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Evolving Trends in Design of Sustainable Built Environment

[1]Alozie, G. C, [2]Eze M. U. & [3]Ifebi, O. C
[1]*Department of Architecture, Abia State University, Uturu.*
[2]*Department of Estate Management, Abia State University, Uturu*
[3]*Department of Architecture, Chukwuemeka Odimegwu, OjukwuUniversity, Uli*

Abstract

Energy is scarce and limited especially in developing nations, while the level of environmental pollution is on the increase. Most of the pollutants of our environment today are from architectural products. This paper explores evolving trends in the design of built environment. One of these trends is the green or sustainable building concept. The paper x-rays green building potentials, and presents most simple definition of sustainability. It enumerated reasons for poor performance of designers of built environment and presented ideas that will lead to the design and construction of better, healthier built environment. The study was carried out through the review of books, journals and periodicals as major source of information. The authors also drew inferences from observations of events of architectural significance in their immediate and large environment. The paper became necessary in order to draw the interest of architects in built environment to developments in the profession. One of such developments is the green or sustainable architecture whose benefit stretches from reduction in energy use, to reduction in level of environmental pollution from carbon monoxide. The developer on the long run enjoys a cost effective project due to limited maintenance cost on his buildings. The paper listed measures the environmental designer should apply to achieve sustainability in built environment. Some of such measures include reduction in energy buildings use through an understanding of passive design ideologies, the engagement of architects and other professionals from design inception, construction, operation and deconstruction.

Keywords: *Green building, Sustainable building, Trend, the architect, Built environment*

Corresponding Author: Alozie, G. C

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Background to the Study

Early form of life in all societies requires a constant input of energy. If the flow of energy through organisms or societies cease, they stop functioning and begin to disintegrate (Enger and Smith 2006).Some organisms and societies are more energy efficient than others and also that in general, complex industrial civilizations use more energy than simple hunter gatherer or primitive agricultural cultures. If modern societies are to survive, they must continue to expend energy. However, they may need to change their pattern of energy consumption as traditional sources become limited, (Enger and Smith 2006).

The amount of energy consumed by countries of the world varies widely. The highly industrialized countries consume more energy than less developed countries, while the amount of energy required for residential and commercial use varies greatly throughout the world, for instance record shows that 16% of energy use in the United States is for residential uses. The way also energy is required for residential use also differs, as this may depend on climate, as in North America 75% of residential energy consumption is spent on refrigeration, water heating and space heating, However in many parts of Africa and Asia much of the energy used in homes is for cooking(Enger 2006).

As with other forms of energy use, electrical consumption in different regions of the world vary widely. The industrialized nations of the world, with about 20% of the world's population consume 60% of the world's electricity. While less developed nations of the world with 80% of the world's population, use 40% of world's electricity. (Enger and Smith 2006). Oil remains the world's major source of energy, accounting for about 38% of primary energy demand. Coal accounts for 26% and natural gas 24%. The remainder is supplied mainly by nuclear energy and hydro power (Enger 2006).

Energy crisis is nothing new, for as far back as 2500 years ago, the Greeks especially in the fourth century, put a ban on the use of timber as fuel, when timber faced extinction. The Greek quickly learnt to build in response to climate as they began to face their buildings south, so that the low winter sun penetrated areas that needed heat and the summer sun did not penetrate areas that needed to be cool.The Romans also turned to solar energy for same reasons that the Greek sought it out, but with much greater application and success.

The Romans used glass windows to increase the effectiveness of solar heating, developed green house and raised food during winter. They invented public bath houses (some of which accommodated up to 2000 people) to use passive solar energy. The use of solar energy was so important in early Rome that law covered ones right to light as it became illegal to construct buildings that shaded light (Botkin and Keller 1998). Energy efficiency was the case in most vernacular architecture, until the 16th Century when Michael Faraday and his electricity era changed everything, as buildings lost their passive energy potentials and buildings depended on electricity to attain indoor thermal comfort.

The root of modern call for green building could be traced to the ancient theoreticians that include Vitruvius, who in the Ten Books of Architecture discussed the benefit of designing with the local climate and indigenous materials (Morgan, 1960). The skill of preindustrial

builders, the mastery of using on-site resources, such as proper orientation, thermal mass, shading, ventilation and local construction materials, were all abandoned after the invention of artificial lighting and air-conditioning.

Except for several notable exceptions (organic movement), architecture of the first half of the 20th Century disregarded the environmental context of building (Sonnett 2004 ed). However, the energy crisis brought about by the 1973 Arab oil embargo hastened the return to energy efficient designs. The passive solar architecture movement of the 1970's also responded by offering appropriate technical solutions which for most parts failed to address broader environmental and architectural concerns. Then emerged the sustainability (green) movement in 1980's, as an outgrowth of the energy efficient period, adding to a heightened environmental awareness which was determined to achieve more comprehensive and integrated design solution (Sonnet, 2004).

With the beginning of the twentieth century, divisions, conflicts and struggles increased between the patrons of environmental conservation. Then came a call for environmental friendly buildings and reduction in the consumption of energy through the use of natural means. Architects and other activists in built environment without doubt got challenged, being major recipients of this product.

According to Botkin and Keller (1998), man's activities in recent years have done so much in impoverishing his environment, as man have through dangerous gas emissions, burning of fossil fuel and other degradable practices which act on the ozone strata, and depreciates the ozone layer. A depreciation that resulted to the trending issue of global warming, and climate change, whose environmental impact effects the world is battling today.

The solution to face the bad effects of technology and these human practices which contribute to the ugly defacement of our environment perhaps lies also in good utilization of technology by environmental designers to attain man's convenience without harming the environment, hence it becomes very important to think of new architectural trends capable of utilizing the latest scientific innovations in the field of information technology. These new trends should at the same time conserve the environment and rationalize energy consumption in buildings.

This was the beginning of one of such evolving trends in design of the built environment that has come to be known in diverse names, like the green building, high performance building, smart building, energy efficient building, intelligent building and sustainable building, which have become practical models for the possibility of reconciliation between technology and the environment.

This paper presents major information on principal environmental trends or issues that impact on architectural designs and its products today.It does so in a manner that can guide and support the design process as well as sustain the environment, since an understanding of such environmental trends, in terms of its concept and principles must be present at the beginning of the design process, to inform the initial schematic design decisions.This is in

agreement with Smith (2011) who noted that a response to the critical environmental issues should be at the core of any environment design, and not an accommodation added as an afterthought or an appendix, if functionality is desired.

Smith (2011) also noted that the trends are not external to effective design, nor should they be considered only as corrective measures which allows one do something illogical in terms of design, rather than an understanding of the principles is fundamental to the design sustainability and in its productivity, also that the exploration of the trends will be of greater value, as we progress in our studies and throughout our professional careers.

Green building, intelligent building, smart building, energy efficient building, high performance building or sustainable buildings, whatever name are two sides of the same coin as cited in Abdin and Ahmed (2010)'s intelligent building and sustainable building definitions.

According to Abdin and Ahmed (2010) Intelligent building is "the building which is capable of comprising the most recent of the present and future technological means that enables it to perceive what is going inside and outside it and plan for making its decisions on time, concerning the most effective methods for creating a responsive and sustainable environment that enhances the effectiveness of its occupants, with the least possible cost, all through the life time of the building". Abdin (2010) also defined sustainable building as the architecture that sustains the environmental balance through relying on ecological construction of systems and recycled material resources, meeting the needs of the present generation without compromising the ability of the future generations to meet their own needs. Notably, by these definitions it is clear that realizing a sustainable environment is the main objective of intelligent architecture, smart building, green building, high performance building or energy efficient building.

Clarification of Concepts

Evolve: The word "evolve" is simply defined by the new international Webster's Encyclopedia Dictionary of the English language (2003) as to unfold or expand, to work out or develop.

Trend: is also defined in same dictionary as to have or take general course or direction or to incline.

Sustainable: Is defined as arising from the word sustain which is defined by Webster (2003) as to keep from sinking or falling especially by bearing up from below; the ability to do so is termed sustainability, while the;

Built environment: is defined as the totality of the human-made surrounding that provide the setting for human activity, ranging in scale from buildings and parks or green space to neighborhood and cities, that can often include their supporting infrastructure, such as water supply or energy network. The built environment is a material, spatial and cultural product of human's labour that combines physical elements and energy in forms for living,

working and playing. It has been summarized as the human made space in which people live, work and recreate on a day to day basis (Roof and Oleru, 2008).

Green Building: green building also known as green construction or sustainable building refers to both a structure and the using, of process that are environmentally responsible and resource-efficient throughout a buildings life cycle: from siting to design construction, operation, maintenance, renovation and demolition
http://www.epa.gpv/greenbuilding/pubs/about.html.13/09/05

Green building is also the practice of creating structures and using process that are environmentally responsible and resource efficient throughout a building's life cycle, from siting to design construction, operation, maintenance, renovation and deconstruction (Henderson, 2011). The practice expands and compliments the classical building design concerns of economy, utility, drivability and comfort. Green building is most often known as sustainable or high performance building (Henderson, 2012). In another definition means (2011) defriend Green building as a way of enhancing the environment, which when done right benefits human wellbeing, community, environmental health and life cycle cost.

This means tailoring a building and its placement on the site to the local climate site conditions, culture and community in order to reduce resource consumption, augment resource supply and enhance the quality and diversity of life, more of a building philosophy than a building style. Green building according to Mean (2011) is part of the larger concept of "sustainable development".

Sustainable Building: In recent times, the word sustainability trends. Sustainability like the word renaissance is a global trending, cutting across all bodies of civilization. Just like there was renaissance in architecture, music, arts and in all fabrics of life, so is there sustainability in architecture or call it building and elsewhere.

Sustainability has been defined as living life today in a way that ensures that the children, their children-children, and their children as well be able to live as well as we do (Henderson, 2012). This means laying the groundwork for a future that is more prosperous and healthful and more equitable than present. It means that our habits at a personal level as well as a global level do not lead to an inevitable depletion of resources that will disrupt our quality of life. Living sustainably means exactly what it says; that our lifestyle can be sustained and that we don't prove to be our worst enemies (Henderson, 2012).

Sonnet (2011) added credence to Henderson (2012) by defining sustainable building (architecture) as the expression environmentally coined for responsive building practices which differs from conventional designs by considering the environmental impacts of design decisions throughout the entire building life cycle, from cradle to cradle instead of from cradle to grave. It provides comprehensive examination of all aspects of building design including site selection, energy conservation, waste minimization, lighting and use of renewable energies. Sonnet, ed. (2011)'s definition agrees with (Sassi, 2006) who defined sustainability in architecture as the architecture that seeks to minimize the negative impact

of building by efficiency and modernization in the use of materials, energy and development of space, which uses a conscious approach to energy and ecological conservation in the design of built environment, and whose idea is to ensure that our actions and decisions today do not inhibit the opportunities of future generation.

An in-depth study and analysis of these definitions postulated by knowledgeable experts in the field, reveals that green buildings, sustainable buildings, energy efficient buildings, smart buildings and high performance buildings are of the same common purpose since all are tailored towards providing a better today and sustained tomorrow, thus the only gap between sustainable buildings and green buildings remains that the sustainable buildings are integrals of the green buildings concept. This paper therefore adopted the name green building for ideal communication.

The Need for Green or Sustainable Design

All over the world, cities are becoming ever taller, ever bigger and ever more architecturally innovative. From concrete to steel structures that hover over 900 meters (2,700 feet) above earth to urban areas packed with more than twenty million people, humans have pushed inventiveness past the limit of what was ever thought possible (Henderson, 2012).
Innovations according to Energy Information Association (EIA2009) come with trade off, of which much of the fall out is environmental.

As documented in Henderson, in United States for instance Energy Information Association (EIA) noted buildings to account for 30% of the waste output of the country, which is about half of the energy usage and almost three quarters of the nation's electricity consumption. Many of these large impacts such as air pollution, energy consumption and water scarcity are created or contributed to in large part by the built environment of which buildings rank highest (Henderson, 2012).

Air Pollution

One can survive a few days without food or water, but only minutes without access to air. Air problem is easy to ignore by virtue of its typical invisibility, poor air quality in buildings often takes the form of fine particulates, toxic emissions and mold. A common contributor to poor air quality is increased volatile organic compounds (or VOC) emitted as gasses by everything from paints to building materials to furniture to cleaning supplies. Energy production, consumption and leaching of toxic building materials can affect air quality as well. All of these air concerns can cause serious health problems, such as asthma, upper respiratory illness, development issue in children and even cancers (Henderson 2012).

Energy consumption

Energy is central to the mechanics of most buildings. Air cooling, heating, lighting, cooking and electrical needs all require energy to function. Environmental energy concerns range from the limited resource of fossil fuels to climate change impacts, which have been argued to contribute to rising sea levels, changing food supplies, and the eventual specter of displacing millions of people (Henderson, 2012). Reducing energy use in buildings saves resources and money while reducing pollution and CO_2 in the atmosphere (Means, 2011).

Water Scarcity

Water is one of the most essential elements for human survival, used for everything, for drinking, hygiene, cooking and tending crops. Indeed a person can only live for two to ten days without water (USGS 2011). But the planets supply of fresh water is rapidly dwindling and our needs for it are quickly expanding. According to 2009 research report by Mckinsey and company, global water needs will increase by 40 percent by the year 2030, while shrinking water shades, droughts and rising sea levels are at the same time resulting in decreasing world supplies (Mckinsey, 2009). The building remains an end point to water supply.

Environmental needs

Environmental issues are enough to persuade one on the importance of going green. There are also myriads of businesses and financial benefits to take into consideration such as;

1. Building owners could get higher returns on their investment as there is less need for expensive building upgrade cost when green regulation takes effect, and additional money is saved.
2. Money and health are preserved, as better building health is demonstrated, which results in better inhabitants' health, thereby reducing absenteeism for illness, increasing work productivity and test scores, and ensuring long term retention. Green thinking is better for the inhabitants and the environment. The architect and other environmental activists especially in developing nations should hurry therefore to queue in with developed nations in making green building ideology a way of life. This they could start by creating energy efficient buildings.

Accordingly, Alozie (2014) in a study "Sustainable Environment" observed that for effective result in sustainability, energy must be conserved. He noted that the easiest way to solve "energy problem" is not to augment energy supply, but to reduce the amount of energy needed , as in buildings, great opportunities lies in simple solution that intelligently respond to location and climate. He noted for instance the case of North American sites where simple facing of the long side of building within 15 degrees of the true south and using proper shading to block summer but not winter sun, can save up to 40% of the energy consumption of the same building turned 90 degrees.

Alozie agrees with Means (2011) who concluded that orienting buildings to optimize solar gain (in Northern Hemisphere for instance maximizes the southern exposure). Also produce shading devices, and that taking advantage of prevailing summer breezes will maximizes energy consumption, in buildings. Logically, Means (2011) called this approach to energy conservation the "Integrated Design", which makes use of the sites natural resources, technological efficiency and synergies between systems.

Means (2011) argued that once the building's envelope is efficiently designed to reduce heat flow, natural heating and cooling methods can be used to greatly downsize, or even eliminate fossil fuel based mechanical heating and cooling. He enumerated techniques that could be used in integrated design approach to include daylight, solar heating, and efficient and right sized HAVC systems. Other efficient cooling methods listed also by Means (2011)

are multiple techniques for natural ventilation and cooling, such as

1. Including the chimney and evaporative cooling mechanism during design in hot dry climates
2. Making use of earth sheltering and earth coupling, this takes advantage of the vast thermal mass of the ground that remains at constant temperature at a certain depth below. This may vary dependingon climate. Earth sheltering can also protect the building against inclement weather such as wind.
3. Taking advantage of the thermal Mass, in climates with large diurnaltemperature swing such as in northern Nigeria town of Bauchi, Thermal mass cooling can be accomplished by allowing cool nighttime air to flow across a large indoor building mass, such as slab,the cool thermal mass then absorbs the heat during the day.
4. Radiant cooling is also effective in hot dry climates, whole evaporative cooling works well for humid climates.
5. Renewable Energy. (The wind, tidal and biomass are all derived from solar energy, the architect and his allies should employ these abundant energy source effectively, just like the early GreeksArizonas of America and Romans did when faced with energy crisis.
6. Recycling (Re-use). The need for energy to be recycled (reused) must be developed; this means collecting and re-energizing your energy waste for use again.
7. Environmental sensitivity; environmental awareness among the populace, especially the developers and designers on the benefits of green or sustainable projects, must be emphasized.

Actualizing Green Projects

Energy efficient buildings are integral of the green building ideology, and to actualize or develop energy efficient buildings, the client must submit totally the conceptualization and development of the structure to the architect and other professionals in the industry. The client, architect and his allies should employ the following green potential as listed below by Alozie (2014) in a study of "Thermal Comfort and Energy Efficient Buildings".

1) The engagement of the architect and other professionals from design inception to delivery. This ensures that,
   a) That buildings are designed and raised on site in agreement with the local climate, and will guarantee the buildings are developed to have;
      i. Good orientation to the prevailing climate factors.
      ii. Proper zoning of spaces according to functional needs example all, living spaces such as bedrooms and parlor are zoned away from direct sun influence, that many create unwanted indoor heating.
      iii. Proper choice and placement of windows, in order to take proper advantage of the prevailing air movement to offer satisfactory openings for ventilation.
      iv. Proper design and specification of materials in landscaping, of the environment, which should include trees for shading and grasses to help absorb heat.
      v. Right specifications of building materials and their application on site.
      vi. Observing building codes and regulations such as
         a. Keeping to permissible set-backs from other structures.

b. Regulation of building heights, and theprovision of required floor areas in all spaces.
c. Ensuring that plots of land are not over designed or developed.
d. Keeping low fencing walls for free air flow and relationship within the structure and the environment.
e. Advising the client in all building matters.

Recommendations

Since the passionate appeal for green buildings is made to the architect and other designers in built environment, it becomes very important that the architect and his allies recognize that;

1 An understanding of environmental issues particularly in terms of climate, concept and principles must be present at the beginning of the design process, so that it can inform the initial schematic activities of the architect and other environmental designers.

2 Responding to critical environmental issues must be at the core of any effective project, not merely an applied accommodation added later.

3 For sustainable innovations in the delivery of architectural products, the commitment of environmental designers, architects, landscape architects and urban designers to the enhancement of human experience can be realized through designs that are both aesthetically pleasing and socially meaningful and to accomplish this effectively, designers must have an understanding of science and technology in addition to sensitivity for composition and form (Smith 2011).

4 It has become increasingly clear that an attitude in many segments of various design professions is "one of complacent lasses faire, whose aesthetic expression is a general eclecticism. This attitude therefore must be dropped and completely replaced by a more active, original and research purpose oriented one, if notable success is to be made in development of green or sustainable built environment.

5 The observed obvious situation that saw a degradation in the fundamental responsibility of many designers rather than enhancing the natural environment and also the unattended flaunting of plagiarism of architectural products should stop and be replaced by more lively attitude. One of originality and of increasing contribution to the development and sustainability of the environment, as in architects' line of duty, no two sites are exactly the same, and if form must follow function their designs must differ.

Conclusion

Green building, also known as sustainable building and sometimes called high performance building is a major trending issue in the worldof built environment that has continued to evolve with technology. It becomes pertinent, therefore for architects in Nigeria and other developing nations to queue alongside their counterparts in developed nations in adding their ideas to this noble course of cleaning the world's environment from pollution, while replacing the displaced with green and sustainable ideas. This is not optional, for the many benefits that follows it. It is obvious that when we think green, design green, construct green,

deconstruct green, we then have green or sustainable built environment. Then as defined earlier by (Henderson 2012) we ensure that we live well, our children, their children and children-children also live well and our architecture lives from cradle to cradle and not cradle to grave. That is sustainability. That is green design; that is the evolving trend in the design of sustainable built environment.

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