Facility Performance and the Need for Building Sustainability in Nigeria: A Review

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Abstract
Over the years, Nigeria has had a disturbing history of unsustainable building practices, mismanagement of buildings and poor maintenance culture with no consideration for its impact on the environment. There has been several cases of building collapse and failures reported in various cities across the country resulting in the loss of lives and properties, thus raising concerns and questions as to the efficiency of our building industry regarding the quality of building construction, maintenance and management in the country. The building industry is a vital element of any economy which has a significant impact on the environment and by virtue of its size; construction is one of the largest users of energy, material resources and water. With respect to such significant influence of the building industry, there is the need to adopt a sustainable building approach which has a high potential to make a valuable contribution to sustainable development in the environment, reduce the rate of building collapse recorded in the country and save human lives. This paper researches on building facility performance and the need for sustainability in Nigeria. Methodology applied involved extensive literature review on design, construction and maintenance of "green" buildings as a sustainability approach for high performance buildings and findings revealed that sustainability issues of building include ways of designing, constructing, and maintaining a building with its facilities that maximizes its health, efficiency, cost-effectiveness and durability. This will minimize the state of building failures in the country and improve its value in the long run.

Keyword: Building, facility, performance, maintenance, sustainability, Nigeria.

Introduction

The presence of buildings are no doubt vital to the environment and major contributors to sustainable development of the society as they serve various needs of the society which include shelter from the weather, security, living space for various activities, privacy, to store belongings, and to comfortably live and work. In simple terms, a building can be described as a walled roofed structure used for many economic activities and that deteriorates throughout its lifespan (Olanrewaju, Khamidi, & Idrus, 2011). The design, construction and maintenance of any building determines to a large extent the duration of its lifespan. Hence, the failure in the performance of any building can largely be traced to the state of design, construction and maintenance of the said building. Ayininuola & Olanusi (2004) defined building failure as an unacceptable difference between expected and observed performance in a building component when that component can no longer be relied upon to fulfill its principal functions. This failure often results in a collapse of the building. Building collapses in Nigerian major cities today continues to engender an excessive number of fatalities, injuries and property damage, among the most recent being the building collapse of Synagogue Church of All Nations in Lagos, Nigeria, which claimed the lives of over 117 people (Okolie, Okorie & Ikekpeazu, 2016). This recurring disaster has raised concerns and questions as to the efficiency of our building industry regarding the quality of building construction, maintenance and management in the country just as Oloyede, Omogun, & Akinjare (2010)

attributed causes of building collapse as due to man's negligence to some vital areas in construction and the use of substandard materials among others, while Chendo & Obi (2015) included other causes ranging from faulty design, negligence, incompetence, faulty construction, foundation failures, extraordinary load to corruption and forces of nature. The bottom line however is that collapse of building; either total or partial collapse, leads to the failure of building to perform its intended function of protection, safety or stability (Olagunji, Aremu & Ogundele (2013) in addition to its negative impacts on the environment. This calls for an urgent response from all stakeholders in the building industry on the need to embrace sustainable strategies for building performance and efficiency.

Concept of Building Sustainability

Sustainability is a broad and complex concept, which has grown to be one of the major issues in the building industry today. Sustainability or Sustainable development has been defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). As Brandon & Lombardi (2005) rightly put, sustainability is about leaving the environment in at least the same state by a generation or leaving it in a better state for newer generations to come. The idea of sustainability involves enhancing the quality of life, thus allowing people to live in a healthy environment, with improved social, economic and environmental conditions (Ortiz, Castells, & Sonnemann, 2009). Sustainable development has emerged as a paradigm for balancing environmental, social and economic goals which includes the provision of safe buildings (Tah, 2006, Howard, 2000) and offers a framework within which the appropriate combination of consumption and preservation can be sought. It is a concept of needs, an idea of limitations, a future oriented paradigm and a dynamic process of change (Shields, 2001).

Sustainable development concepts, when applied to the design, construction, and operation of buildings, can enhance both the economic well-being and environmental health of communities in Nigeria and around the world. The Union Internationale des Architects/American Institute of Architects (UIA/AIA) World Congress of Architects recognized that in its 1993 Declaration of Interdependence, which acknowledges that buildings and the built environment play a major role in the human impact, on the natural environment and on the quality of life. When sustainable design principles are incorporated into building projects, benefits can include resource and energy efficiency, healthy buildings and materials, as well as ecologically and socially sensitive land use (Graef, 1996). It is true that buildings are the main physical assets of any nation; they are created for providing shelter and enhancing people's quality of life (Lam, Chan & Chan, 2010) and according to Wood (2006), if these buildings are not properly planned and maintained in a sustainable manner, they will become liabilities. In the United Kingdom, from the year 2002, 50% of all annual construction activities were exclusively for building maintenance (Lam et al, 2010). However, this is not the case in Nigeria, where there is poor maintenance culture and values with high record of poor performance operations, poor maintenance and mismanagement (Abigo, Madgwick, Gidado & Okonji, 2012; Iyagba, 2005). The sustainability of building performance therefore demands great attention. One of the ways to achieve this is the adoption of maintenance as an essential practice.

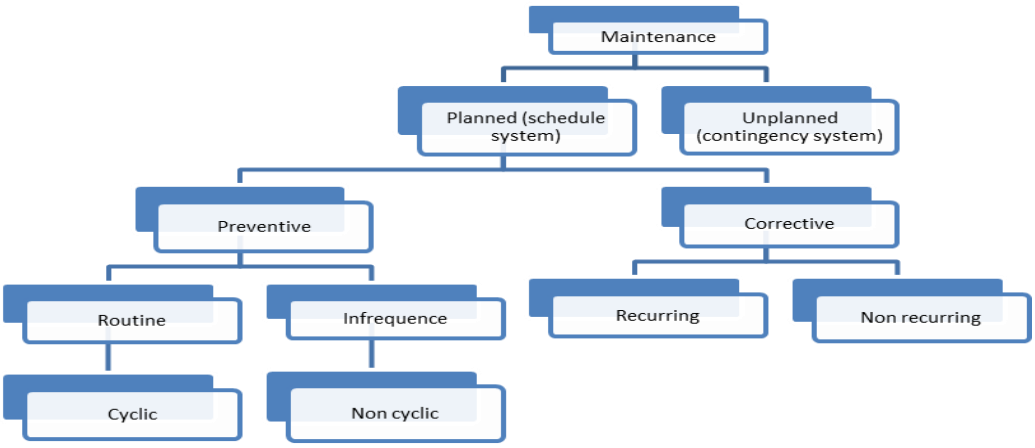
Building Maintenance Principles

Buildings have been considered as one of the most valuable assets of a nation to provide people with shelter and facilities for work and leisure and time passes by, maintenance of buildings become an invaluable process in retaining the value and quality of a building (Vijverberg, 2002). Yusif (1998) stated that though highly desirable, it has not yet been feasible to produce maintenance free buildings. The reality is that all the elements and components, which make up a building unavoidably deteriorate with time due to the inherent defects in design and construction

and the effects of environmental agents and user activities. Buildings are basically required to provide a conducive and safe environment for the performance of various human activities. The ability of a building to provide the required environment for a particular activity is a measure of its functionality. As the components and elements of a building begin to deteriorate, it becomes necessary to take measures aimed at ensuring that the desirable characteristics, which enable the building to provide convenience and safety are retained. This is the basic philosophy of maintenance.

Building maintenance according to the British Standard Institution (1993) BS 3811, is defined as works undertaken in order to keep or restore every facility including the site, building and to an acceptable standard/condition. Olanrewaju et al (2011) asserted by saying that building maintenance involved "processes and services to preserve, repair, protect and care for a building's fabric and engineering services after completion to current standards to enable it to serve its intended functions throughout its entire life span without drastically upsetting its basic features and use." Onwuka (1989) in Odediran, Opatunji & Eghenure (2012) stated that maintenance management is concerned with the planning and control of construction resources to ensure that necessary repairs and renewal are carried out with maximum efficiency and economy. Hence, Kolawole (2002) advocated that maintenance culture requires the correct diagnosis of defects, current remedial measures, sound technical knowledge of material usage, management resources as well as the formulation and implementation of integrated plan and policies to sustain utility. The condition and quality of buildings is one of the most fundamental components of the quality of life. Lee & Wordsworth (2001) opined that vast majority of people spend over 95 per cent of their time in or next to a building of one kind or another, thus making the built environment in this sense, our "natural" environment. According to Zailan (2001), maintenance management is the physical aspect of property management which has been defined by Tiun (2009) as an activity that covers a wide range of activities such as property development, facilities management, project management, property portfolio management, human resources management, space management, risk management as well as investment management and it must be carried out by the qualified property/estate manager.

Fig 1: Classification of Maintenance Strategies



Source: Udechukwu, 2012.

In the maintenance of buildings and its facilities, the appropriate strategy to use is the decision of the estate manager, the nature of the estate and the type and nature of the maintenance work required. However

the objectives remain the same as enlisted by Ihuah & Fortune (2013):

(1) To ensure that buildings and their associated services are in a safe condition
(2) To ensure that building are fit for use
(3) To ensure that the condition of the building meets all statutory requirements
(4) To maintain the value of the building stock
(5) To maintain or improve the quality of the building.

The survival of any building is underpinned by these maintenance strategies discussed below and still accepted as the most sustainable and suitable way to conserve buildings (Dann & Cantell, 2007).

Corrective Maintenance

Udechukwu (2012) described corrective maintenance strategy as work which is carried out after an element has failed in order to reduce the effects of the failure where possible and restore the element to its original state or to a state which is acceptable, taking into account the current or proposed use of the building. Corrective maintenance is the simplest type of maintenance strategy, where an element in a building is used until it breaks down. It covers all activities, including replacement or repair of an element that has failed to a point at which it cannot perform its required function. Corrective maintenance is sometimes referred to as failure-based or unplanned maintenance. Thus, its tasks often take places in an ad hoc manner in response to breakdowns or user requests (David & Arthur, 1989).

Corrective maintenance can be extremely expensive for two reasons: the failure of an item can cause a large amount of consequential damage to other elements in the building. For example, failure of the roof could cause damage to the ceiling and the interior of the building; failure of an item can occur at a time which is inconvenient to both the user and the maintenance team. This can make manpower and spare parts planning extremely difficult. However, corrective maintenance is still an important part of any maintenance management strategy.

Preventive Maintenance

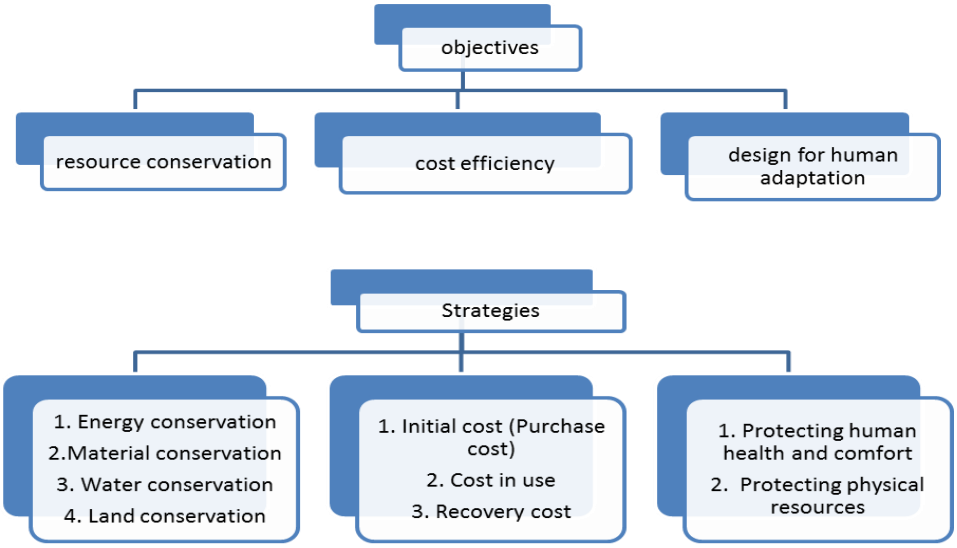
Preventive maintenance was introduced to overcome the disadvantages of corrective maintenance, by reducing the probability of occurrence of failure and avoiding sudden failure. This strategy is referred to as time-based maintenance, planned maintenance or cyclic maintenance. Preventive maintenance tasks are performed in accordance with a predetermined plan at regular, fixed intervals, which may be based for example on operating time, with the aim of retaining the facility in good condition. Chan (2014) however maintained that even though preventive maintenance can retain facilities in good condition and extend their lifespan, the buildings' usability may not be efficient or have any value-added if sustainable components have not been considered. Therefore, strategic sustainable maintenance is required.

Sustainability Requirements for Maintenance of Green Buildings

Globally, the building sector is unarguably one of the most resource-intensive industries. Building material production consumes energy, the construction phase consumes energy, and operating a completed building consumes energy for heating, lighting, power and ventilation. A sustainable green building is one which is designed, built, renovated, operated, maintained or reused in an ecological and resource efficient manner (Ortiz, Pasqualino, & Castells, 2010). It should meet a number of certain objectives: resource and energy efficiency; CO2 and GHG emissions reduction; pollution prevention; mitigation of noise; improved indoor air quality; harmonization with the environment (John, Clements-Croome, & Jeronimidis, 2005). Hill & Bowen (1997) stated that sustainable building starts at the planning stage of a building and continues throughout its life to its eventual deconstruction and recycling of resources

to reduce the waste stream associated with demolition.

Fig 2: Sustainable building objectives and strategies



Source: Akadiri, Chinyio & Olomolaiye, 2012.

Table 1: Stages of the Building lifecycle and sustainability considerations

Stages of building lifecycle	**Examples of environmental sustainability considerations**
Planning stage	Impact of the planned site on the local environment; relationships with the city; quality of the local built environment; mixed-use and density; poly- centricity; infrastructure; public transport; green areas; environmental hazards.
Building design	Considering embodied energy and resource utilization; enabling energy and water efficiency by design; integrating district heating and micro-generation; sustainable waste management; green roofs; robustness and resilience; future-proofing; possibility of upgrading; shaping of lifestyles.
Construction	Safe, environmentally-friendly, local affordable material; minimization of environmental impact from building activity
Operation	Energy performance; air-conditioning, air quality; pollution by residents and impact of the local pollution on residents, water use and water management, water recovery; comfort and hygiene of homes; quality and energy efficiency of the local infrastructure and transportation; property maintenance and management; waste management and recycling; greening the area; natural hazards.
Refurbishment	Choice of refurbishment material; energy efficient design; disturbance of the environment; management of construction waste.
End of life	Demolishing or reusing; recycling of building components; management of construction waste.

Source: UN Habitat

The selection of maintenance system to be operated in the building should therefore take into consideration the life cycle of the building materials, services installation provided, space function or activities to be carried out in that particular building. According to Filani (2011), Akadiri et al (2012), Chan (2014), basic requirements to be considered in order to achieve the ultimate green building, include,

Design efficiency

Building design and construction can affect the natural environment, both directly (i.e., by placing buildings and paved surfaces on previously vegetated areas), and indirectly (i.e., through extracting resources to create building materials; emitting greenhouse gases in the manufacturing and transportation of materials to the site; and through using energy sources such as electricity once the building is operating). Sustainable building design is therefore about reducing these impacts by designing and constructing buildings that are appropriate for the climate, have minimal environmental impacts, and are healthy and comfortable for building users (Cairns Regional Council, 2011).

Energy Efficiency

Most buildings are rated because of their attempts through design to minimize energy consumption. High performance buildings use low energy for day to day activities (operations). Energy efficiency is achieved majorly by use of materials. Construction, finishing and services should have high performance materials that save energy instead of wasting them. Building sites are surrounded by natural energy in the forms of wind, solar radiation, and geothermal heat. Renewable energy systems can be used to supplement or eliminate traditional heating, cooling, and electrical systems through the utilization of this natural energy. Components that encourage day lighting, passive and active solar heating, and on-site power generation are included in this category. Solar power can be utilized in many forms, both for heating and production of electricity. Therefore, placement of external features of the building to aid solar gain and day lighting so as to reduce the need for electricity, also solar water heating, and renewable energy should be highly utilized.

Water efficiency

Sustainability here will involve controlling water use and quality monitoring of water, water purification, usage, renewal, re-purification processes, etc. Also building fittings that allows water's re-usage and management are also green components in buildings. For instance, the building itself can be designed to act as a collector of rainwater (from the roofs), to be stored in a cistern for later use such as for flushing toilets and landscape irrigation.

Material efficiency

There is a wide range of materials that have been certified green because of certain conservative properties that they posses. Most finishing materials have thermal properties, non toxic, natural renewable and recyclable characteristics. Examples are: linoleum, compressed earth block, timber, limestone, etc. The Environmental Protection Agency (EPA) also supports that materials should be sourced locally, and also pre-fabricated materials are encouraged so that on site wastes can be reduced (debris management), as well as effective noise reduction on site. However, the illegal or unsustainable extraction of these materials should not be encouraged; rather, careful selection is required to minimize environmental and social impacts. Some of the locally sourced building materials found in Nigeria are listed in table 2:

Table 2: Locally sourced building materials and their locations in Nigeria

Type of Material	States predominately found

Granite	Plateau,Ondo, Ado Ekiti, Bauchi, Abia and Ebonyi
Limestone	Anambra, Cross Rivers, Benue, Imo, and Bendel
Marble	Kwara, Bendel, Benue, Plateau and Kaduna
Laterite	All States
Clay	Cross Rivers, Ondo, Oyo, Sokoto, Gombe, Kano, Niger, Imo, and Anambra.
Natural fibre	All States
Bamboo	Eastern Nigeria
Timber	Eastern and Western Nigeria

Source: Kogbe, 1989; Okereke 2003.

Indoor quality: A sustainable building must supply a healthy and comfortable indoor climate to the people using it. Ventilation designs, either naturally or artificially provides clean (pure) indoor air as volatile organic compounds, microbial contaminants are reduced in an enhanced indoor condition. Using finishing materials that have low volatile organic compounds (V.O.C) emissions is recommended. This is to improve the health standard for occupants (end user-user comfortability).

Conclusion

The achievement of efficient and high performance buildings has been the major concern for professionals and other stakeholders all over the world. Nigeria is not left out as there has been in recent times a great need to protect the environment and reduce the state of building collapse and failures emanating from poor functionality. Sustainability in building design, construction and maintenance therein lies the way forward. How we design and construct buildings can affect the natural environment both directly and indirectly. Green or sustainable building is the practice of creating and using healthier and more resource-efficient models of construction, renovation, operation, maintenance and demolition. Sustainability in building brings together a vast array of practices and techniques aimed at reducing the impact of the building industry on energy consumption, the environment and human health. It is necessary that a high performance building should accommodate the activities it is built for and provide floor-space, room volume, shelter, light and amenities for working, living, learning, curing, processing, etc. In meeting these basic requirements, the building should not cause harm to its occupants or the environment.

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