, Opoku, Antwi-Afari, & Li, 2022). To combat the effects of global warming and produce more ecologically friendly constructions, encourage the use of environmentally friendly building methods.

2. B. International Green Building Rating Systems

Section 2. B provides an overview of internationally recognised green building rating systems, highlighting their key features, assessment criteria, and benefits. The chapter explores some of the most well-known grading systems that have achieved international acclaim and have been widely adopted in various countries.

2.B.1 LEED – Leadership in Energy and Environmental Design

The Leadership in Energy and Environmental Design (LEED) rating system, created by the U.S. Green Building Council (USGBC), is the subject of this section. It examines the key principles, rating categories, and certification levels offered by LEED. The section discusses the assessment criteria for energy and atmosphere, sustainable site development, water efficiency, materials and resources, innovation in design, and indoor environmental quality (UGREEN, 2023). It also highlights the international flexibility and adaptation of LEED and its influence on green building practices worldwide.

2.B.2 BREEAM – Building Research Establishment Environmental Assessment Method

This section explores the UK-based BREEAM - Building Research Establishment Environmental Assessment Method. It discusses BREEAM's method of rating buildings' environmental performance, including its categories of health and well-being, sustainable design as well as construction, energy, waste, management, transport, ecology, land use, water, and materials (Karlberg, 2023). The section highlights the flexible nature of BREEAM and its widespread adoption in many parts of the world, including Europe.

2.B.3 Green Star

This section focuses on the Australian green building grading system, Green Star, which was developed by the GBCA, the Green Building Council of Australia. This chapter hints at the focus of Green Star on a variety of buildings, such as offices, homes, and communities. It explores Green Star's categories, inclusive of indoor

environmental quality, management, energy, ecology, transport, land use, materials, and water (Cao, Xu, Kamaruzzaman, & Aziz, 2022). This section highlights the emphasis on Green Star on construction, operation practices, sustainable design, and the positive impact throughout the Australian construction industry.

2.B.4 Green Building Rating Systems from Other Countries

This sub-chapter provides an overview of other international grading systems of green buildings that are well recognised as well as adopted in different regions of the globe. It explores systems such as DGNB (Germany), CASBEE (Japan), Estidama (United Arab Emirates), and Green Mark (Singapore), among others. The chapter highlights their unique features, assessment criteria, and regional relevance. It hints at their contributions to sustainable methods of building construction techniques as well as their effect on promoting sustainable and environment-friendly, ecologically sound buildings within the global community (Temmerman, Mastrorilli, Popovac, Adams, & Feraille, 2022).

2. C: Regional Green Building Rating Systems

2. C also delves into specifically applicable regional environmentally friendly construction grading methods for the Nigerian setting as well as the broader African region. This section explores rating systems developed and adopted within the region, taking into account local climate conditions, socio-economic factors, and cultural considerations.

Other African nations have created independent rating systems for green buildings to promote sustainable construction methods in addition to the Green Building Council of Nigeria (GBCN) within their specific contexts. These rating systems address the unique challenges, priorities, and opportunities present in their respective countries and regions.

3. A. Impact of Climate Change in Nigeria

Chapter 3. A examines Nigeria's distinct changing climate effects, focusing on the environmental, social, and economic consequences. It delves into the observed and projected changes in climate patterns and their implications for various sectors and communities within the country.

3.A.1 Changing Temperature Patterns

This subsection discusses the increasing temperatures in Nigeria and their effects on the environment and human well-being. It explores the impacts on agriculture, including changes in crop yields and shifts in planting seasons. It also addresses the implications for human health, such as increased heat-related illnesses, and the challenges faced by vulnerable populations in adapting to extreme temperatures (FutureLearn, 2021).

3.A.2 Altered Rainfall Patterns

This section examines the shifting patterns of precipitation in Nigeria and their effects. It looks at how they have an effect on the agricultural sector, especially in terms of agricultural output and availability of water (FAO, 2021). In the same vein, it also addresses the increased risk of floods and droughts, and the subsequent implications for food security, water resources, and socio-economic stability.

3.A.3 Coastal Erosion and Sea-Level Rise

The subsection focuses on the dangers that coastal districts in Nigeria face from coastal subsidence and increases in sea levels. It highlights the vulnerability of coastal communities, infrastructure, and ecosystems to rising sea levels (Andrews, et al., 2021). It explores the socio-economic impacts, including displacement of populations, loss of land, damage to infrastructure, and the implications for coastal livelihoods and biodiversity.

3.A.4 Extreme Weather Events

This subsection examines the impact of increasing catastrophic weather conditions on Nigeria, including storms, tropical cyclones, as well as floodwaters. It explores the risks to infrastructure, agriculture, and human settlements (FAO, 2021). It addresses the challenges faced in disaster preparedness, response, recovery, and the importance of adaptive measures to minimise the impacts of these events.

3.A.5 Ecological and Biodiversity Implications

This subsection discusses the effects of warming temperatures on Nigeria's ecology and the preservation of biodiversity. It explores the impacts on ecosystems, including forests, wetlands, and wildlife habitats. It addresses the risks to biodiversity, species extinction, and ecosystem services (Weiskopf, et al., 2020). The subsection emphasises the significance of protecting and managing environmental assets in light of warming temperatures in order to sustain ecological harmony and support sustainable development.

The section emphasizes Nigeria's considerable concerns by analysing the effects of warming temperatures there. In order to lessen the negative consequences on the natural world, finances, and the

community, the paragraph emphasizes how urgent it is to address the mitigation and adaptation of climate change methods. It prepares the ground for more investigation into the function of sustainable construction grading systems in reducing the effects of global warming and fostering robustness in the framework of construction.

3. B. Emissions of Climate Change-Related Gases from the Construction Sector

The greenhouse gas (GHG) emissions connected to Nigeria's construction industries are the subject of Section 3. B. It looks at how buildings are constructed and used to produce emissions of greenhouse gases while emphasizing the importance of environmentally friendly procedures and the function that green building grading systems have in reducing pollution. (Bungau, Bungau, Prada, & Prada, 2022)

3.B.1 Building Energy Consumption

This subsection addresses the significant contribution of building energy consumption to GHG emissions. It explores the reliance on fossil fuels for electricity generation and the use of inefficient energy systems in buildings. The section discusses the impacts of energy consumption on carbon dioxide (CO2) emissions and the potential for energy-efficient building design, renewable energy integration, and improved operational practices to reduce emissions.

3.B.2 Material Production and Waste

The segment investigates greenhouse gas (GHG) emissions linked to the manufacture of building supplies and the generation of garbage in the built environment. It discusses the carbon footprint of materials such as cement, steel, and glass, highlighting the importance of sustainable material choices and recycling practices to minimise emissions. The section emphasises the need for lifecycle assessment and circular economy approaches to reduce emissions throughout the building's lifespan.

3.B.3 Transportation and Infrastructure

This subsection addresses the GHG emissions generated by transportation and infrastructure systems supporting the built environment. It discusses the reliance on fossil fuel-powered vehicles, the impact of urban sprawl, and the requirement for environmentally friendly mobility options like public transportation, bicycle facilities, and electric automobiles. This section emphasises the role of compact and connected urban planning to reduce transportation-related emissions.

3.B.4 Operational Emissions

The subsection explores the ongoing operational emissions from buildings, including heating, cooling, and ventilation systems, as well as water and waste management. It discusses wastewater and water management, as well as air conditioning systems. It explores ways to reduce operational greenhouse gases through the use of energy-efficient technologies, the integration of energy from renewable sources, and effective water and waste management techniques. The section emphasizes the significance of environmentally friendly architectural concepts and operational procedures in achieving substantial emission reductions.

3.B.5 Green Building Rating Systems: Their Functions

The importance of green building rating systems in reducing GHG emissions in the built environment is highlighted in this subsection. It discusses how these rating systems encourage sustainable building practices, energy efficiency, renewable energy adoption, and responsible material choices. The section explores the certification process and Motivation offered by green building rating systems to encourage the reduction of and mitigate greenhouse gas (GHG) emissions in the construction sector are highlighted in this subsection. It highlights the potential for these systems to drive market transformation and support Nigeria's climate change mitigation efforts.

By examining GHG emissions in the built environment, Section 3. B highlights the importance of addressing emissions from buildings to mitigate climate change. It emphasises the requirement for eco-friendly construction methods, improved efficiency of energy, and the use of energy from renewable sources. This subsection underscores the importance of green building grading systems in Nigeria as a useful tool for lowering pollutants and encouraging an environmentally friendly construction industry.

IV. WATER CONSERVATION AND MANAGEMENT

In Chapter Four, the focus is, on how environmentally friendly building grading systems might encourage the use of efficient water management techniques and water-saving practices in buildings (Kumar M, 2020). It explores the strategies and criteria employed by these rating systems to minimise water consumption, preserve water resources, and enhance water efficiency.

4.1 Efficient Plumbing Fixtures and Fittings

This subsection addresses the significance of water-saving plumbing equipment and fixtures in lowering water use. In order to promote the fitting of toilets with reduced flow, water conservation faucets, and effective heads for showers, it covers the standards employed by ecologically friendly construction assessment methods (Basak, Tuhin, Ahmed, Uddin, & Pal, 2020). The section highlights the potential water savings achieved through these measures and their contribution to overall water efficiency in buildings.

4.2 Greywater and Rainwater Harvesting Systems

This subsection focuses on the adoption of greywater and rainwater collection systems as part of sustainable water management. It discusses the standards used by sustainable construction grading systems to encourage stormwater to be collected and kept for non-potable purposes including farming, flushing toilets, and outdoor cleaning. Additionally, it addresses the utilisation of systems for treating and reusing washbasins, bathing, and washing clothes water for uses not requiring drinkable water (UNESCO, International Centre for Water Security and Sustainable Management, 2020). The section emphasises the potential for significant water savings and reduced strain on municipal water supplies through these practices.

4.3 Landscape Water Conservation

This subsection explores the strategies employed by green building rating systems to promote landscape water conservation. It examines the factors that support the adoption of effective irrigation systems, drought-tolerant plants, and water-wise gardening techniques (Kumar M, 2020). The section highlights the importance of proper design, scheduling, and maintenance of irrigation systems to minimise water waste and ensure efficient water use in outdoor areas.

4.4 Water Metering and Monitoring

The subsection addresses the significance of water metering and monitoring systems in promoting water conservation. The article goes over the standards that green building grading systems employ to encourage the placement of water consumption metres sub-metering systems, and water monitoring devices. (Oberascher, Rauch, & Sitzenfrei, 2022)The section emphasises the role of real-time monitoring, leak detection, and water consumption data analysis in identifying inefficiencies, promoting water-saving behaviours, and optimising water use in buildings.

4.5 Water Recycling and Treatment

This subsection highlights the potential for water recycling and treatment systems to enhance water efficiency. It covers the standards used by green building grading systems to encourage the purification of wastewater for purposes other than drinking and regeneration. The section addresses the utilization of advanced treatment technologies, such as membrane filtration and disinfection processes, to ensure the quality and safety of recycled water (Obaideen, et al., 2022). It emphasizes the importance of integrated water management approaches that incorporate both centralized and decentralized water treatment systems.

By focusing on water conservation and management, Section 4. C emphasises how important green building grading systems are for encouraging wise consumption of water and enhancing water efficiency in buildings. It highlights the potential for significant water savings achieved through the adoption of efficient plumbing fixtures, rainwater harvesting, greywater systems, and landscape water conservation practices. The section emphasizes the importance of water metering, monitoring, and recycling to optimize water resources and In the framework of environmentally conscious construction and operation, lessen the burden on the availability of freshwater.

4. B. Indoor Environmental Quality and Health Benefits

Section 4. B focuses discusses how the internal quality of the atmosphere (IEQ) and the related health advantages in construction environments are promoted by green building grading systems. It explores the strategies and criteria employed by these rating systems to enhance acoustic conditions, lighting, thermal comfort, and indoor air quality within buildings (Jia, et al., 2021).

Indoor Environmental Quality is guaranteed in the sustainable design principle enshrined in the Case Study of an indigenous Nigerian Artist/Builder/Architect.

V. GREEN BUILDING RATING SYSTEMS IMPLEMENTATION IN NIGERIA

An overview of Nigeria's use of green building grading systems is given in this Chapter. It investigates the situation, difficulties, and possibilities surrounding the implementation and use of various evaluation methods in the Nigerian setting.

5.1 Nigerian Green Building Rating Systems

The paper introduces systems for evaluating green buildings that are being used in Nigeria. It provides an overview of internationally recognized rating systems, such as Building Research Establishment Environmental Assessment Method (BREEAM), and Leadership in Energy and Environmental Design (LEED), as well as regional and local rating systems developed specifically for the Nigerian market. The section highlights the important aspects and standards for various rating systems, including indoor environmental quality, water conservation, sustainable materials, energy efficiency, and other sustainability aspects.

5.2 Adoption and Awareness

The study examines Nigeria's existing usage and knowledge of sustainable construction grading systems. It discusses the extent to which these rating systems have been embraced by the construction industry, government agencies, and other stakeholders. The section explores the elements affecting the use of environmentally friendly construction techniques, such as economic incentives, regulatory frameworks, and the availability of technical expertise. It also addresses the level of familiarity and comprehension of professionals, developers, and the general public with the advantages and requirements of environmentally friendly construction grading systems.

5.3 Challenges and Barriers

The difficulties and impediments to the broad adoption of environmentally friendly construction grading systems in Nigeria are identified in this section. It discusses issues such as limited technical capacity, high upfront costs, lack of awareness, as well as market barriers. The section explores the specific challenges faced by different stakeholders, including architects, engineers, developers, and policymakers, and discusses the need for tailored strategies to overcome these obstacles.

5.4 Opportunities and Drivers

This section highlights possibilities and factors influencing Nigeria's adoption of environmentally friendly construction evaluation techniques. It discusses the potential economic, environmental, and social factors. Reduced utility bills, lower emissions of greenhouse gases, improved air quality inside the building, and greater human well-being and health are all advantages of green buildings. This part also looks at how campaigns to educate the public, monetary incentives, and regulations from the government can all work together to encourage the use of green construction techniques and grading systems.

5.5 Case Study

Case studies of green construction initiatives in Nigeria are presented in this section that have successfully implemented green building rating systems. It showcases notable examples from different sectors, such as commercial buildings, residential developments, educational institutions, and public infrastructure projects. The case studies highlight the sustainable design features, certification achievements, and lessons learned from these projects, providing practical insights and inspiration for future green building and sustainable design initiatives.

By providing a description of Nigeria's environmentally friendly construction grading system implementation, Chapter Five sheds light on the current status, challenges, and opportunities in encouraging environmentally friendly construction methods nationwide. It explores the implementation and awareness of rating systems, identifies barriers and drivers, and presents case studies that show how to effectively apply environmentally friendly, context-specific construction ideas. This chapter aims to inform and inspire stakeholders, policymakers, and industry professionals in their efforts to promote sustainable and resilient built environments in Nigeria.

5. D. Case Studies of Nigeria's Successful Green Building Initiatives

DEMAS NWOKO: Establishing Nigeria's Successful Green Building Style

The Principal in the Case Study of Nigeria’s Model Green Building did not name his buildings ‘Green’ He was only interested in doing something sustainable and affordable (Sijuwade & Esiebo, 2010). The Review was carried out by **Amber Sijuwade, Aljazeera** Journalist. The pictures are courtesy of Andrew Esiebo/Al Jazeera

Nwoko is a genius of sustainable architecture and Global Life-Service Award Winner 2023

Figure 1. Demas Nwoko with intern Ibim Cookey –at home in his office in Idumuje-Ugboko, Nigeria.

In Idumuje-Ugboko, southeast Nigeria, Artist/Architect Demas Nwoko works at home, Monday to Friday. He is never too busy to instruct his mentees as shown in Figure 1.

The ***African Designs Development Centre*** is the only industrial enterprise in the community. It is Nwoko's factory, and is run by an Architect and Contractor, Demas Nwoko's 54-Year-old son Ashim. The idea is to hire and train locals to produce building and furniture components using indigenous materials produced locally that will be distributed nationwide. In the interim, Demas Nwoko's building commissions are supplied by the workshop's custom-built parts.

Nwoko insists, continuing to look off into the distance as if he could see his future self there. "I'm a realist, a concrete thinker, allergic to wasting effort," he says. He still has a lot to accomplish as he continues to "keep pushing in my own small corner at what is positive and viable" according to his strategy.

Observing Patterns Worldwide

As the son of the local ruler, Nwoko was raised in a mud palace as a royal. The laterite-built palace, which has areas for private meetings and public gatherings, as well as clandestine ceremonies, was designed to resemble the Palace of His Royal Highness, the Oba of Benin, who is historically an ancestor of Demas Nwokos family.

However, he observed that "there was a complete absence of the study of our own traditional knowledge" when he arrived at Ahmadu Bello University in Zaria. Nwoko recalls how modern art was left out of the curriculum because " Because teaching it would indicate that there is an African influence, the Europeans wanted to avoid doing so," according to Nwoko.

He facilitated the establishment of the Arts Society in Zaria in 1958 with other like-minded art students as a team devoted to building their educational programme by researching the independent Nigerian indigenous artistic history. They had the moniker "Zaria Rebels."

Demas Nwoko remembers how "all the things we undertook were aimed at adhering to the global pattern, irrespective of whether it functioned for us or otherwise" as a country. in his reflection on the prevailing ethos of the period. We were unwilling to seek out our own expertise.

Nigerian Conventional Wisdom Designs

Nwoko started his career when he was hired to assist in the establishment of the School of Drama at the University of Ibadan in 1961 having graduated from the Ahmadu Bello University, Zaria.

In Ibadan, Nwoko started constructing his own home using the methods that have come to stand in for him. To create the bricks, he used local the laterite earth that was excavated on the plot of land. The modest hue variations, which range from ochre to rust when left untreated, indicate the layers of the earth from which they were formed.

Recycled wood from the construction process was used for the roofing framework, floor coverings, openings, and window frame shutters. Walls that serve as accents both inside and out are constructed using stone from granite from nearby quarries. Minimal windows were used in the construction of the house to protect against the sun's glaring brightness as well as heat, echoing the practical aspects of conventional Nigerian architecture.

Through airflow portals, floor winds can enter, while hot air can leave via the ceiling as shown in Figure 2.

Because of this ambient cooling system and the ability of the walls of the earth to naturally adjust the ambient temperature, there is never a need for cooling systems.

Figure 2. A portion of the Demas Nwoko-designed and -built New Culture Studio building.

The majority of Nigerians are still residing in colonial master's mansions nearly 60 years after the country's independence, yet this Ibadan home is nevertheless a shining example of how ancient technological advances in construction may be improved by modern creative architecture as demonstrated in Figure 3 below.

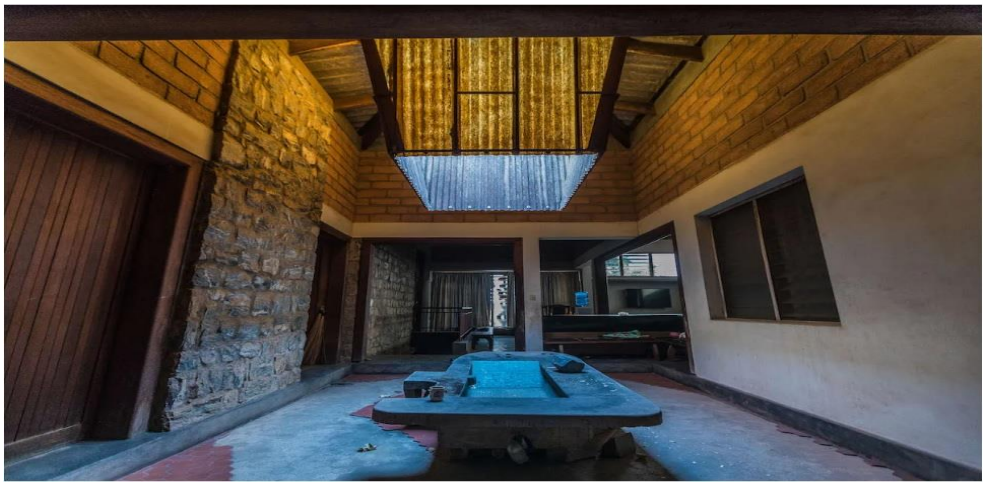

Figure 3. The Interior Courtyard of The New Culture Studio

Figure 4. The outdoor theatre where performers can display their works

Foreign Problems, Adopted Solutions

Concrete construction is ubiquitous in the metropolis, which is currently thought to be the largest urban area in all of West Africa. The constant growth of Ibadan has also resulted in an overabundance of wrapping garbage that is becoming a small business in its own right.

Colonial Principles and Beauty

During the colonial era, using sand and foreign bricks made of cement for both domestic and significant government-owned buildings in Ibadan and across the country established the norm.

After calculating the financial implications associated with importing building materials, the Oyo State government began creating its own models of inexpensive housing using mud bricks in 1976. By using domestic coconut and palm timbers as rafters, officials hoped to show how using natural resources could be a practical and more cost substitute for concrete. Rich indigenous art is demonstrated in Figure 5.

Figure 5. A close-up view of the New Culture Studios

People who praised the government's efforts reportedly also inquired as to why these materials were not used by the state to construct housing for civil servants if the buildings produced were in fact more affordably priced and structurally solid. Local residents were successfully discouraged by the impracticality of such construction as well as the still-in-force municipal planning restrictions that forbade the use of mud in construction.

The Western Regional Law of Nigeria 171 of the colonial government, which specified methods of construction, dimensioning, and acceptable building materials for residential construction, was in effect as of June 2, 1960. It stated that new earth construction was not approved by local city planning offices and could be collapsed if built.

The same laws are still in place today, 60 years later.

Responsibility System

In Bere, where the historic colonial administrative building, Mapo Hall, is just a short drive from the concrete palace of the Olubadan (king) of Ibadan, inspired by Western architecture, traditional buildings are almost falling down. The ground from which the defensive structures rise and their base are virtually identical.

Nwoko thinks that Nigeria's failure to reach its full potential is a result of the same breakdown in cultural and social relations. He asserts that young people nowadays are unable to react when asked what value they offer to society. He asserts that formerly, culture was structured as a "responsibility system" in which each individual was expected to meet a need within the group.

Nwoko, however, is quick to refute the fallacious idea that colonial rule was the cause of the cultural breakdown. Instead, he thinks that the management of funds following independence was what contributed to the start of the breakdown of society.

He recalls that the country began to get financial aid when valuable natural resources were discovered. Foreigners mined and shipped certain types of crude oil without employing local labour. Because they were supported by government handouts and scholarships made possible by money they had not earned, the succeeding generations had a weaker sense of community.

Figure 6. New Culture Studio – An example of Institutional Building in Sustainable Architecture

He sees this trend as continuing the consequences of the slave trade because it is the most recent example of the export of human labour from Africa for the benefit of Western prosperity.

"And we're still transferring human capital over there," says Nwoko, alluding to the movement of people from Nigeria to the economies of the Western world. He further points out that more than 50% of Idumuje-Ugboko residents live and work overseas and claims that when students from his community attend school and receive an education, they do not go back to farming.
According to him, people "build mansions they never reside in and come back to be interred."

The Cultural Product of Design

"I make sure that my creations are sturdy and long-lasting. I can give an appealing alternative to building with imported materials by way of my example, he claims, and whatever I make will endure for hundreds of years.

His buildings, such as the Dominican Chapel, University in Ibadan (Figure 7), the Akenzua Cultural Centre in Benin, and his private residence in Idumuje-Ugboko, are examples of his dedication to proving that traditional building techniques can be artistic and appealing in addition to being functional and efficient.

Some have massive columns supporting extraordinarily high ceilings, while others include impluvium mechanisms that provide fresh air from openings. Their majesty coexists with a feeling of seclusion and soft tenderness

Figure 7. Dominican Chapel, University of Ibadan, Nigeria

According to Nwoko, "an emblematic form is an object of civilization." His artistic additions to metal craftsmanship and ornamental sculpting mix classic Igbo forms with his own creations to produce a distinctive design that is incomparable to any contemporary builder's.

Nwoko reflected on his career-long commitment to sustainable building practises, saying, "I have always put my beliefs into practise. And now that the world is still debating environmental awareness what would have been seen as his unique philosophical, political, and aesthetic choices sound exactly on trend — 'green' building methods are viewed as a vital tool in the war against global warming. A good living example is Figure 8. The Residence of Demas Nwoko himself.

Figure 8. Residence of Demas Nwoko at Idumuje-Ugboko, Nigeria

Nwoko wonders if sustainable development could be a measurable indicator of actual sovereignty. "Independence is to become ourselves," she argues.

According to him, it is imperative that "you become connected to the younger generations there and make your contribution felt wherever you are, wherever neighbourhood you find yourself in."

Nwoko believes that the following subsequent generations will value what the previous one overlooked" by having samples of his design work all around the nation. That generation and the others will have to decide whether or not to follow his example.

VI. RECOMMENDATIONS AND FUTURE DIRECTIONS

Chapter VI provides recommendations and outlines the next steps for environmentally friendly construction practises development in Nigeria. It draws upon the insights gained from the preceding chapters to offer actionable suggestions for key stakeholders and policymakers.

6.1 Strengthening Awareness and Education

This section emphasizes the need to enhance awareness and education concerning environmentally friendly construction methods in Nigeria. It recommends the development of comprehensive enlightenment campaigns targeting professionals, students, and the general public. Furthermore, it suggests incorporating ecological and environmentally friendly building principles into academic curricula and programmes for growth as a professional to foster a culture of sustainability from an early stage.

6.2 Enabling Policy Framework

This section highlights the importance of creating a robust policy structure to encourage and promote environmentally friendly construction practises. It recommends the formulation of clear and enforceable building codes and regulations that incorporate sustainable design and construction principles. Additionally, it suggests offering financial incentives, tax breaks, and subsidies to motivate property owners and developers to use sustainable building methods.

This must be carried out with the immediate removal of retrogressive policies that render indigenous materials and construction technology redundant and useless.

6.3 Development of Capabilities and Abilities

This section emphasizes the necessity of making investments in building capacities and improvement of skills to get beyond the technological obstacles posed by using green construction techniques. It recommends the establishment of training programs, workshops, and courses for certification to advance practitioners' skills and understanding concerning environmentally friendly design, building, and operation. It also suggests collaboration between academic institutions, industry organizations, and government agencies to facilitate knowledge exchange and promote best practices.

6.4 Market Development and Demand Creation

This section focuses on strategies to increase demand from consumers in Nigeria for environmentally friendly construction. It suggests the implementation of financial mechanisms, such as green financing and preferential loan programs, to incentivize investments in sustainable buildings. It also recommends conducting market research to better understand the preferences and needs of consumers and leveraging public procurement guidelines to encourage the use of environmentally friendly building methods.

6.5 Research and Development

This section underscores the significance of R&D in promoting green construction practises. It recommends allocating resources for research initiatives, innovation centres, and pilot projects to explore new technologies, materials, and design strategies that improve the environmental performance of buildings. It also suggests fostering collaboration between academia, industry, and government to facilitate knowledge sharing and promote evidence-based decision-making.

6.6 Monitoring, Evaluation, and Reporting

This section highlights the significance of establishing monitoring, evaluation, and reporting mechanisms to monitor the development and effects of green construction techniques. It recommends the development of performance metrics, benchmarking tools, and data collection systems to evaluate how well a structure performs in terms of energy effectiveness, conservation of water, and general environmental sustainability. Reporting on the results and advantages of green construction initiatives on a regular basis can help raise awareness and build a business case for further adoption.

By providing practical recommendations and future directions, Chapter VI aims to guide stakeholders and policymakers when attempting to enhance environmentally friendly construction methods in Nigeria. These recommendations address domains include regulatory structures, developing capacity, expansion of markets, education and awareness-raising, and development and research as well as monitoring and reporting. Implementing these recommendations can speed the shift to a more environmentally friendly construction industry and aid Nigeria in mitigating the effects of global warming and sustainable development goals.

VII. CONCLUSION

Chapter 7 serves as the conclusion of the article, summarising the key findings, implications, and recommendations discussed throughout the investigation into Nigeria's efforts to mitigate climate change through sustainable construction grading systems.

The conclusion highlights the following points:

1. **Recap of the Study**: The chapter begins by summarizing the investigation into how climate change is impacted by green building grading systems primary goals of the study, which examined the connection between Nigeria's rating systems for environmentally friendly buildings and efforts to combat climate change. The article's origins, the significance of the investigation, the goals of the investigation, and organisational structure are all briefly summarised here.
2. **Key Findings**: The main conclusions discovered in the research are succinctly summarised in the conclusion. It emphasises how rating systems for environmentally friendly buildings have a beneficial effect on lowering electrical power consumption, reducing carbon dioxide emissions, and encouraging environmentally friendly methods in the construction sector. It also underscores Green building rating systems' ability to improve global warming adaptation as well as resilience.

3. Implications for Nigeria: The ramifications of the study's outcomes regarding Nigeria are covered in this section. It emphasises that Nigeria's efforts to combat climate change, lessen environmental degradation, and achieve environmentally friendly development goals will greatly benefit from the implementation and widespread use of green building rating systems. It emphasises how crucial it is to incorporate concepts associated with sustainability into the construction sector in order to meet the nation's particular climatic challenges and promote long-term resilience.

4. Recommendations: The conclusion provides a summary of the recommendations proposed throughout the article. It emphasizes the need for policy initiatives that support green building practices, education, and awareness programs to promote knowledge dissemination, research and development efforts to drive innovation, collaboration, and partnerships among stakeholders, and the significance of state assistance and encouragement in promoting the use of environmentally conscious construction grading systems.

5. Final Remarks: The conclusion concludes with final remarks that reiterate the significance of grading systems of green buildings for climate change mitigation as well as the importance of collective action from policymakers, industry professionals, researchers, and the wider society. It encourages the development of an environmentally friendly as well as more responsible built environment, and stakeholders ought to promote environmentally conscious building practises and cooperate in Nigeria.

Broadly, the conclusion serves as a succinct summary of the research findings, reiterates the importance of green building rating systems in climate change mitigation, and provides a call to action for stakeholders to actively participate in implementing sustainable building practices in Nigeria.

7. A. Implications for Nigerian Climate Change Mitigation

Section 7. A discusses the implications of the study's findings for climate change mitigation efforts in Nigeria. It explores the broader implications of implementing environmentally friendly construction techniques and ecologically friendly grading systems throughout the Nigerian context.

1. **Reduced Carbon Footprint**: Nigeria's ecological impact can be greatly reduced by using environmentally friendly evaluation methods and methods for environmentally friendly construction. These practises assist in reducing the production of greenhouse gases from the built environment, which is a significant contributor to global warming, through the advancement of efficient use of energy, the integration of energy from renewable sources, and principles of environmentally friendly design.
2. **Enhanced Resilience**: Green building practices, facilitated by rating systems, improve the resistance of structures and communities to the effects of global warming. Sustainable site development strategies, efficient water management, and resilient building design contribute to adapting to changing climate patterns, extreme weather events, and other environmental challenges.
3. **Conservation of Natural Resources:** Sustainable building practices promoted by Systems for evaluating environmentally friendly structures promote wise use of the environment's resources. This includes water conservation, responsible material selection, and waste reduction. By minimizing resource consumption and promoting circular economy principles, Nigeria can better manage its resources, reduce environmental degradation, and contribute to sustainable development.
4. **Health and Well-being:** Human health and well-being are affected by the incorporation of green construction practises, which include enhanced indoor environmental cleanliness and proximity to nature. Healthy and more pleasant personal and professional working conditions are provided by environmentally friendly buildings. reducing indoor pollutants, enhancing natural lighting, and promoting occupants' physical and mental well-being.
5. **Economic Opportunities:** In Nigeria, the use of environmentally friendly construction methods leads to the development of new economic prospects and jobs. It promotes the expansion of energy sources that are renewable, green building practises, and enterprises producing environmentally friendly construction supplies. This can lead to the development of a skilled workforce, local manufacturing capabilities, and a thriving green economy.
6. **International Collaboration and Reputation:** Embracing green building rating systems and sustainable practices aligns Nigeria with global efforts towards climate change mitigation and sustainable development. It enhances Nigeria's reputation as a responsible and forward-thinking nation, opening doors for international collaboration, knowledge exchange, and potential access to funding opportunities.
7. **Policy Alignment and Implementation**: The results highlight the significance of integrating sustainable construction practises into the national regulatory framework. incorporating criteria for sustainability into building rules, offering monetary rewards for eco-friendly construction efforts, and strengthening enforcement mechanisms are critical for successful implementation. The implications highlight the need for policymakers to prioritize sustainable building practices and incorporate them into national climate change mitigation strategies.

The implications outlined in Section 7. A emphasise the broader significance of Nigeria's initiatives to combat climate change include combining environmentally friendly methods and buildings with environmentally friendly evaluation systems. By recognising these implications, The widespread implementation of environmentally

friendly building techniques can be accelerated by key players developing efficient plans, policies, and activities, fostering a low-carbon, resilient, and sustainable built environment in Nigeria.

7. B. Call to Action

Section 7. C serves as a call to action, urging stakeholders in Nigeria to take concrete steps towards implementing green building rating systems and embracing sustainable building practices. It emphasises the collective responsibility and the importance of immediate action in dealing with global warming and encouraging growth that is environmentally friendly.

i. **Government Leadership**: The government is vital in promoting the use of environmentally friendly construction methods. It should take a proactive stance by enacting supportive policies, establishing regulatory frameworks, and providing financial incentives to promote environmentally friendly building planning, execution, and maintenance. Strong leadership from government bodies and agencies is essential to establish an encouraging setting for sustainable construction methods.

ii. **Industry Engagement:** The environment and climate change are significantly impacted by the construction sector. Adopting sustainable construction practises is crucial for industry professionals, such as designers, architects, engineers, developers, and constructors. This includes acquiring knowledge, adopting green building rating systems, and their projects include environmentally conscious design concepts. Professional associations should actively promote environmentally friendly procedures and give those they represent advice in this regard.

iii. **Education and Awareness:** Driving change requires educating people about the advantages of environmentally friendly building practises and spreading awareness of them. To create and deliver training programmes, colleges and universities, associations of professionals, and governmental organisations need to collaborate together with workshops, and certifications that focus on sustainable building principles, green technologies, and rating systems. Practitioners can make contributions to the adoption of environmentally friendly construction practises by improving their expertise and skills.

iv. **Cooperation and Information Sharing:** Stakeholder cooperation is essential to making real change. Government bodies, industry associations, research institutions, and non-governmental organizations should collaborate and share knowledge, best practices, and Stories of success including environmentally friendly development and environmentally conscious construction grading systems. This collaboration will foster innovation, enhance capacity, and facilitate the exchange of experiences to drive sustainable building practices forward.

v. **Financing and Incentives:** Sustainable construction practises are frequently difficult to apply due to financial constraints. Financial institutions should develop innovative financing mechanisms, such as green loans, grants, and incentives, to support sustainable building projects. Authorities should additionally provide incentives in the form of tax breaks, and subsidies to promote the use of environmentally friendly practises and sustainable construction grading systems..

vi. **Monitoring and Evaluation:** For assuring accountability and tracking advancement, regular monitoring and evaluation of projects involving green construction and their outcomes are essential. The establishment of procedures by the authorities to monitor power and utilisation of resources, deploy environmentally friendly construction grading systems, and evaluate the effects of environmentally conscious construction endeavours on society as well as the environment are necessary. This data can inform future policies, guide decision-making, and drive continuous improvement.

The call to action encourages all stakeholders, including government, industry professionals, educational institutions, and the wider community, to take ownership and aid in the adoption of environmentally friendly construction techniques and ecologically friendly grading systems throughout Nigeria. By working together and embracing sustainability, Nigeria can make tremendous progress in reducing global warming, protecting our natural resources, as well as creating an architectural framework that is more enduring and ecological.

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