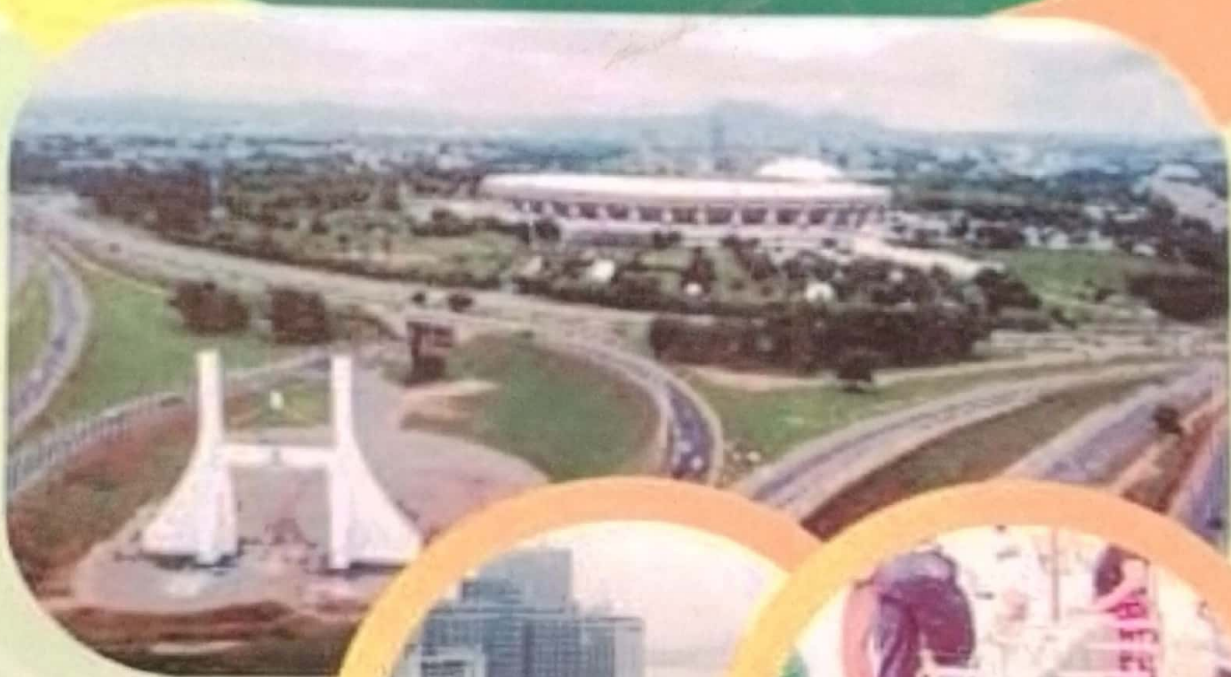


PLANNING AND MANAGEMENT OF SUSTAINABLE INFRASTRUCTURE DEVELOPMENT IN NIGERIA



A Book in Honour of
Professor Nurain Bolanle Tanimowo

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Rafiu Babatunde Ibrahim
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CHAPTER THIRTY

GREEN BUILDINGS AS ENVIRONMENTAL MANAGEMENT INFRASTRUCTURE: PROSPECTS AND CHALLENGES

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ABSTRACT

High rate of environmental degradation by traditional buildings have been affirmed by researches across the globe. This revelation has spurred investigations into the adoption of green buildings as an effective ways to manage construction related environmental impacts. Conventional buildings impact the environment negatively from construction to deconstruction stages. A large quantity of natural and human resources are consumed during construction. Buildings continue their impacts on the environment through energy and water consumption and waste generation among others. According to the World Business Council for Sustainable Development, building block accounts for 40% of total energy consumption (WBCSD, 2010). At the end of life of buildings, the disposal of buildings is also associated with energy consumption and waste production. Green buildings; however, have been found to offer a number of benefits among which are environmental, economic, health and community benefits (USGBC, 2009). The green building design focuses on increasing the efficiency of resources like, energy, water,

and building materials, while also reducing the impacts of building on human health and the environment. This can be achieved through better use of site design of building, construction, operation, maintenance and deconstruction. This study therefore assesses the prospects and challenges of green buildings as infrastructure for the management of the environment. The benefits and the challenges of green buildings were explored through the review of the literature. It is concluded that Green Buildings have potential to effectively address environmental problems in the built environment. The benefits range from environmental to economical while the only major drawbacks of green buildings are high cost of initial take off when compared with conventional buildings, awareness and knowledge among others.

Keywords: green building, environment, infrastructure, prospects, sustainable development.

INTRODUCTION

Increasing rate of awareness of environmental problems has spurred people and government into devising new ways to solve or decrease environmental degradation. The built environment particularly has been of great concern considering its high consumption of energy and resources of the environment. This consequently leads to severe impacts on the health of the people and environment. The environmental impacts of developments on homes and buildings are profound globally. As observed by Roodman, *et al.* (2004), Traditional buildings consume approximately 45% of the world's total energy use; 50% of all materials and resources; 50% of wood use in North America; 35% of the world's CO₂ emissions; 80% of potable water use; 25% of

freshwater withdrawal (including power plants); 40% of municipal solid waste destined for local landfills; and 50% of ozone-depleting CFCs still in use. In the specifics, the building sector in Canada is responsible for 33% of all energy consumed; 50% of natural resources used; 12% of non-industrial water usage; 25% of landfill waste; 10% of airborne particulates; and 35% of greenhouse gases.

While in the United States alone, buildings account for 72% of electricity consumption; 39% of energy use; 38% of all carbon dioxide (CO₂) emissions; 40% of raw materials use; 30% of waste output (136 million tons annually) and 14% of potable water consumption. These figures are startling and the development needs to be urgently arrested to achieve the sustainable goals set by the United Nations.

Green building is one of the ways to curtail these numerous unsustainable energy and resource consumption in the built environment. This concept has been found to offer a number of benefits among which are environmental, economic, health and community benefits (USGBC, 2009). The green building design focuses on increasing the efficiency of resources like, energy, water, and building materials, while also reducing the impacts of building on human health and the environment. This can be achieved through better use of site design of building, construction, operation, maintenance and deconstruction. The basic principles behind sustainable architecture include the concept of optimum size, energy efficient, water conservation, use of local natural material, recycling capabilities, and self-sufficiency in material used. Such practices ensure minimum material use, reduced energy use and consequently reduce wastes.

Several studies globally have lent credence to the efficacy of green buildings in managing the environment. Specifically, a USA study showed that green

buildings are eco-friendly, healthier, and economical based on energy usage. Green homes proved to reduce energy consumption up to 50%, while carbon dioxide emissions were up to 39% (Kats and Capital, 2003). In another comparative study for consumption of resources, green building designs reduced water use by 40% and solid wastes generation by 70 %. Similarly, Confederation of Indian Industry asserted that green buildings in India consume 30 to 50% less energy as compared to conventional buildings.

REVIEW OF LITERATURE

What Makes a Green Building?

Green Buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by: Efficiently using energy, water, and other resources; protecting occupant health and improving employee productivity; reducing waste and pollution as well as environmental degradation. These are achieved through incorporating sustainable materials in their construction (e.g., reused, recycled-content, or made from renewable resources); creating healthy indoor environments with minimal pollutants (e.g. reduced product emissions); and featuring landscaping that reduces water usage (e.g., by using native plants that survive without extra watering).

Objective of Green Building

A recent report by the Canadian Green Building Council (2007) describes the purpose of green buildings thus:

Green buildings strive to balance environmental, economic, and social considerations in design, construction and operation. Energy, water and resource efficiency; occupant comfort and wellbeing; site development and

community context; the economics of building construction and operation are key considerations. In comparison to conventional buildings, green buildings take advantage of natural processes to generate less waste, less pollution, and reduce their overall environmental footprint. In other words, green building or sustainable building is aimed at being in total compliance with environmental dictates in order to ensure that no strain is impacted on the several elements of the environment so as to consequently achieve a balanced system.

Environmental Benefits and Costs of Green Roof Technology

As an integral part green building, though, not a must in all such type of building, green roof has been found to effectively render certain environmental benefits. In some of the earliest reported research, measurements in Berlin conducted in 1984 revealed not only that green roof installation is capable of reducing the maximum surface temperature but also reduced temperature amplitudes by half (Kohler *et al.*, 2002).

Akbari *et al.* (1999, 2001), while investigating means of reducing building energy in mid-latitude cities as one of several means for reducing the urban heat island (UHI), documented the enhanced air conditioning demands (up to 10%) brought about by the UHI. This elevated load generally occurs in the late afternoon hours, corresponding to the peak summer electric utility load. Akbari also demonstrated that the afternoon electric utility load for Southern California increases by more than 2% per degree Celsius increase in air temperature. Also noteworthy, was the determination that ozone concentration in the Los Angeles basin was positively correlated with air temperature, increasing at a rate of 5% per degree Celsius (Akbari *et al.*, 1990; Sailor, 1995). By making roofs cooler, designers can reduce the amount of absorbed solar energy, and consequently reduce the amount of heat conduction into

buildings. This reduces daytime net energy inputs (Akbari and Konopacki, 2004; Akbari *et al.*, 2001; Konopacki *et al.*, 1997) and the demand for air conditioning.

Del Barrio (1998) explored the thermal behaviour of green roofs through mathematical analysis, and found that green roofs effectively act as thermal insulators. Eumorfopoulou (1998) also carried out calculations to examine the thermal behaviour of a planted roof and concluded that green roofs can contribute to the thermal performance of buildings. This study further showed that 27% of the total solar radiation absorbed by the planted roof is reflected, while the plants and the soil absorb 60%, and 13% is transmitted into the soils. Evidently, with a green roof the insulation value is in both the plants and the layer of substrates (Eumorfopoulou, 1998). Patterson (1998) also showed that green roofs prevented temperature extremes and the insulation value of the soil on the structure lowered the cooling energy costs.

Concept of Green Building

Green building, also known as sustainable or high performance building is defined by the United States Environmental Protection Agency (2017) as the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. It also refers to an environment friendly structure which is built in such a manner that it continues to be environmentally responsible and resource efficient throughout its life KeTTHA. (2010). By this, it includes everything right from an eco-friendly design to the use of material which will make sure that the environment is not harmed even when the structure in question is demolished.

The concept of green architecture has come a long way, with modern green buildings being built by taking into consideration all the needs of people who would use them - right from expenditure incurred to comfort and durability. Basically, the main idea of green buildings is to promote the preservation of the natural environment of the project location, while still being able to build a structure that serves its purpose.

According to CaGBC (2007), in principles, A Green Building is one that is built considering the following five factors.

1. Selection of appropriate sites and environmentally sustainable site development
2. Efficiency in the use of water resources
3. Conservation of energy, Use of renewable energy and Protection of atmospheric resources
4. Conservation of building materials, reduction of construction waste and sensible use of natural resources
5. Protection and enhancing indoor environmental quality

However, most green buildings do not incorporate all of these measures altogether, but at least the project team selects those that are appropriate for a project's budget and overall goals.

"Green" or "sustainable" buildings use key resources like energy, water, materials, and land much more efficiently than traditional buildings built on standards. They also create healthier work, learning, and living environments, with more natural light and cleaner air. By these numerous benefits, Sustainable buildings are cost effective, by reducing the cost of operations and maintenance as well as by lowering utility bills.

The traditional buildings in which people live, work, and play protect them from nature's extremes, yet they also affect people's health and environment in countless ways- The energy used, the waste generated, water usage and materials used from the environment among others are capable of degrading the environment in several dimensions.

Some of the principles on which green buildings are based according to Amina, et al (2012) are summarized as: "Small is beautiful; Heat with the sun; Keep your cool; Let nature cool your food; Be energy efficient; Conserve water; Use of local natural materials; Save the forests; Recycle materials; Build to last; Grow your food and Share the facilities".

These principles underscore the care given to human environment and the dangers to be avoided with the introduction of green buildings. Furthermore, for green building to really achieve the performance of environmental benefits, the material used from the construction to finishing must be those in the following categories and sourced from within the natural environment: they must respect the limitations of nonrenewable resources such as coal and metal ores, they work within the pattern of nature's cycles and the interrelationships of ecosystems.

Green building materials are nontoxic. They are made from recycled materials and are themselves recyclable. They are energy-efficient and water-efficient. They are green in the way they are manufactured, the way they are used, and the way they are reclaimed after use.

Green building materials are those that earn high marks for resource management, impact on indoor-environmental quality (IEQ), and performance (energy efficiency, water efficiency, etc.) Mehta and Sharma (2014)

Green Buildings and their Environmental Benefits

The various parts of green building that sum up the environmental as well as health benefits of the concept are listed below:

i. Siting: This is the location of building in a particular site. The siting is to be given adequate attention such as locating projects on sites away from wetlands, away from prime agricultural land and away from endangered or threatened species habitat. Siting projects on sites where there is already urban infrastructure to serve them. These steps are important to forestall further threat to the already disturbed ecosystem and its accompanied dangers. Observing this measures largely prevent the development of urban sprawl and its attendant ills.

ii. Design: The green building approach applies a project life cycle cost analysis for determining the appropriate up-front expenditure. This analytical method essentially calculates costs over the useful life of the asset in order to cut cost, though, in the long run. These and other cost savings can only be fully realized when they are incorporated at the project's conceptual design phase with the assistance of an integrated team of professionals (Architects, Engineers, Town Planners and Contractors among others). Also, the integrated systems approach ensures that the building is designed as one system rather than a collection of stand-alone systems.

In order to create a successful green building, the entire building team must work together, everyone from the owner, designer, to contractor must develop a building site and use products that enhance environmental sustainability.

iii. Construction: At the construction stage of green buildings, careful evaluation of construction material must be done to allow for selection of sustainable construction materials and products. This is done by weighing the several characteristics of the materials as well as their efficiency. Issues such

as reused and recycled content, zero or low off gassing of harmful air emissions, zero or low toxicity, sustainably harvested materials, high recyclability, durability, longevity, and local production are greatly considered. Materials of the aforementioned features highly promote resource conservation and efficiency. Similarly, the use of dimensional planning and other material efficiency strategies reduce the amount of building materials needed and are also capable of cutting construction costs.

iv. Operation: operation involves the day to day occupation and use of the facilities of the green buildings. It goes a long way in determining and perception of the benefits or otherwise of other various aspects of green building as claimed. It ranges from installation of permanent locations for recycling bins to encourage reuse. Reuse existing building materials, both interior and exterior materials, to reduce the energy use and environmental impacts associated with producing new ones. For instance, the use of salvaged and reclaimed building materials such as decorative brick and wood timbers that are still structurally sound may go a long way in reducing the cost incurable on home items. Also, the use of materials that are harvested and processed not far away from the location of the buildings, to cut the transportation impacts associated with bringing them from farther away. While purchasing 50% or more of the wood products in the building from forests, certified for sustainable harvesting and good management practices can also aid sustainable operation.

v. Maintenance and Renovation: The maintenance and renovation of green buildings must take into consideration activities incapable of injuring the inhabitants and degrading the environment. Prevention of unhealthful exposure to hazardous materials such as paints, solvents, cleaners, batteries, yard chemicals, pesticides and others must be a target. Maintenance such as

replacement of fittings, doors, windows and other materials need be done within sustainable practices.

vi. Deconstruction: Like an organism, buildings have a life cycle within which they exist, grow old and die i.e natural collapse or demolition. At this stage, like every other aspects, deconstruction of green buildings should incorporate sustainable practices. The materials from the demolition should be recyclable and reusable so that they don't constitute environmental nuisance or health hazards either to the environment or its inhabitants.

Other Benefits Associated with Green Building

Environmental Benefits

Aside the various parts of green building and the environmental purposes they serve, green building generally are of different other benefits to the environment and the people. These include but not limited to:

- i. Provision of opportunities and building of infrastructure for people to commute to work using public transit and bicycles.
- ii. Minimizing parking to discourage excessive use of automobiles.
- iii. Provision of low-emission vehicles and car-sharing arrangements to reduce the use of fuel.
- iv. Protection of open space in site development and restoring open space on already impacted sites.
- v. Management of storm water to reduce the rate and quantity of storm water runoff, and use best practices to clean storm water before it leaves the site.

- vi. Judicious management of landscaping and parking lots to reduce urban heat islands. This prevents excessive heating of the area around a building and limits the use of air-conditioners.

Economic Benefits: Cost advantage – Initial investment on green building may be on the high side, cost is saved through lower operating costs over the life of the building. For instance, cost incurred on energy, waste disposal, and water are lesser because of energy saving devices and materials used, coupled with lower environmental and emissions costs, lower operations and maintenance costs. This can however be recouped in the overall life cycle of the building.

CHALLENGES OF GREEN BUILDING

Despite considerable knowledge and benefits related to green building, the project is faced with numerous challenges. Some of these are real and perceived while others bother on regulatory and non-regulatory. Some of these problems are itemized and as follows:

- i. **Availability:** This has to do with the availability of current technology to satisfactorily meet desired green building standards. Certain barriers limit the availability of higher performance green building components in the world market. This means that builders and developers have limited markets from where most energy efficient or environmentally low impact products can be sourced. This is a daunting problem both in the developed and developing countries.
- ii. **Accessibility:** This bothers on the ability of the market to respond to the improvements required for green building products for residential buildings. Meeting the demand need of the developers and builders without hindrances cannot be guaranteed. This results

from low number of market players in the supply of green building materials (i.e. manufacturers, distributors and contractors). Construction industries are also skeptical to adopt new practices and technologies, some of them prefer to count on their past successes to enter into the risk of innovation. Furthermore, legal and administrative institutions have created regulatory problems, the conventional planning standards and codes do not easily accommodate green building concept as most of them are contrary to already known standards by which development permits are granted

iii. **Affordability:** This aspect involves the financial aspects of technologies and processes required to put green building in place. It ranges from the cost of materials to cost of maintenance of the buildings i.e the entire life cycle maintenance. Although, the cost can be recouped in the long run making green building less expensive, the initial cost is always on the high side. Therefore, higher initial costs including the additional costs of design, analysis, engineering, energy modeling, etc., can act as deterrents to green building.

iv. **Inadequate awareness and knowledge:** This is in two folds, one, on the part of the industry and the other as concerned the users of buildings. Most, if not all actors in construction industries seem to be lacking in the knowledge of relevant green building technologies as well as practices (Mutinta Sichali *et al.* 2017). Low level of education, training and technical expertise within the building industry greatly hampers the use and adoption of green building technologies and standards, making building green more

difficult, time-consuming and costly. The users as well are not too aware of the benefits attached to building green or at most have little knowledge about them leading to low acceptability.

- v. **Acceptability:** The acceptance of the green building concepts starting from materials, practices and standards as the norm against the conventional buildings is threatened owing to the earlier mentioned challenges by both the supply and demand side actors. While the former continue to face the herculean task of sourcing materials and technologies for green building, the latter, either because of low awareness of the benefit inherent in and the initial high cost, still give preference to the conventional types of residential housing development. Even in the developed world, no level of government has set specific policies, standards, or targets to encourage or regulate green residential building. The financial and insurance sectors are also not exempted from this; as they are either slow in accepting green buildings or recognizing the long-term potential for economic gain. They give preference to financing and insuring traditional building projects rather than those using new and innovative green technologies.

CONCLUSION

In the recent time, there is increasing concerns for care of the environment owing to diverse environmental extremes such as global warming, pollution and other environmental disasters plaguing the world. Green building has been examined as an effective means of addressing environmental problems in the built environment. The benefits of green building range from environmental to economical. The major drawback of green buildings is that one would need to expend a lot more money initially, than would do for a regular building.

Although, the overall costs may come down, once it starts saving money due to lesser energy consumption, yet, early on, one would need to pay more. The main reason behind this is that the eco-friendly materials which are used in such buildings are not available in many markets. So when these materials are imported from other places, they cost much higher, thus adding on to the initial cost of the green building.

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