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Development of a building performance assessment and design tool for residential buildings in Nigeria

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Abstract

Building performance and assessment tools are not new to the global audience. What are new however are the concerns, on the part of policy makers and building practitioners, with their adaptation to the Nigerian context. These concerns have become especially salient in the face of continued climate change and excessive environmental perturbations.

This paper presents the development of a building performance and design tool that is intended to assist the Nigerian government with its building codes and policies and also building practitioners with the design process. The methodology is based on a review of existing building rating systems such as LEED and BREEAM, from which a system adapted to the requirements of the Nigerian National Building Code for residential buildings is proposed. The methodology is further developed into a design tool whose features include a schematic design serving as a reference building validated through energy simulation.

The underlying proposal of this paper will assist the Nigerian National Building Code in establishing policies favourable to the built environment and aid designers in the creation of sustainable buildings in Nigeria, as well as serving as an exemplar to other developing African countries.

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Keywords: Performance Assessment; Nigeria; Design tool; LEED; BREEAM; residential building

1. Introduction

The primary objective of a building is the provision of shelter, comfort, and safety for its occupants. Therefore to attain this purpose buildings are designed, planned, constructed and managed according to certain codes and regulations, governed by experts and government bodies [1-4]. The adverse effect of climatic change and the increase in public environmental awareness in the building industry has resulted in the development of creative solutions to reduce the Green House Gas [5-9]. Building assessment tools are being developed worldwide with a considerable amount of success, such as the Building Research Establishment Environmental Assessment Method (BREEAM) and Leadership in Energy and Environmental Design (LEED). These assessment tools provide an effective framework to measure the environmental performance of the building and construction process. Considerable research has been put into development of effective assessment tools for different localities,

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due to differences in each country's climatic conditions, availability of material, land, cultural adaptation, population growth, public awareness and legal support. In this paper a detailed analysis of existing performance assessment tools will be conducted with a view to their adaptation for Nigerian conditions. The research adopts a qualitative approach, with the main instrument of data collection generated from literature sources such as books, journals, articles, libraries and databases. An analytical discussion of pre-existing building performance assessment tools will be used to develop a framework to assess the Nigerian case. The derived framework is then incorporated into a design tool which features a schematic design validated through energy simulation for residential buildings.

2. Appraisal of Existing Performance Tools

Two performance assessment tools have been selected for appraisal, due to their popularity and widespread usage: BREEAM which was the predecessor of all green building rating tools; and LEED which is one of the most widely recognized building environmental assessment schemes.

BREEAM was first developed in 1990, with the most recent updated version produced in 2014 [8]. The main function of this assessment tool is primarily on building specification evaluation including the design, construction and use [10] based on four assessment tools that can be used at different stages of a building's life cycle. BREEAM methodology is calculated by awarding a point or credit that is based on the following categories (management, health & wellbeing, energy, transport, water, material, waste, land use & ecology, pollution and innovation) which determine the environmental impact of the building. The total number of credits awarded in each category is multiplied by an environmental weighting factor which defines the importance of the category. The category scores are added up to produce an overall score, designated as Unclassified, Pass, Good, Very Good, Excellent, and Outstanding. A star rating from 1-5 is also provided. The BREEAM International certification system also uses a star rating system [11].

LEED was founded by the U.S. Green Building Council (USGBC) in 1998. According to LEED [12] more than 72,000 LEED certified projects across 150+ countries, comprising over 13.8 billion square feet (approx.12.8 billion square metres) has been executed, which makes it one of the most widely used assessment tools. The latest version "LEED Version 4" [9] was officially launched in 2014, and includes schemes for Building Design & Construction, Building Operations & Maintenance, Interior Design & Construction, Neighborhood Development and Homes. The LEED Neighborhood Development scheme is one of the first developed schemes for community sustainability evaluation; however it overlooks essential issues such as the local economy and the provision of jobs and affordable houses [13]. LEED consists of nine categories namely: integration process, location & transportation, sustainable site, water efficiency, energy & atmosphere, materials & resources, indoor environmental quality, innovation in design, and regional priority. Here, building grades are classified as follows: Certified (40-49points), Silver (50-59 points), Gold (60-79 points), and Platinum (80-above points) [9]. In order to establish an explicit understanding of these systems, each is examined comprehensively highlighting their respective strengths and potential as listed in Table 1 and described in what follows.

There are a number of categories comprehensively established by the building assessment tools for BREEAM and LEED. These categories are noted in Table 1, with their indicators and sub-indictors. These categories will be reviewed with reference to the subject location (Nigeria) and the findings incorporated into the proposed framework.

Table 1. Comparison of performance assessment tools

Categories	BREEAM	LEED
Sustainable site and Ecology		
Ecological status		
Biodiversity protection	√	√
Contaminated Land	√	√
Enhancing site Ecology	√	√
Ecological impact	√	√
Construction site		
Site protection	√	√
Site selection	√	√
Site Development	√	√
Energy		
Natural Resources		
Renewable energy strategy	√	√
Energy performance		
HVAC	√	√
Lighting (internal)	√	√