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APPRAISAL OF GREEN BUILDINGS RATING SYSTEMS: FOCUS ON RELEVANT PARAMETRICS FOR ACHIEVING SUSTAINABLE DEVELOPMENTS IN NIGERIA

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ABSTRACT

Green rating systems for buildings are standardized measuring systems that quantify different buildings' sustainability levels. These have been proven to enhance the adoption of design methods that are less harmful to the environment, thereby making buildings environmentally, socially and economically viable in the long run. For any building to qualify as green certified, six crucial criteria need to be met, including the use of energy effectively, water use, sustainable sites, effective use of resources, operations while occupied resulting in its associated repair works while also considering the comfort levels of the building occupants. Several reasons might be responsible for non-availability of green building standards in Nigeria, including knowledge levels of the stated standards, an absence of regulatory policies, and an absence of clear certification standards in the country. The study seeks to identify green rating systems currently being used to access buildings globally and their current use in Nigerian building industry space assessment. This study aims to understand critical variables lacking towards attaining green building standards and certification of Nigerian houses. The study will also identify the use of an existing rating system in certifying a green building in Nigeria to highlight the levels of sustainability attained by the building and propose actions of improvements that will make green building ratings systems the norm while putting up a building to serve the various functions assigned in the Nigerian building construction space. A comprehensive literature review using search engines like Researchgate, Scopus and Google Scholar and articles found useful for the research spanning from 2008 to 2023 were included in study. The advantage of this study is that it serves as a reference for policymakers to effectively develop a green building policy for Nigeria. Secondly, it draws attention to building regulatory bodies for enforcing greening compliance building standards implementation within projects domiciled in the built environment. It also highlights advantages associated in terms of revenue generation for the respective bodies through payments for green rating systems applications in building construction projects. Thus, green building rating systems can increase sustainability levels of construction projects in the Nigerian built environment.

Keywords: Green, Buildings, Rating, Systems, Built, Environment, Nigeria

INTRODUCTION

Building construction significantly improves the quality of life of man and his household while addressing his societal needs and associated significant environmental challenges. Construction activities contribute 40% of powering and functional activities, 30% of harmful gas pollutants, and 17% of freshwater consumption (Li, et al., 2023). As a result of climate change and associated risks directly linked to the built environment affecting humanity at large scale, it has become expedient to find alternative solutions to environmentally friendly design and construction techniques at addressing these challenges (Michael, 2013). The author further believes that while these unique solutions have been adopted worldwide, Nigeria has not been left out of these adverse climatic conditions that have threatened to harm

the built environment globally. Therefore, building green and applying technologies associated with green standards and rating systems have been recognised as cutting-edge solutions to combat these issues. With its Green Building Councils, Europe has become a global leader in reducing wastages associated with building construction, thereby striving for net-zero resource usage (Anzagira, Duah, and Badu 2022).

However, adopting green building rating systems with their associated technology within less developed economies faces barriers related to both country-specific factors related to design and construction (Akcay 2023). These challenges have led to a call for a shift away from carbon-intensive construction techniques towards more environmentally friendly approaches (He, et al. 2018). Green buildings meet specific performance requirements while minimizing disruptions and providing ecological benefits (Li et al. 2023). These buildings often earn certifications through Green Building Rating Systems (GBRS) (Chaldy, et al. 2023). Governments worldwide promote green buildings for their sustainable use of materials and natural resources, enhanced living conditions for occupants, and environmental benefits (Li, et al., 2023).

Green buildings offer various advantages, including lower development and operating costs, increased user comfort, improved indoor air quality, enhanced durability, and reduced maintenance expenses (Zafar, 2017). They also contribute to resource efficiency and minimize environmental impacts. One essential tool for managing and measuring a building's green compliance level and success depends on its ability to comply with existing standards as set out by a green building rating system (GBRS) (Akinyemi, et al., 2017). This rating system provides a structured framework to monitor and enhance sustainability in construction. In South Africa, green buildings have great value for their economic benefits, such as reduced energy costs and recognition by industry rating systems (Sanboskani, et at., 2022). Standardised compliance systems associated with the greenness of a building's compliance levels relating to its environmental impact on the built environment qualitatively assess the structure's sustainability compliance level with the surrounding built environment. (Weerakoon, et al., 2023). They help inform assessors about a building's eco-friendliness and the extent of green features incorporated in its design and construction (Shan and Hwang 2018). These rating systems express a building's sustainability attributes (Ampratwum, et al. 2021).

Establishing a regulatory body that regulates green buildings within the practising environment is the first step in enforcing a building's greenness compliance levels with standardised systems, yardsticks and scaling techniques. (Akinyemi et al. 2017). These non-profit organizations shape tools to objectively rate a building's performance regarding ecology, environment, and spatial surroundings. Therefore, these already established greening tools (Building Research Establishment Environmental Assessment Methodology) domiciled in the U.K., and (Leadership in Energy and Environmental Design) in the US, emerged in the 1990s to promote sustainability in construction (Nduka and Sotunbo 2014). These systems provide scores for buildings' environmental performance, facilitating comparisons between different structures. Despite the growing awareness of the importance of measuring a building's greenness level in the Nigerian built environment by construction industry professionals, it still needs an effective green building rating system. This gap prevents buildings in Nigeria from being rated using established systems like LEED and BREEAM. Therefore, the research objectives highlight knowledge of greening tools in Nigeria's construction industry and identify the greening tools currently used by Nigerian construction stakeholders to achieve a robust, sustainable built environment for the Nigerian built Environment space. Additionally, the study aims to examine an existing green building in Nigeria certified by an established adopted green building rating system.

LITERATURE REVIEW

Green Building Drivers in the African Built Environment

Many vital drivers exist towards implementing green buildings in the built environment towards reducing carbon dioxide emissions into the environment, but Windapo (2014) defines a construction projects greenness level as those projects which have been subjected to a certified green rating system and therefore qualify it for an approved certification while also further noting that this is quite a new concept in Africa. The author then identifies the drivers of green buildings as two arguments: mainly due to preserving the environment and the ecology within its immediate environment and secondly due to economic factors which have seen the need to reconsider the cost of running buildings, providing financial savings and competitive advantages. According to Atanda and Olukoya (2019), the Nigerian built environment at both the urban and rural settings are faced with diverse challenges that range from urban sprawl, slum and squatter developments, land air and water pollution, flooding and erosion all contributing to serious environmental, economic and social challenges necessitating the need for a green building rating system to combat these challenges.

A recently conducted Southern African study on the advantages of building green, which is still in its infancy stage (Simpeh and Underwood 2018), has identified several advantages of these types of construction developments. These have been categorized as environmental, financial, economic, and social benefits, meaning that the buildings are comfortable for the occupants, healthy and aesthetically pleasing. In addition, these types of buildings are said to have market and industry benefits, opportunities for research and development in the green building field, advantages for collecting more tax revenue for the government from construction stakeholders for going green and climate-change-related benefits.

The Concept of a Buildings Greenness and Their Rating Systems in Construction Projects

Critical deficiencies identified by King (2008) in the greenness and sustainable development assessment of structures while embarking on construction deliverables is that the assessment process goes far beyond the design stage of a project. It is believed that this can be improved if the selection of more environmentally friendly designs are considered during the project appraisal stage. The author further suggests that as a rule of thumb, environmental issues regarding a project may be classified as principal and addressed earlier in project conceptualization phase, thereby mitigating adverse consequences that construction projects pose to the built environment as environmental hazard. Secondly and of significant importance is the possibility of using natural resources during the building construction phase and, finally, emphasizing reductions in remediation techniques and associated costs. Buildings consume much energy while using available resources in the built environment during construction. They are also major emitters of CO2 into the atmosphere, causing significant environmental risks and also causing unhealthy indoor quality to building occupants and the planet at large (Cascone, 2023). Thus among the numerous advantages of designing and constructing green buildings are the fulfilment of the essential elements of comfort and enhancing the health of the users (Purwaningsih, et al., 2018). While there is a lot of information on building green, there has been limited attention paid to using these environmentally friendly building construction techniques by construction stakeholders in the field of associated use of these construction techniques, which enhances sustainability in the long run. This, therefore, is responsible for the lack of adequate information on this current construction technique available in the body of knowledge regarding green design in less developed economies of the world.

Green buildings, according to Chen, et al. (2023) are considered buildings that offer their occupants more significant health benefits while also applying principles that emphasize their ecological balance which reduce environmental impacts on the immediate vicinity of the building construction site. This improves the productivity of the society in which the building is domiciled. Traditional buildings have been observed to have environmental issues associated with them while also consuming a lot of energy, causing a lot of environmental pollution and further leading to wastage of resources believed to be the dangers associated with these kinds of buildings, according to Wu, et al. (2023). Before the advent of a green building rating system, Song, et al. (2023) identified three milestones that initiated the establishment of this standard evaluation with the third being the most important. The authors identified this as a milestone discovery in winning the noble peace prize in 2007, acknowledging the influence of humans regarding climate change issues, the value of green building and their greenness levels for the construction stakeholder and the buildings occupants. Therefore, it is suggested that a green building evaluation system, which will be based on the building's physical framework, be constructed to achieve energy savings and consumption. Environmental challenges associated with high energy consumption levels of buildings have formed the bedrock in applying standard rating systems in construction projects worldwide (Nocerino & Leone 2023). These standards, which are used in measuring a construction projects sustainability by an assessment criteria is suitable for the purpose and encourages an adoption system of environmentally, socially and economically sustainable practices in three phases associated with the development of a construction project (design of the project, constructing the project and eventually demolition the building when its useful life has been exceeded) and therefore being a precious tool in assessing and guiding the construction industry towards becoming greener and environmentally friendlier (Marchi, et al., 2021).

Assessment tools in the view of Akhanova, et al. (2019) attempt to improve building functional performance systems while also aiding in decreasing the environmental burdens associated with buildings. Other deliverables are estimating the building's environmental influence, thereby objectively assessing and evaluating the building's development during construction. As a result of measuring the environmental friendliness of buildings and other associated deliverables, a measurement that meets a certified standard is necessary in guiding the ways buildings are rated (Purwaningsih et al. 2018). Further fall outs of these are the recommendations

by the authors that greening tools are required for its measuring in buildings. Therefore, existence of a wide range of institutions and standards for greening in buildings abound and these include the British greening tools BREEAM, the American greening tool-LEED, the Australian greening tools NABERS and GREEN STAR, and GREEN MARK which is widely used in Singapore. These rating systems mostly target critical criteria including passive design aspects, energy efficiency, life cycle assessment, incorporation of renewable energy systems and site planning, which Chodnekar, Yadav & Chaturvedi (2021) approve are well highlighted in most of the countries rating systems. In addition, the authors agree that wlmer worldwide, most countries are using international and nationally developed greening tools, it is noted that using these different tools depends on variant climatic conditions in each clime, building typologies and the respective economic and social priorities. Thus there is no one best fit all system for a particular climatic region.

Greenness Levels and Compliance Standards of Buildings in Nigeria

In order to achieve compliance levels of sustainable development by the building construction sector in developed and developing economies, it has been suggested that there are four basic actions that need to be taken by both governments and the private sector (Umar, et al., 2013). These are in the form of regulations, education and training programs, financial incentives and measures to changing market demands. It is the belief of construction stakeholders that the end state of the building sector is to ensure that the construction market demands for buildings that are high performance and sustainable. Developmental strides at enhancing standardization practices of green building developments and standard assessment tools within the Nigerian context need to be improved, which Akhanova et al. (2021) suggest are because there is no standard rating tool for use in the Nigerian Built Environment. The authors further allude to the fact that buildings also consume a lot of natural resources that harm the environment, which they statistically present as consuming 70% of cementitious materials and 25% of steel and virgin wood. In many developing countries and economies of the world, it is believed that there exist measures and practices developed to support sustainability and the greenness initiatives of buildings that has been in existence for quite some time now, but there have been many impeding factors that have been responsible for the slow advances in these societies as compared to global advances (Karaca, et al. 2020). Green buildings as a concept and development process started around 1960s during the world energy crisis which Zhang, et al. (2019) attributed to the reasons that spurred research into energy efficiency and decrease of environmental pollution and further led to the introduction of environmentally friendly building construction practices by construction stakeholders. Green buildings and their systems of ratings emerged in building construction projects in 1990 with the introduction of BREEAM and by 2010, 382 types of greening tools softwares worldwide were already available (Khan, et al. 2019). Such rating systems, in the long run, have the advantage of using tools in assessing a building's green aspects or sustainability attributes, thereby being able to establish building greenness compliance level based on the total points obtained during assessment criteria in the long run (Prabhakar, et al., 2023). These became an effective way of monitoring and enhancing the building's roles in reducing their environmental effects. This becomes necessary in developing economies due mainly to social, economic and environmental issues associated with neglecting these key strategies (Ali and Nsairat 2009).

As the upsurge in the attainment of green buildings in the built environment has continued to gain relevance, most developing and developed economies have adopted this all-encompassing phenomenon of a building greenness level, and Nigeria is also compliant with this (Nduka and Sotunbo 2014). The authors further highlight the need for facing the current challenges in the Nigerian region, like evolving performance standards evolvement of codes and standards at mitigating and developing the built environment. Nigerian enforcement agencies' in government have established laws like the Federal Environmental Protection Agency Act (1988), Policies on regulating the Nigerian Built Environment (1989) and the Environmental Impact Assessment Act of (1992). In addition, the authors highlight the influence that professional bodies and private organizations in Nigeria have contributed to this discussion through the establishment of the Greening Council of Nigeria with affiliation with the World Green Building Council.

This newly developed Green Building Council of Nigeria, according to the authors is yet to produce a rating tool, which has necessitated the willingness of the Green Building Council of South Africa (GBCSA) to allow a rating system in Nigerian Buildings known as the Green Star SA (South Africa) adoption pending using greening tools in the Nigerian construction industry in accessing building construction projects.

Advantages of Greenness Levels and Compliance Standards of Buildings in Sub-Saharan Africa

Bernardi, et al. (2017) highlight that Rachel Carson's book titled Silent Spring (1962) gave birth to the discussion on the harmful activities of humans on the environment, which gave rise to the current environmental movement the world over. Climate change repercussions and adverse effects are predicted to be experienced in different ways in Sub-Saharan Africa through both Natural and Human systems. These point to a warming trend most observable in the inland subtropics, with increases in temperatures being estimated at (4 Degrees) warming scenarios (Serdeczny, et al. 2017). Nigeria, despite being the largest economy in Sub-Saharan Africa, has faced challenges in the introduction and creation of an effective rating system. This can ensure that buildings are not only environmentally friendly but enhance comfort levels of building occupants (Olawunmi, et al. 2020). Therefore, it is essential to submit that greening tools are applied in determining the environmental damages buildings cause to the built environment, including urban projects and provisions of infrastructural facilities (Bernardi et al. 2017). Greening tools and software are currently applied in construction projects in Sub-Saharan Africa as an effective performance evaluation system ranging from civil works to infrastructural projects that have been embarked upon (Olawunmi et al. 2020).

The Council for the Regulation of Green Buildings in Nigeria

Nigeria has recently established a council for the regulation of green buildings. It is non-governmental, formed around 2011, with its primary mandate for advocating, educating, and setting greenness compliance levels of construction projects in the Nigerian built environment space. As an advocacy based organization, it is the voice of Nigeria's green building sector by catalyzing a positive change in the Nigerian Built Environment through direct engagement with the building construction stakeholders. On the other side, as an educational enhancement group on deficiencies regarding issues related to green buildings and enhanced built environments that are free of greenhouse gases and carbon dioxide emissions, the Green Building Council of Nigeria bridges this gap by organizing seminars and courses while also developing standards in delivering greenness within built environments. Thirdly, part of their mandate is establishing local greening tools for evaluating building construction projects which, in the long run, will guide developers, professionals and building construction stakeholders. Finally, the Green Building Council of Nigeria's certification system provides designers and developers with recognition of the greenness of their designs/buildings. Also, it offers products endorsement to vendors and manufacturers on the sustainability of their products.

RESEARCH METHODOLOGY

In embarking on the study, it was essential to systematically analyze secondary data obtained from existing literature from forty-five relevant articles through detailed content analysis from journal and conference articles obtained from Google Scholar, Semantics, and Scopus covering the period from 2008 to 2023.

Search for Publications

Information relevant to the study's key themes was obtained from the secondary database, which focused on the existing green building rating systems. For ethical reasons, the data was inspected thoroughly, categorized and synthesized for semantic reasons. In achieving this scientific review, the articles selected were the most relevant to the study's area of focus. These were Greening tools applications in Africa, the concept of greening and ratings systems in construction projects, the emergence of greening tools in Nigerian the advantages of greening tools in sub-Saharan Africa and the emergence of regulatory institutions and bodies and the application of the South African greening tools system, Green Star South Africa Rating tool for use in Nigeria and LEED certified buildings in Nigeria.

Selection Criterion

A thorough method of intensive exclusion and inclusion techniques enabled the researcher to remove all irrelevant data and concentrate on critical parameters associated with green buildings, green rating tools, climate change, and environmental impacts. The findings identified advantages and disadvantages associated with the programs and policies targeted at Green Building Rating Systems and their implementation in Nigeria. These were thoroughly evaluated to crystallize key findings as highlighed in Figure 1.

Data Analysis

As this was a qualitative study, all data were presented by content analysis structured design. These were done in order to identify the current gaps existing in the compliance levels of buildings and their greenness standards within the construction industry in Nigeria and the adopted strategies established for implementation.

Table-1: Green Star SA Category Weighting System for Use in Nigeria.
Source: South African Greening Tool for Implementation in the Nigerian Building Space 2014.

Credit No.	**Management**	**Scores**
MAN-1	South African manpower attendant	2
MAN-2	Applications during commissioning of the project	2
MAN-3	Deliverables	2
MAN-4	Third party input	1
MAN-5	Manual	1
MAN-6	Environment and associated deliverables	2
MAN-7	Wastes	3
MAN-8	Compliance with tightness of the structure	
MAN-9	Recycle- retail	
MAN-10	Man-10: managements and systems – retail & peb	1
MAN-11	Green lease - retail	
MAN-12	Compliance rules – multiple units residential	
MAN-13	Learning resources - peb	1
MAN-14	Life cycle costing - peb	1
MAN-15	Maintainability - peb	1
	Total	**17**
Credit No.	**Indoor Environmental Quality**	
IEQ-1	Rates of ventilation movement	2
IEQ-2	Change in air movement	
IEQ-3	CO2 compliance	1
IEQ-4	Daylighting	3
IEQ-5	Glares during daylighting	1
IEQ-6	Ballast	
IEQ-7	Lightings	1
IEQ-8	Building facades	2
IEQ-9	Temperature comfortability levels	2
IEQ-10	Building occupants comfortability	
IEQ-11	Materials that cause harm	1
IEQ-12	Acoustics	3
IEQ-13	Dangerous compounds	3
IEQ-14	Harmful organic compounds reductions	1
IEQ-15	Dryness levels	1
IEQ-16	Tenants exhausts and risers	1
IEQ-17	No Smoking	
IEQ-18	Places of respite and recreation – retail	
IEQ-19	space and outdoors for privacy- multiple units residential	
IEQ-22	universal access - multi unit res	
IEQ-23	stairs - peb	1
	Total	**23**
Credit No.	**Energy**	
ENE-0	CRs	0
ENE-1	GHEs	20
ENE-2	Metering's	3
ENE-3	LPD	
ENE-4	Lightings and Zonings	2
ENE-5	PEBs	3
ENE-6	Metrerings - RETAIL	
ENE-7	Heated Water - MULTIPLE UNITS RESIDENTIAL	
ENE-8	Usage of Energy - MULTIPLE UNITS RESIDENTIAL	
ENE-9	LEEG- MULTIPLE UNITS RESIDENTIAL	
ENE-10	EEAs - MULTIPLE UNITS RESIDENTIAL	
ENE-11	Unoccupied Spaces - PEB	2
	Total	**30**

Credit No.	Transport	Scores
TRA-1	Parking Provision	2
TRA-2	Transportation and Fuel Efficiency	2
TRA-3	Cycling Provision	3
TRA-4	Transportation for users	5
TRA-5	Accessibility Locally	2
TRA-6	Trip Reduction – Mixed Use – RETAIL	
TRA-7	VOEs– RETAIL & PEB	2
	Total	**16**
Credit No.	**Water**	
WAT-1	Occupant Amenity Water / WAT-1: Potable - PEB	12
WAT-2	Metering's for water usage	3
WAT-3	Watering of Landscaping	
WAT-4	Heat Rejection Water	
WAT-5	Consumption of water for fire emergncies	
WAT-7	Potable Water Efficient Appliances - MULTI UNIT RES	
WAT-8	Swimming Pool / Spa Water Efficiency - MULTI UNIT RES	
	Total	**15**
Credit No.	**Materials**	
MAT-1	Recycle	3
MAT-2	Reusability	5
MAT-3	Reusable materials	2
MAT-4	Fit-outs	
MAT-5	Natural concreting	3
MAT-6	Reinforcement	3
MAT-7	PVC minimisation	
MAT-8	Sustainable timber	2
MAT-9	Design for disassembly	1
MAT-10	Dematerialisation	1
MAT-11	Local materials	2
MAT-12	Efficient dwelling size - multi unit res	
MAT-13	Masonry - multi unit res & peb	2
	Total	**24**
Credit No.	**Land Use and Ecology**	
ECO-0	Conditional Requirement	0
ECO-1	Topsoil	1
ECO-2	Reuse of Land	2
ECO-3	Reclaimed Contaminated Land	2
ECO-4	Change of Ecological Value	4
ECO-5	Urban Heat Island – RETAIL	2
ECO-6	Outdoor Communal Facilities - MULTI UNIT RES	
ECO-7	Urban Consolidation - MULTI UNIT RES	
ECO-8	Community Facilities - PEB	1
	Total	**12**

Credit No.	Emissions	Scores
EMI-1	Refrigerants/gaseous ozone depleting potential (odp)	
EMI-2	Refrigerants/gaseous global warming potential (gwp)	
EMI-3	Refrigerant leaks	
EMI-4	Insulant odp	
EMI-5	Watercourse pollution	3
EMI-6	Discharge to sewer	5
EMI-7	Light pollution	1
EMI-8	Legionella	1
EMI-9	Boiler and generator emissions	1
EMI-10	Kitchen exhaust emissions - retail	
EMI-11	Atmospheric deterioration avoidance	1
	Total	**12**
Credit No.	**Innovations**	
INN-1	Innovative Strategies and Technologies	
INN-2	Exceeding Green Star SA Benchmarks	**5**
INN-3	Environmental Design Initiatives	
	Total	**5**

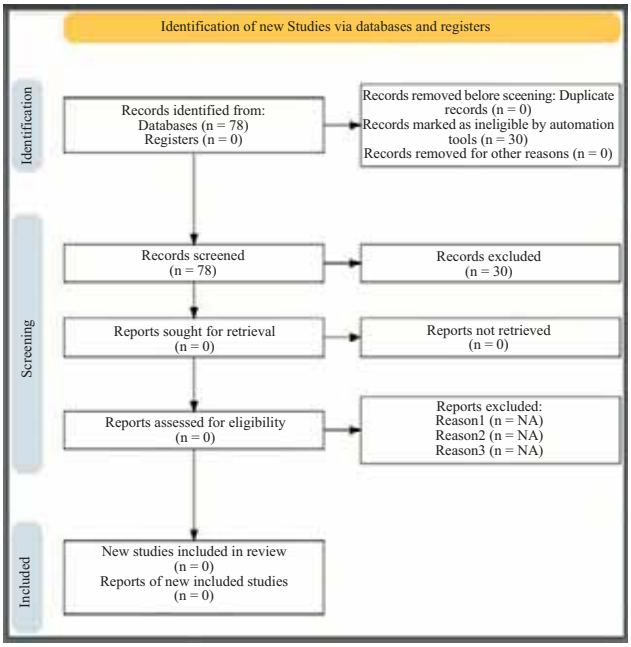

Figure-1: Prisma Template.
Source: https://estech.shinyuapps.io/prisma_flowdiagram/2024.

FINDINGS

Green Star South Africa Rating Tool for use in Nigeria

Efforts were made at implementing a regulatory policy framework for greenness levels of buildings in Nigeria, its environs and city spaces. Shaba and Noir (2014) in their study on the South African greening tool to be used in the Nigerian construction industry highlight that this rating system was used by the Australian Greening Council allowing use in Ghana, South Africa, Mauritius and Namibia. As a result of having an effective greening tool and rating system in the Nigerian built environment, the South African Greening Council is seeking approval from their Australian counterparts to use their adopted rating tool effectively in Nigeria for compliance and monitoring purposes. This they have further achieved by insisting on applying all Green Star SA v1 Design/As Built Rating tools for offices, retail centres, and multi-unit residential, public and educational buildings domiciled within Nigeria and referring to the certification as Green Star SA-Nigeria. This rating tool deals with nine different categories, each with a credit unit attached.

Leadership in Energy and Environmental Design (LEED)

Sustainability-related concerns are urgent issues that need worldwide solutions according to Bisegna, et al., (2018) are believed to have started in 1973 and 1979 when the energy crisis informed man of the dangers of over-relying on nonrenewable energy sources as a means of energy consumption and production. Since then, this has necessitated the concept of global warming, which has further exacerbated the need by several countries to reduce their Greenhouse gas emissions and energy consumption patterns and rates from their building construction projects (Jeong, et al., (2016). Bisegna et al. (2018) In addition, believe that a measure of sustainability is essential when a level of comparison is sought from different and competing alternatives in terms of materials, production, energy resources, and production processes. Green buildings are a

system whereby building construction professionals use and apply energy efficient designs with healthy advantages to building occupants, improving their comfort levels thereby reducing negative impact on environmental conditions within the surroundings (Larson, et al., 2008). In the US, the Green Building Council was formed in 1993, which was an agglomeration of a wide building construction influencers in the private and public spaces with a common interest in addressing the environmental issues related to building construction. Closely related to this was the establishment (LEED) greening tools in 1998, which intended to transform the building market with a system of compliance rules in the development of green buildings. It is also a rating system associated with various construction projects (Roosa 2020). Therefore, the LEED Green Building certification systems limit the energy use of buildings and address the sustainability aspects in construction (Amiri, et al., 2019). LEED is currently the best greening tool that is widely recognized for its versatility and compliance levels, which insists on taking actions that limit the energy consumption levels of buildings, thereby constructing them more sustainably (Amiri, et al., 2021). Rodriguez, et al., (2023) highlight in their research that having greening parameters involves categorizing buildings in a systematic hierarchy. They conclude that the first early building assessment tools like LEED and BREEAM allow for a complete greening assessment of multiple sets of building construction projects. The authors highlight that the two best rating tools in the building industry today comprise BREEAM and LEED, which can be applied to different building construction projects.

Amiri, Ottelin and Sovari (2019) highlight that the LEED rating system currently has five certification types, namely LEED building design and construction, LEED interior design and construction, LEED neighbourhood development, LEED building operations and maintenance and LEED for homes. Building certification levels are based on points

Table-2: Green Rated Buildings in Nigeria.
Source: United States Green Building Council 2023.

S. #	Name of Building	Project Type	Location	Rating
1	The Patheon	New Construction	Lagos, Nigeria	LEED v4
2	African Reinsurance Head office Building	New Construction	Abuja, Nigeria	LEED v4
3	Plot 989 Yedserem Steer Maitama	New Construction	Abuja, Nigeria	LEED v4
4	Our First Home	New Construction	Abuja, Nigeria	LEED v4
5	Karishma C.K. Manufacturing Ltd Factory	New Construction	Ogun State Nigeria	LEED v4
6	Prime City	New Construction	Lagos, Nigeria	LEED v4
7	Olarewaju Bello	New Construction	Lagos, Nigeria	LEED v4
8	World Bank Abuja	New Construction	Abuja, Nigeria	LEED v4
9	Place OC	New Construction	Owo, Ondo, Nigeria	LEED v4.1
10	Mr Emeka Ndu	New Construction	Lagos, Nigeria	LEED v4
11	U.S. Consulate General Lagos	New Construction	Lagos, Nigeria	LEED v4
12	Misa	New Construction	Lagos, Nigeria	LEED v4
13	No4 Bourdilon Street	New Construction	Lagos, Nigeria	LEED v3
14	P&G Nigeria MDO Warehouse	New Construction	Agbara, Ogun Nigeria	LEED v3 Silver
15	AfDB Nigeria Field office	New Construction	Abuja, Nigeria	LEED v3
16	U.S.Embassy Abuja-New Annex	New Construction	Abuja, Nigeria	LEED v3
17	Procter and Gamble Lagos Facility	New Construction	Agbara, Ogun Nigeria	LEED v3
18	Asdsds	New Construction		LEED v3
19	Procter and Gamble Lagos Master Site	New Construction	Lagos, Nigeria	LEED v3
20	1913-Ssa-Nigeria-D&M Base Ph	Existing Buildings	Port Harcourt, Nigeria	LEED v4
21	FDE1911 Blue Base Nigeria	Existing Buildings	Port Harcourt, Nigeria	LEED v4
22	3250-SSA-Nigeria-NTC Camp	Existing Buildings	Port Harcourt, Nigeria	LEED v4
23	AFREXIM Bank-Abuja Regional office	Core and Shell	Abuja, Nigeria	LEED v4
24	Heritage Place	Core and Shell	Lagos, Nigeria	LEED v3
25	Nestoil Tower	Core and Shell	Lagos, Nigeria	LEED v3 Silver
26	bba's Heart Montessori School	Schools	Lagos, Nigeria	LEED v4
27	RFA SH-Classroom South	Schools	Abuja, Nigeria	LEED v3
28	RFA SH-Classroom North	Schools	Abuja, Nigeria	LEED v3
29	Microsoft Nigeria	Commercial Interiors	Lagos, Nigeria	LEED 4 Silver

Table-3: LEED Scorecard Nestoil Corporate Headquarters.
Source: United States Green Building Council 2023.

	Sustainable Sites	**19/28**
SSP1	Control of environmental pollutants	0/0
SSC1	Effective selection of building construction site	1/1
SSC2	Building Density	5/5
SSC3	Brownfield Redevelopment	0/1
SSC4.1	General transportation access	6/6
SSC4.2	Green bicycle storage and changing rooms	2/2
SSC4.3	fuel-efficient vehicles	3/3
SSC4.4	parking	0/2
SSC5.1	Maintenance of the natural habitat	0/1
SSC5.2	open spaces provisions	0/1
SSC6.1	Storm water design -	0/1
SSC6.2	Storm water design -	0/1
SSC7.1	Heat island effect – non-roof	1/1
SSC7.2	Heat island effect - roof	0/1
SSC8	Light pollution reduction	0/1
SSC9	Tenant design and construction guidelines	1/1
	Water Efficiency	**6/10**
WEP1	Efficient use of water	0/0
WEC1	Landscaping and water efficiency	4/4
WEC2	Innovative Wastewater Technologies	0/2
WEC3	Water reuse Reduction	2/4
	Energy And Atmosphere	**15/37**
EAP1	Fundamental commissioning of building energy systems	0/0
EAP2	Minimum energy performance	0/0
EAP3	Fundamental refrigerant management	0/0
EAC1	Optimize energy performance	5/21
EAC2	On-site renewable energy	0/4
EAC3	Enhanced commissioning	0/2
EAC4	Enhanced refrigerant management	2/2
EAC5.1	Measurement and verification - base building	3/3
EAC5.2	Measurement and verification - tenant sub metering	3/3
EAC6	Green power	2/2
	Materials and Resources	**0/13**
MRP1	Storage and collection of recyclables	0/0
MRC1	Building reuse - maintain existing walls, floors and roof	0/5
MRC2	Construction waste management	0/2
MRC3	Materials reuse	0/1
MRC4	Recycled content	0/2
MRC5	Regional materials	0/2
MRC6	Certified wood	0/1
	Indoor Environmental Quality	**4/12**
EQP1	Internal air control quality	0/0
EQP2	No smoking	0/0
EQC1	Outdoor air delivery monitoring	0/1
EQC2	Increased ventilation	1/1
EQC3	Construction IAQ management plan - during construction	1/1
EQC4.1	Less harmful use of materials	0/1
EQC4.2	Less harmful materials usage in terms of paintings and coatings	0/1
EQC4.3	Less harmful materials flooring materials	0/1

EQC4.4	Less harmful composite and agri fibre	0/1
EQC5	Indoor chemical and pollutant source control	0/1
EQC6	Controllability of systems - thermal comfort	0/1
EQC7	Indoor temperature comfort - design	1/1
EQC8.1	Daylight and views - daylight	0/1
EQC8.2	Daylight and views - views	0/1
	Innovation	**2/6**
IDC1	Innovation in design	+1
IDC2	LEED Accredited Professional	+1
	Regional Priority Credits	**4/4**
EAC1	Optimize energy performance	+1
EAC5.2	Measurement and verification - tenant submetering	+1
WEC1	Water efficient landscaping	+1
WEC3	Watter use reduction	+1

Figure-2: Nestoil Corporate Headquarters.
Source: www.researchgate.net (2023).

allocated on how healthy buildings satisfy these criteria, which consist of Certified (40-49 points), Silver (50-59 points), Gold (60-79 points)and Platinum (80+ points). It further allows points for six other basic deliverables like sustainable sites, water efficiency, atmosphere and energy, materials and resources, indoor environmental quality and innovation. Energy-related credits have the highest score regarding this rating system, with 30% of overall credit scores, which usually results in a higher overall certification score.

LEED Certified Green Buildings in Nigeria

The United States Green Building Council believes buildings and communities will regenerate and sustain the vitality of all life within a generation. Their mission further states that transforming how buildings and communities are designed, built and operated enables an environmentally and socially responsible, healthy and prosperous environment that improves the quality of life (USGBC 2023). They intend to achieve this by subjecting buildings to the LEED Greening building tool. According to the US Greening Buildings Body, there are a total of 29 green buildings in Nigeria (Table 1).

According to the architects that designed this commercial complex (Adeniyi Coker Consultants Limited), it comprises 15 Storeys which is subdivided into different functional uses consisting of 7,500sqm of offices, 350sqm of accommodation spaces, a multi-storey parking facility as well as a recreational facility. This gigantic building is located at the intersection of Akin Adesola and Saka Tinubu streets in the Central Business District of Victoria Island Lagos State Nigeria. The buildings form was created using gentle curved horizontal surfaces of high performance glass with horizontal tubular details which accentuate the sweeping effects of the curved façade. Further to this are the functions of the arched curtain walls which are defined by surrounding of solid white metal panels to complete the contemporary composition of the magnificent edifice.

The LEED Score card for the Nestoil Building Project was categorized into seven sub-divisions namely:

1 Sustainability of the site
2 Efficiency in using water
3 Efficiency in using energy
4 Efficiency in the use of materials of construction
5 Efficient quality of the indoor environment
6 Creativity
7 Credits based on points gained

RESULTS

Buildings, which could take the form of houses, are essential for man's needs, as they not only shelter him but also act as man's investment, in hold, for future profit at retirement or old age. While this is notably important, these buildings continue to harm the ecosystem and the built environments in which they are domiciled. As a result of these harmful and costly associated damages to the built environment, countries worldwide have joined resources together to find

a lasting solution to the menace of global warming and environmental pollution. Further moves at enhancing eco-friendly sustainable development practices resulted in the signing of memorandums of understanding between countries like the Kyoto Protocol in 1997 and the Washington Earth Observation Summit in 2003 (Alotaibi, et al., 2023). A key component in determining the building compliance standards is adhererence to current environmental sustainability conditions. In addition, (Song, et al., 2023) all green building rating systems arrive at a best-fit green compliance rating system (Song et al., 2023). Another major determining factor for green building rating systems is consumption patterns of energy that have become alarmingly high, leading to the search for a globalized solution. Cai and Gou (2023) have suggested using rating systems to appropriately guide and promote building compliance ratings with green building construction methods and materials usage. The overall environmental efficiency of the world's building stock has seen the effects and advancements at which climate change has negatively impacted them. Therefore, the construction industry needs to discover newer ways and practices that are more environmentally friendly (Maqbool, et al., 2023). These may be in the form of green construction materials with more environmental advantages when applied. Therefore, by using both BREEAM and LEED and other recognized certification rating systems, they could enhance the attainment of low cost energy efficient buildings. While conducting a study in Kano, Alotaibi et al. (2023) believe that greening tools need to be adopted for compliance and greening standards in creating a sustainable building environment. They highlight the importance of green rating systems in establishing more sensible approaches to the current issues regarding environmental control and dominance. In addition, they agree there are few sustainable construction projects in Nigeria, which they attribute to a paucity of experience in greening processes and an absence of adequate government regulations and laws. lack of knowledge and derived advantages of greening construction projects in Nigeria are identified, thereby calling for more research in this area of awareness studies. This also aligns with the study by (Ibrahim and Raji 2018), who assert in their research of adoptions of greening tools in the city of Kano, North Western Nigeria, but efforts towards enhancing their high implementation compliance levels are not in synergy between concerned stakeholders. Atolaibi et al (2023) additionally, point that Nigeria's national laws and policies responsible for compliance with green construction and rating systems are ineffective towards enhancing compliance; as such, these should be further strengthened for sustainability and sustainable built environments. Agyekum, et al., (2020) in understanding adoption of greening tools in Ghana, also a developing economy like Nigeria, identify that there is little literature available on this subject in Ghana highlighting key variables responsible for adoption. These are observability of the benefits, government's commitment level, incorporation of green building certification codes by professionals and their regulatory organizations, and enactment of green certification concepts.

CONCLUSION

The study appraised green building rating systems focusing upon relevant parametrics at achieving sustainability within Nigeria as a case point. The study further identified the different green building drivers in the African Built Environment as environmental, financial, economic, and social benefits, meaning that the buildings are comfortable for the occupants and healthy while also being aesthetically pleasing. This was closely followed up by the concept of greening in buildings. The essentials of green buildings is that they are a system of assemblages that cause less harm to the areas they are domiciled. Green Buildings as a concept first came into existence after the energy crisis of 1960 with the introduction of which led to the introduction of BREEAM in 1990 further saw an increase in developments of other green building rating tools the world over as a way of addressing the threats of global warming. The study further discussed the world's leading green building rating tool, LEED and identified 29 projects in Nigeria that have been certified with the LEED rating system. The Nestoil Corporate Headquarters was used as a reference building to highlight the use of LEED as a rating tool on an existing project, reflecting the various aspects that were used in certifying this building as green. Although the Green Building Council of Nigeria in collaboration with the Green Building Council of South Africa, have agreed to use the Greening tool of South Africa in Nigerian as a certification system for ensuring green buildings, the Nigerian Built Environment still falls short of an effective local rating tool for certifying buildings green which has further exercabated the effects of building construction projects in the short term and the long run. There still appears a lack of willingness on the part of government at implementing regulatory and policy frameworks that will further reduce the effects of buildings on the Nigerian Cityscape. The GBCN of Nigeria continues to play its part in enlightening construction stakeholders regarding the harm caused by non-green-compliant buildings in the environment through training and workshop programs, but more is needed to mitigate the effects of construction projects in Nigeria. Therefore, further research concerning encouraging implementation of regulatory and policy frameworks within the built environment landscape in Nigeria

will effectively enhance certifications and green building standards. There should be the introduction of desk officers at the building regulatory agencies on the insistence of design and construction of green projects, which will further act as revenue generation for this arm of governments towards having resources to implement green building construction. Tax incentives are also suggested for building construction professionals and vendors that want to engage in the purchase and supply of green building construction materials. Policy and Regulatory frameworks that emphasize implementation strategies at improving the green building rating systems in Nigeria towards achieving sustainability and sustainable development should be the foremost priority and focus of all stakeholders concerned.

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