GREEN BUILDING: A PANACEA FOR SUSTAINABLE BUILT ENVIROMENT IN TROPICAL CLI MATE.

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Abstract

As the threat from global warming grew stronger in the turn of the century, green building and sustainable architecture are rapidly moving from the periphery to the mainstream architecture.

The need for green building is generally acknowledged by professionals in built environment and there have been many attempts to enlightened professionals about the consequence of global warming and why we must adopt to the current demands of Sustainability. Also the tropical environment is faced with some negative climatic impacts as a result of high radiation received from the Sun. The impact is especially felt in the area of human thermal comfort and the environment at large. The extreme climatic conditions prevalent in tropical region, witnessed almost throughout the year leads to high rate of energy consumption for cooling the building interior and the surrounding environment. This paper present green building as a way to sustained the built environment in tropical region through reduction in cooling loads within building interiors also the use of landscape elements to enhance and reduce drastically the climatic effects in other to achieve maximum sustainable built environment.

Keywords*: Green Buildings, Sustainability, Built Environment, Climate.*

INTRODUCTION

The natural environment works like a living organism, so also the built environment. The people react with it and it reacts with people. The Urban environments are the mirror with which we reflect our beings; to look at our cities is to see into our future (Ozoenemene 2004). Simonds (1999) admits that when we recreate environment, the environment recreates us.

Onibokun (1990) also observes that everything added to or subtracted from the landscape change it for the better or worse.

Housing has been universally accepted as a basic essential human need that comes only after food and clothing. Housing in all its ramifications is more than mere shelter since it embraces all the social services and utilities that make a community or neighbourhood a liveable environment. It is the total environment in which man lives and grows. Man's strive for increased comfort and financial independence, the densification of congested urban areas, increase in traffic levels and the growing electric smog problem due to new communication technologies all cause ever rising stress levels in individuals and the society at large. These human activities cause various environmental problems including air and water pollution, generation of domestic and industrial waste, emergence of slums and global warming with attendant negative effects on quality of life and health standard of the citizenry.

The green building movement in the United States of America originated from the need for more energy efficient and environmentally friendly construction practices. There are a number of motives to building green, including environmental, economic, and social benefits. However, modern sustainability initiatives call for an integrated and synergistic design to both new construction and in the retrofitting of existing structures. Also known as sustainable design, this approach integrates the building life-cycle with

each green practice employed with a design-purpose to create a synergy amongst the practices used. This energy design or energy conscious design can be achieved through intelligent design and use of materials and technology (Adedeji and Folorunso, 2008).

GREEN HOUSING IN TROPICAL CLIMATES

Green building (also known as green construction or sustainable building) is the practice of creating structures and using processes that are environmentally responsible and resource efficient throughout a building's life-cycle (Bauer *et al*, 2009). Starting 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 (U.S. Environmental Protection Agency, 2009b).

Green Building often emphasizes taking advantage of renewable resources e.g., using sunlight through passive solar, active solar and voltaic techniques and using plants and trees for reduction of rainwater run-off. Many other techniques, such as using packed gravel or permeable concrete instead of conventional concrete or asphalt to enhance replenishment of ground water, are used as well. While the practices, or technologies, employed in green building are constantly evolving and may differ from region to region, there are fundamental principles that persist from which the method is derived: sitting and structure design efficiency, energy efficiency, water efficiency, materials efficiency, indoor environmental quality enhancement, operations and maintenance optimization and toxic waste reduction (U.S. Environmental Protection Agency, 2009a). The essence of green building is an optimization of one or more of these principles. Also, with the proper synergistic design, individual green building technologies may work together to produce a greater cumulative effect.

Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

a. Efficiently using energy, water and other resources;

b. Protecting occupant health and improving employees' productivity and

c. Reducing waste, pollution and other environmental degradation.

Green housing is fundamentally the basis of green living and green building. This means that the lifestyle of the homeowner, design and functionality of the house influence the degree of green housing anticipated. There are a wide variety of options to be chosen from in order to "green" a building. These includes reducing energy use and converting to alternative energy solutions**,** reducing water use, choosing an environmentally friendly location for houses, designing homes with green building materials and increasing recycling.

BENEFITS OF GREEN BUILDING OVER CONVENTIONALS ONES

Green building practices aim to reduce the environmental impact of new buildings. Buildings account for a large amount of land use, energy and water consumption, and alteration of the environment. Considering the statistics, reducing the amount of natural resources buildings consume and the amount of pollution given off is seen as crucial for future sustainability (U.S. Environmental Protection Agency, 2009b). Benefits derivable from green housing can be categorized into two. These are environmental benefits and economic benefits. The environmental benefits include improving air and water quality; protecting the biodiversity and the ecosystem of our planet and conserving natural resources such as natural gas and fossil fuels (Greg *et al*., 2003). Economic benefits include lower energy consumption with energy saving

electrical appliances, lightning bulbs, home designs and locations; and through green energy solutions such as solar panels and wind turbines which generate electricity independently from utility companies. Additionally, green housing increases the value of a home.

Green buildings can be used to achieve the following:

Improvement of Indoor Air Quality

Improvement of Indoor Air Quality (IAQ) seeks to reduce volatile organic compounds (VOC) and other air impurities such as microbial contaminants. Choosing construction materials and interior finish products with zero or low emissions will improve IAQ because many building materials emit toxic gases. These gases can have a detrimental impact on occupants' health and productivity as well (Lee & Guerin, 2009).

Increase in Energy Efficiency

Green buildings often include measures to reduce energy use. To increase the efficiency of the building envelope, (the barrier between conditioned and unconditioned space), they may use high-efficiency windows insulation in walls, ceilings, and floors. Another strategy, passive solar building design, is often implemented in low-energy homes. Personal temperature and airflow control over the HVAC system coupled with a properly designed building envelope will aid in increasing a building's thermal quality. Designers orient windows and walls and place awnings, porches, and trees (Simpson, 2002) to shade windows and roofs during the wet season while maximizing solar gain in the dry season. In addition, effective window placement (day lighting) can provide more natural light and lessen the need for electric lighting during the day. Solar water heating further reduces energy loads. Creating a high performance luminous environment through the careful integration of natural and artificial light sources will improve the lighting quality of a structure (National Institute of Building Sciences, 2010)

Waste Reduction

Green architecture also seeks to reduce waste of energy, water and materials used during construction. During the construction phase, one goal should be to reduce the amount of material going to landfills. Well-designed buildings also help reduce the amount of waste generated by the occupants as well, by providing on-site solutions such as compost bins to reduce matter going to landfills. To reduce the impact on wells or water treatment plants, several options exist. Waste water from sources such as dishwashing or washing machines, can be used for subsurface irrigation, or if treated, for non-potable purposes, for example, to flush toilets and wash cars. Rainwater collectors are used for similar purposes.

Protection of Ecosystem and resource conservation

A typical convectional building, a code compliant building makes a minimal efforts to address energy, water issues and totally ignores materials waste, resource conservation, impacts on the construction site among others are not specifically covered in the building code. Ecosystem protection, efficiency in the use of key resources like energy, water, materials and land are of primary importance of green building.

Integrated and systemic approach to design

The green building incorporates an integrated team of professionals at the project's conceptual design phase. This approach ensures that the building is designed as one system rather than a collection of stand-alone system. The entire life cycle of the building and its constituent components are carefully considered from resource extraction to use in the building and disposal at the end of its useful life.

Economic Performance

The green building provides an array of financial benefits that conventional buildings had failed to do. These benefits include lower operating costs via reduced energy, water costs, waste disposal lower environment and green house emissions costs. It also reduces maintenance and replacement costs due to greater durability of materials.

Protection of public health and improvement of enhanced productivity

Generally, people spend 90% of their time indoors, and the concentration of Pollutants indoors is typically higher than outdoors, sometimes by as much as 10 or even l00times (US, EPA, 2003). A sustainable building has tangible public health and productivity benefits as a result of using an integrated approach to create environmentally sound and resource- efficient buildings.

A measurable benefit such as enhanced day lighting, natural ventilation, better sitting, improved indoor air quality in buildings associated with these "green" features include enhanced worker and student productivity, as well as reduced absenteeism and illness. Judith, 2000 affirms that a study at Herman-Miller showed up to 7% increase in worker productivity following a move to a green, day light facility. Another study performed by the Heschong- Mahone group looked at students in three cities and found that students in classrooms up to 20% better than those in classrooms that had little daylight.

SUSTAINABLE LANDSCAPING IN TROPICAL COUNTRIES

A sustainable landscape is designed to be both attractive and in balance with the local climate and environment and it should require minimal resource inputs such as fertilizer, pesticides and water. Sustainable landscaping begins with an appropriate design that must be functional, cost-efficient, visually pleasing, environmentally friendly and maintainable. It pays close attention to the preservation of limited and costly resources, reducing waste and preventing air, water and soil pollution. Also, compost, fertilization, pest control measures that avoid or minimize the use of chemicals, integrated pest management using the right plant in the right place, appropriate use of turf, irrigation efficiency and or water-wise gardening are all components of sustainable landscaping. A sustainable environment is the one in which all plants, animals and other forms of life are able to exist in an ecosystem without any exterior aid or interference (Sustainable Landscape Designs (2010); White, 2010).

Sustainable landscaping includes a diversity of practices that have developed in response to environmental issues. These practices are used in every phase of landscaping, including design, construction, implementation and management of residential and commercial landscapes

Sustainable landscaping can be achieved by the adoption of the following:

a. Reduction of storm water run-off through the use of bio-wastes, rain gardens and green roofs and walls.

b. Reduction of water use in landscapes through design of water-wise garden techniques (sometimes known as xeriscaping)

c. Bio-filtering of wastes through constructed wetlands

d. Landscape irrigation using water from showers and sinks, known as gray water

e. Integrated Pest Management techniques for pest control.

f. Creating and enhancing wildlife habitat in urban environments.

g. Permeable paving materials to reduce storm-water run-off and allow rain water to infiltrate into the ground and replenish groundwater rather than run into surface water.

h. Use of sustainably harvested wood, composite wood products for decking and other landscape projects, as well as use of plastic lumber (Weber, 2006).

i. Recycling of products, such as glass, rubber from tires and other materials to create landscape products such as paving stones, mulch and other materials.

MODEL FOR SUSTAINABLE LANDSCAPING OF BUILDINGS

Landscaping can be used to control several aspects of the microclimate of buildings. According to Ogunsote & Prucnal-Ogunsote (2004), the climatic variables that can be regulated include solar radiation (sol-air temperature), air temperature, relative humidity, wind speed and direction; and glare.

Sol-Air Temperature Control

Ventilated shading provided by trees, shrubs and climbers can be used for the control of radiant temperature, and reduction of air, ground and surface temperature. Ventilated shading reduces the amount of solar radiation reaching ground and wall surfaces, thereby reducing the sol-air temperature, which is an indication of the globe temperature.

Air Temperature Control

The air temperature control achieved through landscaping is a direct result of reduction in sol-air temperatures by ventilated shading. Ventilated shading is accompanied by evapotranspiration, a process whereby plants take water from the soil and lose the water by evaporation through the leaves. This causes cooling just like sweating causes cooling in humans, with the latent heat of

evaporation taken from the surrounding air.

Humidity Control

Plants in general increase the humidity of the site. They can therefore increase the thermal comfort during hot, dry seasons, although the plants have to be watered regularly. The plants take water from the soil, and when this water evaporates from the leaves it increases the relative humidity while lowering the air temperature. Pools and ponds behave in a similar manner. Water evaporating from the surface increases relative humidity while reducing air temperature.

Control of Air Velocity and Wind Speed

Plants are used to reduce wind speed and to increase the velocity of stagnant and slow-moving air. Windbreakers in the form of rows of trees are a very effective way of reducing wind speed and filtering dust. The almond tree effect induces air movement under and around trees even when there is relative calm in unplanted areas.

Control of Wind Direction

Landscaping can be used to direct wind away from the building, or towards the building. Fences, walls, hedges and trees can be combined to form an obstruction that will deflect the wind above the building. This can be useful when protecting the building from the cold harmattan wind. The more common use of trees however, is to channel air flow towards living space. While trees allow a portion of the wind to pass through them, some wind is deflected above and below the trees. The wind forced to flow beneath the trees increases air movement in living space. On larger plots groups of trees can also be used to channel the wind in a particular direction.

Control of Surface Absorptivity and Reflectance (Albedo)

Landscaping can be used to control the rate at which surfaces absorb and reflect solar radiation. The use of lawns, plants, colour and careful selection of pavement materials can control the

proportion of solar radiation absorbed to that reflected (Wilmers, 1991).

Glare Control

Direct glare can be prevented by using trees to block off the relevant portions of the sky while indirect glare can be prevented by planting flowers, shrubs and grass on surfaces that would normally reflect light into the building.

Fresh Air and Fragrance

Plants produce oxygen and fragrances, which combined with the almond tree effect, create the refreshing atmosphere of gardens. While the freshness of the air and fragrance may not be measurable by climatic variables, the improvement in the microclimate is unquestionable.

LANDSCAPE ELEMENTS FOR MICROCLIMATE CONTROL

Microclimate control can be achieved by hard and soft landscaping elements. Soft landscaping elements refer to vegetation while the hard landscaping elements are all other elements including simple structures, steps, paving, garden furniture, walls and fences.

Soft landscaping elements

Trees and shrubs

Trees and shrubs are the most significant in the provision of shade and the control of relative humidity and air movement. They contribute more to the attainment of thermal comfort than any other element. Ventilation is affected by plant materials. Air crossing hard reflective or absorptive surfaces like parking lots and sidewalks is warmed, but air passing through trees and plants will be cooled (Caudill *et al,* 1974). See Plate 1. Tree leaves are arranged to catch as much of the sun as possible. In the process, they provide the best possible shade. This shading is far superior to that provided by a roof or a wall. While a roof may provide full shading, the roof

heats up in the process and hot air is trapped under the roof causing discomfort. The roof also radiates heat, causing further discomfort. A tree on the other hand filters the radiation, with the upper leaves receiving most radiation and thus becomes hotter. The leaves at the bottom receive less radiation and are much cooler and hence radiate less heat. The tree also allows air to rise through the leaves to the top of the tree, thereby preventing hot air from being trapped under the tree (Ogunsote & Prucnal-Ogunsote, 2004).

Plate 1.Old Engineering building in Federal Polytechnic, Ilaro landscaped with shrubs and trees

Source: Field Survey (2015).

Lawns and Flowerbeds

Lawns and flowerbeds are used to reduce ground temperature and to prevent glare. Vegetation generally improves air freshness and fragrance. See Plate 2.

Pools and ponds

These water bodies are used for humidification and evaporative cooling.

Hard landscaping elements

Walls and fences

Walls are used to deflect the wind, and they can also be used to channel the wind. Walls are usually solid, while fences are made from stakes, rails, wire, netting, et cetera. Fences thus allow some wind to flow through them, even when they have climbers.

Steps and paving

The choice of the surface finishing, material and construction of steps and paving can play a significant role in the reduction of ground temperature. The use of asphalt in parking lots without any form of shade is a primary source of discomfort.

Slopes and barriers

The use of slopes and barriers to direct airflow can be very effective on sites with significant variations in the topography.

Stones and boulders

Stones and boulders can be arranged to direct airflow and to provide shade.

Outdoor living space

Outdoor living spaces occupy that region between the house and the garden. These are conditioned outdoor spaces. They are partly garden, partly house. They are partially protected from the elements, yet open to nature. They include courtyards (courts), patios, corridors, terraces, balconies, loggias and porches (verandas). Outdoor living space can be considered a part of the landscape and its design can significantly impact on the indoor comfort conditions.

Plant Selection in Landscaping

Most of what makes a landscape unsustainable is the amount of inputs required to grow a nonnative plant on it. A local plant, which has adapted to local climate conditions, will require less work on the part of some other agent to flourish. Also, by choosing native plants, certain problems with insects and pests can be avoided because these plants will be adapted to deal with

any local invader. By choosing the right kind of local plants, money can be saved on pest control and watering.

RECOMMENDATIONS

(i). Nigeria Green Building Council (NGBC) should be established to shoulder the responsibility of preaching the gospel of environmental awareness, understanding the building ecosystem through which natural and manufactured resources flow as well as giving the stakeholders the skills and knowledge-bases to seek and find sustainable design solution. It also ensures green building certification.

(ii).An integrated approach to design should be encouraged by relevant authority on building designs, construction techniques and operations. This interdisciplinary team should include Client representative, Project manager, Planner, Architect, Engineers, Landscape expert, interior designer, Sustainability consultant and others.

(iii). Use of resources-efficient building materials with recycled content, low embodied energy, recycled, renewable, environmentally benign, non-toxic, low VOC (Volatile Organic Compound) emitting, durable products that give highlife cycle value for the cost since maintenance culture in this part of the world is a nothing but a disaster.

(iv).Good Indoor Air Quality (IAQ) should be strongly encouraged by carefully selecting products and finishes that are low or non-toxic and low VOC emitting air, Asbestos, Lead paint, pesticides, formaldehyde adhesive, carpeting, upholstery copy machines among others are common sources of chemical contaminants.

(v). Optimized use of interior space by Architects through careful design so that the overall building size and resources used in constructing and operating would be kept to a minimum.

(vi).Locally produced building materials save energy and pollution generation as a result of proximity.

CONCLUSION

This paper specifically examined our built environment and critically suggests best ways to achieve sustainability through green building approach. This concept provides a platform for our resources to be used in an ecological and efficient manner so as to reduce overall impact to the environment.

It also gives array of environmental benefits of green building compare to conventional ones such as protecting occupants' health, improving employee productivity, water and energy savings as well as ensuring integrated systems approach as applied to buildings and other structures.

Lastly, some recommendations which implementation would contribute towards achieving a sustainable built environment were made.

Going green should be seen not only to be better, healthier and more responsible; it should mean more greenbacks, even if only in the long run.

REFERENCES

Adedeji, Y. M. D. & Folorunso, C. O. (2008): The Roles of Architectural Education in Sustainable Energy Resource Buildings in Nigeria. *Proceedings of the Association of Architectural Educators of Nigeria (AARCHES) Conference, Owerri. Imo State, Nigeria.* 13-15 November.

Bauer, M., Mosle, P. & Schwarz, M. (2009): Green building: Guide for Sustainable Architecture. Stuttgart: Drees & Sommer, Advanced Building Technology GmbH, 10-12.

Charles, J.K (2004): Green Buildings: An overview of progress. University of Florida Journal of land use (vol. 19:2 springs 2002).

Giddens, A (1999):"Risk and Responsibility" Modern Law Journal 62(1):4

Judith H. (2000): Do Green buildings enhance the wellbeing of workers? Environmental Design and Construction magazine. July/August.2000.

Lowton R.M, (1997): Construction and the natural environment Butterworth-Heinemann, Jordan Hill Oxford OX28DP British Library Cataloging in Publication Data.

Ogunsote, O. O. & Prucnal-Ogunsote, B. (2003): Choice of a Thermal Index for Architectural Design with Climate in Nigeria. *Habitat International – A Journal for the Study of Human Settlements,* 27:1, 63-81. Pergamon Press, London.

Ogunsote, O. O. & Prucnal-Ogunsote, B. (2004): Landscape Architecture: The shaping of mans natural environment, New York, McGraw-Hill

Onibokun, P, (1990): "A review of Government Housing Policy and Programs" Urban Housing Policy in Nigeria.NISER, Ibadan. Akintola Printing works Nigeria.

Ozoenemene U.O (2004): Pluralism as a panacea to sustainable urban slum governance: Paradigms with Institutional pitfalls. 44(XLIV) General Assembly/Conference of NIA, 2004 at Maiduguri.

Prucnal-Ogunsote, B., Okwoli, F. J. P. & Ude, O. A. (2010). Progress and Prospects of Promoting Sustainable Architecture through Education in Nigeria. *The Architects Registration Council of Nigeria (ARCON) 3rd Architects Colloquium.* Theme: Architecture and the National Development Agenda III. 19 – 21 April 2010, Abuja.

Salami, R.O and Olaniyan, M.K: Continental J. Sustainable Development 1: 45 - 50, 2010

Sands, P (1995): Principles of International Environmental Law, Frameworks Standards and Implementation. Manchester University Press. P. 17.

Simonds, J.O (1961): Landscape Architecture: The shaping of man's natural environment, New York, McGraw-Hill Book Company, Inc. USA

US EPA, (2003): US Environmental Protection Agency, Indoor Air Quality.

UN CHE, (1972): United Nations Conference on the Human Environment, Stockholm, 5-16