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Comparative Analysis for the Development of a Green Building Rating System for Nigeria

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Abstract: The functionality of buildings depends on the climate they are subjected to, this means buildings constructed these days need to be built to perform efficiently within the current and future climate and with the aim of reducing the greenhouse emission induced on the environment. In order to lower CO_2 emissions and assist in reinforcing the capability of cities to adapt to climate change whilst enhancing the quality of the built environment, it is vital to improve the environmental performance and energy efficiency in buildings. This study aims to identify and compare existing GBRS (green building rating system) with Nigerian climatic condition. Proposal criteria weighting was developed from the questionnaire supplying expert opinions. It began with a comparative analysis of GBRS. The analysis was conducted to find the similarities and differences between existing rating systems and come up with an appropriate rating system for Nigeria. These approaches included a fieldwork approach (pilot study, survey); questionnaire; and interviews, both structured and unstructured. Then, the information generated in this pre-test investigation formed the conversational guide and described the decision to determine the main factors that should be involved in the new assessment system for Nigeria.

Key words: Green building, GBRS, climate change, Nigeria.

1. Introduction

Climate change, which is recognized as one of the major obstacles to sustainable development, is caused and accelerated by the GHG (greenhouse gas) emissions produced by virtually all energy end-user industries, among transportation, industry, agriculture, energy and waste management [1-4]. The construction industry alone consumes about 40% of most of the generated energy. Energy used in buildings has consequently received attention as being among the crucial problems to deal with in order to meet the climate change challenge [2]. Climate change is assessed to be one of the greatest issues facing the world in the 21th century, with extreme and global implications to the environment [2], human health [4] and the economy [5]. The built environment can be a significant contributor to GHG emissions. About 25%-40% of greenhouse emissions will be related to buildings, 40%-95% of these emissions can be brought on by operational energy use with the rest being caused by construction and demolition [6, 7].

In a region of rapid urbanization, the level of the building operations keeps growing rapidly and requires close monitoring regarding its environmental impact (Table 1) [8]. Due to the fact that building operations are estimated to be accountable for 56% of the energy used in the sub-Sahara African continent, with an increase of international interest, the cross-cultural transferability of assessment methods is of particular importance to people in developing nations. Since developing countries are confronted with pressing social and economic issues, their domestic constraints on environmental development are, therefore, qualitatively distinct from the people in the developed countries. As construction activities are among the main and primary sectors of the Nigerian economy, the role buildings play is essential towards the realisation of sustainable development and green construction. Public awareness of environmental challenges has grown tremendously

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in Nigeria. Property or home owners and even clients are trying to find residential buildings that meet up with satisfactory environmental and health levels. Unfortunately, there is the absence of institutional structures promoting green building awareness on the part of clients, tenants, and professionals as well as stakeholders in the built environment in Nigeria; these necessitate comparable study in order to tackle these issues. Today, a number of policy options are being developed around the world to tackle each of these fence. These policies will help bridge the efficiency gap, enabling critical actors in the market to make decisions that favor energy efficiency. Each country or city must map their own policy pathway to transform the built environment in a way that is most appropriate for them [9].

2. Green Design Concept

Among the numerous changes that have occurred within the construction sector and engineering disciplines during the last decade in the advancement of environmentally responsible building, the environmentally friendly buildings use valuable resources like energy, water, materials, and land more efficiently as compared to buildings that have just been built to code. These green buildings are also safer to the environment and offer indoor spaces which are generally more healthy, comfortable and effective. As the environmental impact of buildings becomes greater, man has been seeing an increasing movement in the construction of sustainable buildings and the way to minimise the bad effects of construction at the source. Architects, designers, builders, and building owners are increasingly becoming attracted and interested in green buildings. Countless projects have been built over the last decade, providing real proof of what green buildings can achieve when it comes to improved comfort levels, aesthetics, and energy and resource efficiency.

Energy building requirements in the economy depend on the region, and are therefore of strategic importance in reducing GHG [9]. A primary contributing key to the growth of a building's efficiency is the demand from occupants and tenants who have to reside and work within these buildings. There exists a growing body of research relating more efficient buildings with improved working conditions which result in greater productivity, minimised turnover and absenteeism, and other added benefits [10]. The related concept of sustainable development and sustainability has nowadays become fundamental to green building. This allows for the conclusion that the green building achievement necessitates the implementation of an integrated approach to building design [4]. Yet it is important to consider every green alternative during the early design programming and planning stages.

2.1 Sustainability Begins with Climate

The primary reason that green practices are regarded as green is due to the fact they typically operate in harmony with the surrounding local climate and geographic conditions. This means that developers have to understand fully the environment where they are designing and building to be able to utilise them to their great advantage. To be successful in sustainable designing one must be very familiar with weather conditions for instance the temperature, humidity, rainfall, prevailing winds, as well as with site

Table 1 Environmental impacts of construction process stages.

Activities	Environmental impacts
Extracting	Deforestation, destruction of plant and animals habitats
Manufacturing	Waste generation
Transportation	Energy consumption, CO_2 emission
Building	CO_2 emission, pressure and damage
Maintenance	Energy consumption, water pollution
Demolition	Toxicity, water contamination
Recycle/waste	Ground water contamination

topography and indigenous plants. In order to evaluate the degree of the achievement of a sustainable design, the building performance should be compared to a condition associated to where the construction or project is situated and the microclimate and environmental conditions of that specific area. To realise sustainability, one cannot over emphasise the need to clearly identify and minimise a building's need for resources that are scarce or unavailable locally (example water and energy) and enhance the use of easily accessible resources, such as sun, rain, wind, etc. A good understanding of the local climate is essential because it shows that one understands what is obtainable and at one's convenience, for example, the sun for heating and lighting, the wind for ventilation, and rain for irrigation and other water requirements.

2.2 Effects of Climate Change on Green Construction

The construction sector can be more vulnerable to climate risk than other industries because of short term reactions of other stakeholders to perceived risks [11]. Risk from flooding as a result of changes in the climate is a combination of the flood hazard coupled with exposure and vulnerability to flooding.

According to Clark et al. [12], in the pre-planning stage, the flood risk affects the suitability of locations for planning construction projects and the conditions under which development is authorised. Commercial stability rests upon different factors like: possible reduced land price, increased investment in planning consent, increased construction costs, reduced saleability, mortgaging and insurability, and long term viability of the built facility. Under planning conditions specific drainage, building elevation, structural designs and specialised materials may be necessitated. This could symbolise long-term commitments for construction and design companies and notably their customers. Furthermore, there are direct financial pitfalls to construction project planning linked to the climate change legislation regarding changes to local environmental planning regulations and building specifications.

Planning guidelines in all of the areas that construction projects operate in throughout the world are being reversed to indicate climate change risks and adaptation that have direct financial impacts on the value of any construction project. As the benchmarks become more strict or prescriptive, additional engineering is usually necessary. Besides, high-priced building technologies and changes to building standards in line with climate adaptation risks have financial effects on the design, planning and operational costs of construction projects [13].

2.3 The Need for Designing according to Climate

The need to design according to the climate has always been a significant concern in architecture. Vitruvius, in his *Ten Books on Architecture*, drew attention to the significance of climate in architecture and town planning [14]. He pointed out the luxurious dependence by architects on the latest environmental technologies. Moreover, he advocated, in consonance with the Building and Road Research Institute, Kumasi, "methods of building which will enable the building structure itself to affect the desired environmental control". The search for such methods has been undertaken by several countries, as documented by Refs. [15-17]. Efforts have also been made by the HABITAT (United Nations Department for Economic and Social Affairs and the United Nations Centre for Human Settlements) [18]. The necessity of finding these strategies for Nigeria was pointed out by Madedor [19] when he indicated the need to offer guidelines for design for the different climatic regions in the country. In his *Notes on the Synthesis of Form* [20], he observed that the various parameters included in modern architectural decision-making merely outrun the capacities of even the best brains. Under such conditions, according to O. Ogunsote and B. Ogunsote [21], "the electronic computer has undoubtedly become a vital tool". This discussion is buttressed by the fact that the very nature of the analyses involved in an energy-conscious design motivates the use of computers [21, 22].

A system approach may, consequently, assist to fix the issues confronted by architects in developing nations who have tended to disregard methods of designing according to climate for several reasons, most famously of which are:

- The dynamic nature of the design process.
- The considerable time and effort required, for which the architects receive no obvious extra remuneration.
- The lack of flexibility, the degree of complexity and the arguable ambiguity of some of the existing methods.
- Ignorance and the lack of training and equipment.

Unfortunately, the Nigerian building sector has not taken sufficient action to examine the abundant natural resource for instance, studies have demonstrated that the conventional methods which were at ease with the natural environment have changed as a result of an indiscriminate inflow of conflicting foreign civilisations, religions, technologies and architectural styles. This collective dilemma has resulted in the emergence of disagreeable forms with unnaturally flawed functionalities. The development of the flat roof in the rainy southern part and the pitched roof in the dry hot northern part of Nigeria, correspondingly, are good examples of reckless disrespect for the natural world. The once available free natural materials: timber, thatch straw and water are becoming extinct in an inverse proportion to the increase of the human population and industrial exploitation, thus making the masses in the rural places unable to build even cheap thatch houses.

3. Research Methodology

The research work has focused on the rating systems' analysis, comparison and implementation for a building's environmental performance. Similarities and differences were analysed, criteria for the rating systems' evaluation were set. The rating systems examined were: BREEAM (UK), LEED (US), Green Star (Australia), Estidama (UAE) and GBI (Malaysia). The research adopted a multi-dimensional design strategy that involved a variety of approaches, both quantitative and qualitative. These approaches included a fieldwork approach (pilot study, survey); questionnaire; and interviews, both structured and unstructured. Then, the information generated in this pre-test investigation formed the conversational guide and interview process. In addition, it described the decision to determine the main factors that should be involved in the new assessment system for Nigeria.

The overall approach of the research assumed conducting interviews—structured and non-structured—within a focus group to identify the categories and indicators that should be involved in the assessment system and later to validate the questionnaire and define the weighting for each of them. The professional group included a variety of stockholders, such as architects, engineers, urban planners, decision-makers as well as academicians from some selected universities from different regions as can see from Figs. 1 and 2.

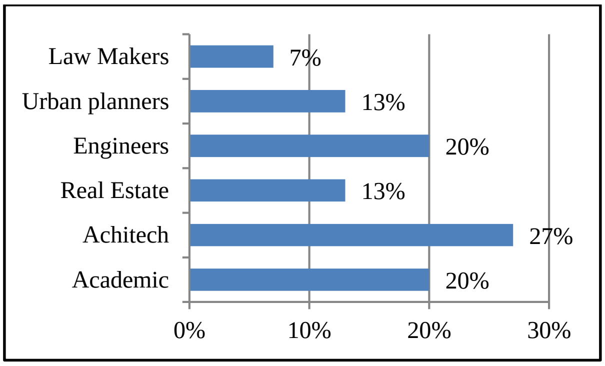

Fig. 1 Distribution of respondent professional wise.

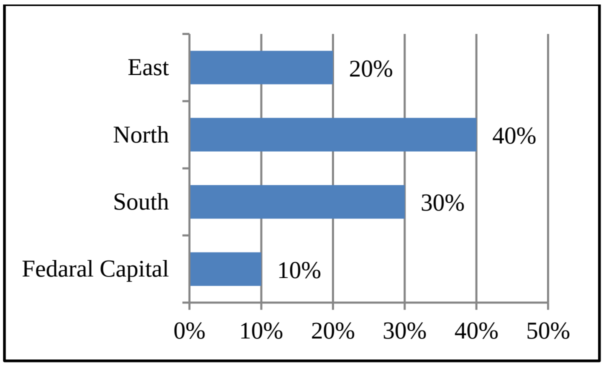

Fig. 2 Distribution of respondent regions wise.

4. Result and Discussion

In order to make a rating system that suites Nigeria, the first step is to compare relevant as well as known rating systems; therefore, five rating systems were chosen. First BREAM was chosen as it was the first rating system developed, LEED as the most widely used rating system around the globe, which is used mostly as a benchmark while Green Star, Estidama and GBI (Malaysia) were chosen simply because they have similar climatic condition to the case study. To comprehend the distinctions between the five systems, one needs to understand their history, background, requirements and sub-criteria weighting, and certification process.

4.1 Comparative Analysis among Rating Systems

Generally, all GBRs (green building rating systems) have a similar aim to address the sustainability of buildings in particular locations or regions. Benchmarking schemes are used to examine the best practice in designs and construction with regards to sustainability. All GBRs have differences as each one is unique to the environment of its intended use. The process in which each rating system is created tremendously differs from one to another.

In terms of project certification, BREEAM and Estidama are the only systems that are mandatory in their countries of origin. In the UK, BREEAM certification is required. Government departments utilise BREEAM for non-domestic buildings and apply the code to most sustainable homes for domestic buildings. In Malaysia the GBI certification for building projects is still voluntary. This is also applied to Green Star and LEED.

BREEAM, LEED, Green Star are systems that were intended to be used both locally and internationally. Green Star was first intended to be used only in Australia but later it was used in New Zealand, South Africa and Indonesia. Estidama is used only in Emirate of Abu Dhabi (UAE) and has also been mandatory for all development projects since 2010 while GBI is only used in Malaysia on a voluntary basis but the GBI legal period of certification is three years. There are no required deadlines to renew certification with LEED; however, requirements for BREEAM differ based on the characteristics of the use of the property, and it needs to be updated every three years, while management and organizational policies need to be updated every year. Green Star and Estidama presently have no required renewal date but it is anticipated to have one in the near future.

In terms of building type and certification process, each rating system is used during different phases of construction, and on different types of buildings. Some GBRSs have very detailed categories of building types. BRE was a government-funded research body when BREEAM was created in 1990. BREEAM’s goal was to provide appropriate research and information to the building sector concerning the best methods to support environmental protection and sustainable development. Therefore, BREEAM has the most detailed categories of building types, totaling 15. BREEAM’s rating system is regarded as the most valuable because of the detailed requirements of each building type. BREEAM uses numerous assessment tools to determine a building’s category. Each building type’s unique specifications are continually identified by BREEAM, and accounted for by updated versions, such as the new BREEAM 2011.

At present, LEED is recognized as the leading rating system in the international market. Since its inception in 1998, LEED has changed the construction industry by using a consensus approach. A total of nine building types have been covered by LEED so far. In order to be more widely accepted, LEED intends to update its processes. The most current version is LEED 3.0, which includes an upgrade for the 2009 rating system. LEED for new construction 2009 is adopted from the Green Building Design and Construction Reference Guide.

Green Star is known for frequently updating building assessment tools. Early on, Green Star was adapted from BREEAM. Over time, it developed its own rating system which took into consideration every factor of building in Australia. Estidama and GBI presently have only three different types of building assessments. Virtually all GBRSs have a third party verification process, where assessors verify all projects and estimate costs.

4.2 Categories

From the comparison shown in Table 2, a list of main categories and their total credits and related weights was made. The total number of credits in each main category is the sum of all the credits given to all of the items shown under that category. Then, the total credit value for each main category was divided by the total credits available in that particular rating system to determine the corresponding weight for that main category. The same was performed for the sub-items inside each main category, where the weights were calculated in correspondence to the total credits of the main category, not the total credits of the rating system itself. This was carried out to ease the comparison among the rating systems. In Table 2 a snap shot of the total credits and their corresponding weights for each main category of the five rating systems were compared.

All GBRSs use a point system and have the minimum requirements for projects to receive certification; they are the mandatory criteria that have impact on building designs and also development strategies. Points scored could be as simple as having a design characteristic or may call for a detailed analysis to verify the building performance. BREEAM uses a different system to evaluate environmental impact. Their system calculates the criteria by weighting the scores. After all of the features have been evaluated, a score is determined. This process gives a final environmental score. The BREEAM rating is then added to the score achieved. BREEAM is also distinctive because it has 10 different criterions.

LEED, Green Star and Estidama use similar scoring assessment procedures. These systems calculate all of the criteria and assign points. No weighting is used for either criteria or sub-criteria. Buildings earn points which accumulate to earn an approval rating. Green Star uses similar criteria to BREEAM. These criteria were developed by BREEAM, and adopted later by Green Star which continually grows based on the local needs in order to remain relevant to present standards. The systems currently most similar to GBI are LEED and Estidama which utilise the same six criteria for scoring.

Table 2 Comparison of GBRS in criteria and points.

Criteria	BREEAM	LEED	Green Star	Estidama	GBI
Management	12		12	-	-
Energy efficiency	19	35	29	44	35
Water efficiency	6	10	12	43	10
Material	12.5	14	22	28	11
Indoor environmental quality	-	15	27	-	21
Sustainable site	-	26	-	-	16
Innovation	10 (add)	6 (add)	5 (add)	3 (bonus)	7
Transport	8	-	11	-	-
Health and wellbeing	15	-	-	-	-
Waste	7.5	-	-	-	-
Land use and ecology	10	-	8	-	-
Pollution and emission	10	-	19	-	-
Regional priority	-	4	-	-	-
Integrated development process	-	-	-	13	-
Natural system	-	-	-	12	-
Liveable buildings	-	-	-	37	-
Total	110	110	145	177	100

4.3 Rating Award

Each GBRS features its own method of scoring. A percentage of each criterion is calculated and a rating awarded after scores is determined. BREEAM has four rating awards. The highest scores are given a rating of "excellent" if the total is 70 points. The lowest rating awarded is labelled "passing" with 25 points to 39 points scored. The maximum points achievable are 70 points. Green Star has three certified ratings available. Four stars are awarded for utilising best practices, five stars represent Australian excellent, and six stars represent the world leadership achievements. The total point possible for Green Star is over 140 points since points for innovation are added. Estidama has five rating awards. The maximum score is the rating of 5 pearls, which constitutes about all of the mandatory credits plus 140 points while for 2, 3, and 4, like 5 pearls, you have to achieve the mandatory requirements and then calculate the number of points to achieve specific awards. The lowest award in Estidama is 1 pearl which is to achieve the mandatory requirements only.

LEED and GBI have similar ratings. Both award ratings from Platinum to the lowest level labeled, Certified. The differences lie in the certified level, since LEED assigns scores between 40 and 49 points, while GBI assigns between 50 and 65 points. The Platinum level for GBI requires 86 points and LEED requires a total of 80.

5. Conclusions

GBRSs are crucial tools for measuring and assessing the environmental performance of a building. These rating systems include a diverse variety of environmental considerations from the building site selection, design, and construction, to building operations and workspace quality. The development and growth of communities have large impacts on the natural environment. The manufacturing, design, construction, and operation of the buildings in which human live and work are accountable for the consumption of the planet's numerous natural resources. Rating and certification systems guide and define green buildings in the market. They inform as to how environmentally sound a building is, provide clarity as to what degree green elements have been integrated, and which sustainable principles and practices have been employed. There are several rating systems and sustainable design tools that provide potentially useful strategies for building designs depending on the needs of the user. Five sustainable building rating systems were examined in detail. Meanwhile, the findings of this study would be useful in ensuring the full implementation of green standards in Nigeria which at the same time would help to ensure the goal of sustainable communities as well as mitigate the effects of climate changes in one's society.

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