



GREEN BUILDING AND ENVIRONMENTAL SUSTAINABILITY: THE ROLE OF THE ARCHITECT

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ABSTRACT:

This study is about Green building and environmental sustainability and the role the Architect plays in harnessing the synergy between the two concepts in addressing the ever increasing distortions in the climatic and environmental balance. The discourse on environmental sustainability remains both a regional and globally-relevant phenomenon especially now that Nigeria and other nations of the world are poised to address the negative consequences of man's unbridled exploitation of the natural resources available to him; hence the adverse effects of climate change. Green Architecture or green buildings or ecological Architecture which are buildings designed and constructed according to energy saving criteria and for the reduction of pollution is now an evolving phenomenon in the struggle for environmental sustainability. The rapid growth in development during the last couple of decades did come with active construction activities which in some instances neglected the impacts on the environment and human health and activities. The concept of organic architecture (green architecture) was the fundamental or guiding concept of great architects like Franklyold Wright (1867 - 1957) but it has now been identified and recognized as a veritable approach towards environmental sustainability. Use of ecofriendly regenerative design approaches such as courtyards, integrative design approach, use of building materials that reduce carbon emissions, energy conservation through recycling and re-use methods to ensure maximum energy efficiency are all part and parcel of the discourse on green architecture and by extension environmental sustainability. The data for this study were collected from both primary and secondary sources, hence the study adopted descriptive design in its investigation. It was discovered that with the right policy in place, Green building practices will help in the efforts towards environmental sustainability; therefore the paper recommends that designers in the built environment should employ more of the concept of green architecture and it should be incorporated into the National Building Code in Nigeria.

Keywords: Green Building, Environment, Sustainability, Environmental Sustainability.

INTRODUCTION

Nature has endowed the environment with various quantities and qualities of resources; thus man has come to regard his environment as a depot for housing his needs and because his wellbeing is dependent on the environment, he is ever evolving ways of extracting or exploiting the available resources to his advantage. In natural systems such as man, animals and plants, nature has perfected an automatic and

highly efficient maintenance system. The process of cell regeneration to effect healing, secretion of fluids to continuously lubricate and protect various parts of the body, just to mention a few, are examples of natural maintenance activities which are highly efficient and which go on continuously to ensure that the systems remain unaltered or rather sustainable.

Man from earliest times has been concerned with efficient services and durability of the resources available to him and not with their sustainability, hence the concomitant depreciation of these natural materials which throws up some adverse effects on the environment. Such adverse effects includes the depletion of the ozone layer leading to global warming. 'The ozone layer is the region of the upper atmosphere, between roughly 15 and 35 kilometers (9 and 22 miles) above Earth's surface, containing relatively high concentrations of ozone molecules (O₃)' (Donald Wuebbles, 2024).

The atmospheric region extending from 10 – 18 km (6 – 11 miles) to approximately 50km (about 30 miles) above earth's surface is known as the stratosphere which harbours about 90 percent of the atmospheric ozone. This ozone layer is under constant depletion when chlorofluorocarbons and hydro chlorofluorocarbons are released into the atmosphere. These chlorofluorocarbons and hydro chlorofluorocarbons are fully or partly halogenated hydrocarbons that contains carbon, hydrogen, chlorine, and fluorine, produced as volatile derivatives of methane, ethane, and propane. These gases cause chemical reactions that break down ozone molecules, reducing ozone's ultraviolet radiation-absorbing capacity, thus causing global warming. 'chlorofluorocarbons (CFCs) cause significantly stratospheric ozone depletion and global warming relating to the greenhouse effect'.

Francis A. Carey, in his article on chlorofluorocarbon (CFC), stated thus 'stratospheric ozone shields life on earth from the harmful effects of the sun's ultraviolet radiation; even a relatively small decrease in the stratospheric ozone concentration can result in an increased incidence of skin cancer in humans and genetic damage in many organisms'. We are the Architects of what we are suffering because human activities cause ozone depletion and global human warming, hence the nations of the world have of recent started looking towards alternative sources of energy other than fossil fuels to ameliorate the problems. Smoke emanating from heavy industrial complexes and automobiles are now being controlled in order to reduce their effect on the environment and make for a sustainable living environment and development. Professionals in the built environment such as Architects are beginning to make paradym shift in conceptual approach towards green architecture which has come to be regarded as a sine-qua-non for environmental sustainability.

In the 1960s the concept of ecological Architecture was introduced into the environmental landscape and the energy crisis of 1970s brought about the creation of renewable energy resources among which are solar, geothermal, wind energy and better energy efficient buildings. In the year 1980 'sustainable development' as a building concept was formulated and some developed countries had started elaborately implementing energy-saving building systems. The united kingdom introduced the world's first green building standard and the United States of America followed almost immediately by the formation of the U.S Green Building Council in 1993.

'Ecological Architecture is a concept that combines environmental science and architectural science' its focus is on development model that focuses on the harmonious balance of the natural environment and artificial environment. Maulina D.P et al. (2022).

Ecological Architecture also refers to 'Sustainable Architecture', hence we often talk about sustainable architectural design or Eco Architecture or Eco-friendly Architecture. By definition, Eco Architecture

describes Architecture which is heavily focused on reducing the carbon footprint of the construction and life of a building, area or volume of space, Acres Architects, (2015). To have as little impact on the environment as possible is the goal of Eco-architecture rather than destroying natural habitats to make way for new construction be they buildings or whatever. In sustainable building and design the focus is to ensure that new projects are being built in and around habitats to ameliorate the effects on wildlife and nature.

In discussing Green Building or Green architecture, Ecological Architecture, or Eco-friendly architecture or organic architecture the end product or the focus is to make the environment friendly to human existence and this focus may not be achieved if efforts are not made to support, manage, sustain the environment.

Statement of Research Problem

The environment where we live and perform our day-to-day activities is experiencing some negative imbalances occasioned primarily by the actions of man himself. World population growth and the scramble for the available natural resources is impacting heavily on the capacity of the natural ecosystem to continue to endure and if measures are not put in place to arrest the ugly trend, mankind would be worse for it.

To address this research problem, the study aims to propose a set of measures which the Architect as a primary player in the built environment can employ to come up with the designs and structures that align with the world commitment to sustainable development and a greener future.

Research Objectives:

The objectives of this research include:

1. To assess the factors that are at play in causing environmental problems which gave birth to green building and environmental sustainability principles.
2. To propose measures which government, corporate entities, players in the built environment, organizations and individuals can adopt to create a better environment for the present generation and for those to come after.

Research Methodology:

The research method utilized in this study is the descriptive survey, data were collected from both primary and secondary sources. The primary sources were through informal discussions and interviews with some staff in the department of Architectural Technology Akanu-Ibiam Federal Polytechnic, Unwana Afikpo Ebonyi State, and practisioners in the built environment. The secondary data involved a review of related literature on the environment, sustainability, environmental sustainability, Green Architecture.

LITERATURE REVIEW: ENVIRONMENT

The term 'environment' is a broad term which can be defined in varied ways because the term is used differently by people in different fields of knowledge. Electromagnetic environment is radio waves and other electromagnetic radiation and magnetic fields; the environment of a galaxy may mean the

interstellar medium, or it may mean other nearby galaxies. In the field of medicine and psychology; the people, physical things and the areas that the person lives with is the person's environment. These varied views in defining the term environment has presented its own difficulty in defining exactly what is meant by the term. However, generally speaking, defining environment from the perspective of public discussions concerning energy especially the negative consequences of energy, the English dictionary defined it as 'The natural world or physical surroundings in general, either as a whole or within a particular geographical area, especially as affected by human activity'. Whether positively or negatively, the environment impacts on human beings much like human activities have impacts on the environment. It follows that a person's behavior, body and mind, growth and development are affected by the environment; also the weather, climate changes in the environment affect the state or conditions of living organisms in that environment.

The Merriam-Webster Dictionary (1828) defines environment as 'the condition that surround someone or something'. It also says the environment is the 'natural world' or 'the complex of physical, chemical, and biotic factors (such as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine its form and survival'.

The Cambridge Dictionary defines environment as 'the air, water, and land in or on which people, animal, and plants live' or 'the conditions that you live or work in and the way that they influence how you feel or how effectively you can work'. So environment can be defined from the perspective of nature, surroundings, that is from the physical realm thus:

'The surrounding conditions and elements with which a living thing interacts with'.

Man lives and interacts with the environment and his actions and inactions produce what is generally referred to as the built environment and these behaviors of man on the environment throw up their consequences either positively or negatively. Human beings; having developed advanced tools (technology) to alter some aspects of his environment and which he introduced all through the world has equally introduced some negative phenomena affecting some aspects of the environment. Some of these aspects of the environment which can also be referred to as the basic components of the environment include the following:

- A. The atmosphere or the air
- B. Lithosphere or the rocks and soil
- C. Hydrosphere or the water
- D. Living components of the environment or the biosphere
- E. The solar energy

IMPACTS OF HUMAN ACTIVITIES ON THE ENVIRONMENT

The impacts humans have on the physical environment are as follows: Over population, deforestation, pollution of all kinds, burning fossil fuels, light pollution, run off (which occurs when there is more water than land can absorb). Climate change including global warming brings about acid rain, photochemical smog and other forms of pollution. These negative impacts are termed generally as environmental impacts; hence it is defined as 'Any change to the environment, whether adverse or beneficial, resulting from a facility's activities, products, or services. The biggest environmental impacts (negatively) can be summarized under the following headings:

- Waste disposal
- Ozone depletion
- Pollution of all kinds
- Acid rain
- Global warming
- Water scarcity
- Desertification
- Ocean acidification

Some of the above problems are natural while some are as a result of the actions of humans hence the search for the solutions so as to mitigate against these impacts.

It has earlier been stated in this paper that humans impact on the physical environment include over population, pollution, burning fossil fuels and deforestation, so how does that happen and what are their consequences.

• **Over population:** This is the state whereby the human population rises to an extent exceeding the carrying capacity of the ecological setting. Sopia Madaan, (2020).

There is a huge housing deficit in housing stock in Nigeria because the country is finding it extremely difficult to house its teeming population. Very many people are struggling for the essential necessities for survival which includes transport, water, shelter, food, social amenities.

Other consequences of overpopulation include depletion of natural resources, increased loss of habitat, increased climate and global warming, loss of biodiversity, depreciation of fresh water owing to over pollution and unaccessibility, reduced life expectancy and low level quality of life, emergence of new disease pandemics and epidemics, intensive farming practices, rise in unemployment, crime rate and violence: Sonia Madaan (2020).

• **Pollution:** Pollution is the addition of any substance (Solid, liquid, or gas) or any form of energy (such as heat, sound, or radioactivity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form. Jerry A.N (2024). Different kinds of pollution exists but the major ones include air pollution, water pollution and land pollution.

However going into their specifics we talk of noise pollution, light pollution, plastic pollution, every form of pollution has its negative impacts on the environment and wildlife as well as human health and well-being. Humans cause air pollution through the activities that they engage in and the primary sources of these human-made air pollution include the following; Vehicle emissions, fuel oils and natural gas to heat homes, by-products of manufacturing and power generation, particularly coal-fueled power plants, and fumes from chemical production.

• **Burning of fossil fuels:** This refers to the burning of oil, natural gas, and coal to generate energy which we use to provide electricity and to power our homes, factories etc. Fossil fuels are formed from the decomposition of buried carbon-based organisms that died millions of years ago.

These produce deposits which are rich in carbon which can be extracted and burned for energy.

These carbon deposits are non-renewable and humans depend on them to make plastic, steel and many other products. Clientearth (2022).

The burning of fossil fuels releases big amount of carbondioxide (a greenhouse gas) into the air and these green house gases released trap heat in the atmosphere which results in global warming. Greenhouse

gases (GHGs) are gases in the earth's atmosphere that trap heat. (National Grid 2023). Burning of fossil fuels leads to land degradation, critical wildlife habitat land that is crucial for breeding and migration ends up fragmented and destroyed. Coal, oil and gas development pose myriad threats to our water ways and ground water. For instance, coal mining operations wash toxic runoff into streams, rivers and lakes and dump vast quantities of unwanted rock and soil into streams causing water pollution. Fossil fuels also emit harmful air pollutants long before they are burned. Melissa Denchak (2022).

• **Deforestation:** Deforestation is the action or process of clearing of forests (Merriam-Webster Dictionary). The clearing of forests to create space for agricultural purposes, grazing land, source wood for fuel, manufacturing and construction has led to deforestation of some areas that were hitherto flourishing with green vegetation. Therefore 'Deforestation is the purposeful clearing of forested land'. Morgan Stanley (2023). Deforestation also refers to the decrease in forest areas across the world that are lost for other uses such as agricultural crop lands, urbanization, or mining activities. Joumatter (2020).

SUSTAINABILITY

Sustainability has acquired great importance due to the negative impacts of various developments on the environment. The rapid growth in industrialization during the last centenary has been accompanied by active construction and human activities which in some instances neglected the impacts on the environment, and these impacts which in some cases manifest negatively are what has made the environment not to endure.

Sustainability means meeting our own needs, without compromising the ability of future generations to meet their own needs. we must act responsibly so that the resources on the planet will be able to support many generations to come. They say that sustainability begins with you-act locally and think globally. There are limited amount of resources on the planet earth which are being exploited every day to produce houses, cars and computers and pretty much more. Other definitions of sustainability are as listed below;

AUTHOR

Daniel T.M (2023) In the broadest sense, sustainability refers to the ability to maintain or support a process continuously overtime.

United Nations (1987) The Brundtland Commission which is amongst the many committees set up to deliberate on sustainability defined the term as 'meeting the needs of the present without compromising the ability of future generations to meet their own needs'.

Egbon P.C at al (1996) Sustainability is the maintenance of capital of which there are three; the human-made capital (i.e houses, roads, buildings, the built environment); human capital (people's capability, knowledge), natural capital (that is natural resources).

Elizabeth C. at al (2023) Environmental Sustainability is defined as the 'responsible management of natural resources so they will still be available in the future'

ENVIRONMENTAL SUSTAINABILITY

When the word environment is joined or coupled to sustainability, a new phenomenon is birthed which in its simplest meaning is the application of the elements of sustainability to the environment. The maintenance of the factors, and practices that contribute to the quality of the environment on a long-

term basis. A state in which the demands placed on the environment can be met without reducing its capacity to allow all people to live well, now and in the future.

The natural environment has a remarkable capacity to give itself new strength or energy and sustain or keep functioning, developing adequately. The use of laterite or mud in constructing houses is environmentally sustainable because if the building degrades eventually the laterite or mud goes back to mother earth and becomes part of the earth constituents, hence nothing is lost. When a tree falls, it is slowly destroyed and broken down by natural processes – bacteria, fungi, chemicals etc, adding nutrients to the soil. The nutrients in turn help sustain suitable conditions so that future saplings can grow.

The disturbance of the natural setting of the ecosystem throws up some consequences which in some cases can be negative. If nature is not disturbed it has the capacity to manage itself but the appearance of humans on the scene changes the narrative the moment he begins to exploit the natural resources provided by the environment. Natural resources are subject to depletion by the actions of humans, hence in the absence of the application of environmental sustainability principles, the environment can lose its viability.

Environmental sustainability is defined as the ability to maintain an ecological balance in our planet's natural environment and conserve natural resources to support the wellbeing of current and future generations.

Again environmental sustainability can also be defined as 'the responsible management of natural resources so they will still be available in the future'. Elizabeth C. et al, (2023). According to the letters of the United Nations environment programme, creating life choices that offer equal or even better line of living for on-coming generations is the summary of the programme of environmental sustainability; hence it strives to make better the status of the life of human beings and in the process avoid actions that may unnecessarily put pressure on the supporting ecosystems of the earth. So in environmental sustainability we interact with the earth in our day to day activities, avoid reducing both the quality and quantity of the earth's natural resources in such a manner that the ability of on-coming generations to meet their own needs and tackle life's challenges is not scuttled or put in harm's way.

Individuals, corporations and government bodies can help achieve the goals of environmental sustainability. Individuals can start by using less water, reducing the amount of meat one consumes, using reusable products. A corporation can achieve environmental sustainability by turning to renewable energy in their offices, factories and warehouses and cutting down on single – use plastics in their manufacturing processes. 'single – use plastic products include plastic and polystyrene food and beverage containers, bottles, straws, cups, cutlery and disposable plastic bags that are designed for or intended to be used once and discarded'.

They are not biodegradable. Single – use plastics (SUPs) have no reusability hence they cannot actually get recycled, examples include chips, biscuits, chocolate wrappers, poly bags, thermocol, tetra pack. 'SUPs are goods that are made primarily from fossil fuel – based chemicals (petrochemicals) and are meant to be disposed of right after use – often in mere minutes', Courtney Lindwall, 2020. These types of plastics are most commonly used for packaging, and service ware, such as bottles, wrappers, straws, and bags. However the use of these form of plastics come with a dangerous price to our environment which will be paying off for years. Our addiction to the use of plastics is impacting negatively on our oceans, wildlife and health.

Examples of environmental sustainability include the following;

- Using renewable energy
- Limiting waste and pollution
- Conserving water
- Using energy – efficient office equipment
- Reducing travel and travel emissions
- Creating products that are easy to recycle
- Constructing and maintaining sustainable buildings.

GREEN BUILDING

A building which can maintain or improve the quality of life of the environment where it is situated because of the manner of its construction and features is termed a green or sustainable building. It is anchored on the use of sustainable materials and technologies for the construction of buildings and other infrastructures. It uses less water, effective or functional energy efficiency, sustains or conserves natural resources, produces less waste, provides convenient and healthier spaces for its occupants. The U.S Environmental Protection Agency (EPA) defines Green building 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.’ archive..epa.gov.

Also known as sustainable building or high-performance building, the practice expands and lends more credence to the considerations in classical building design such as economy, utility, durability, comfort etc.

In the construction of green buildings, there are some factors that should be considered and they include; employing sustainable materials in the construction such as reused materials, recycled content and materials made from renewable resources; creating healthy indoor environments with negligible amount of pollutants; for instance using products that have reduced emissions, and making use of landscaping materials that have minimal water usage; This can be achieved by using plants that are native to the locality which also can survive without the need for extra watering. The policy of building green has some potential economic, social and environmental benefits.

ECONOMIC BENEFITS

- Prospective home buyers go out to look for the building that gives them value for their money which green building is in a better stand to offer, hence going green enhances a building’s marketability.
- In applying sustainable practices that ensure less use of resources such as energy and water, the overall cost of a green building from construction to throughout the life cycle as compared to a normal building is less.
- To reduce the cost of energy use in the building, the design and construction of a green building relies heavily on renewable energy hence the utilization of solar energy in its operations.
- Economically, green building is water – independent because in most cases it re-cycles its water usage.

ENVIRONMENTAL BENEFITS

- Green building ensures reduction in natural resource consumption because the principle of sustainability has made it possible for some of these natural resources to be re-cycled.
- Green buildings offer huge benefits to the environment because both in their design and construction natural materials are specified and used. These natural materials are more friendly to the environment.
- There is a decrease in the environmental impact of construction projects through the use of sustainable practices and this is one of the most important benefits of green building.
- Green building reduce carbon emissions, energy and waste; they conserve water because they use less; they also emphasize the use of safer materials and lower our exposure to toxins. The above benefits were possible through sustainable design, construction and operations of green buildings. Green building reduces carbon emissions and other green house gases and this attribute is about the most striking benefit of green building. 'Building operations and building materials contribute almost 40% of global carbon dioxide (CO₂) emissions'. Kiara, 2024.

SOCIAL BENEFITS

- Green building reduces the load placed on local utility infrastructure, hence it is good for the health of entire eco-system. It reduces impacts on human health and the environment.
- Following from the design, construction and operation of a green building, the indoor Air Quality (IAQ) is assured. It refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. It promotes good health and reduces some negative impacts.
- Through design, constructing and use of materials, a green building ensures health, comfort and safety for all its residents. Since the conditions in a green building are conducive, there is increased productivity for its occupants.

THE ROLE OF THE ARCHITECT

In general the word 'Architect' means several things to several people; he is understood as a designer, planner, builder, manager, but in Nigeria he is one who has been certified to engage in the practice of architecture and having undergone the requisite training for such; the certifying body being the Architects Registration Council of Nigeria (ARCON). The word 'Architecture' often includes design or selection of furnishing and decorations, supervision of construction work and the examination, restoration or remodeling of existing buildings.

The Oxford Dictionary of Architecture and landscape Architecture defined Architecture as the 'art and science of designing a building having qualities of beauty, geometry, emotional and spiritual power, intellectual content and complexity, soundness of construction, convenient planning, many virtues of different kinds, durable and pleasing materials, agreeable coloring and decorations, serenity and dynamism'.

The Nigeria institute of Architects (NIA) which is the umbrella body of registered Architects in Nigeria defined Architecture according to the definition of the Architects (Registration, etc) Act cap A19 laws of the federation of Nigeria 2004 which states that 'Architecture means the art and science in theory and practice of design, erection, commissioning, maintenance and management and co-ordination of all allied professional inputs thereto building or part thereof and the layout and master plan of such building or

groups of buildings forming a comprehensive institution, establishment or neighborhood as well as any other organized space enclosed or opened, required for human and other activities' (sdngnet.com/files/lecture).

Understanding the nature and extent of inefficiencies and negative impacts in the built environment helps drive the development of new approaches and technologies that can improve all aspects of a building's performance.

Architects must endeavour to help in the design and implementation of environmentally friendly building solutions that reduce the environmental effects of urban growth while optimizing energy and resource utilization. Also, Architects must aim at design strategies that are critical to shifting the construction environment towards sustainability.

As specialists in the build environment, Architects should promote Green building principles to achieve better environmental sustainability through providing vital advice to clients and developers on how to create structures that are both visually beautiful and environmentally sound. It is obvious that the building industry has a major role to play in ensuring environmental sustainability starting from the inception and laying out of design to its building materials and construction. Achieving green buildings and environmental sustainability requires critical consideration of the entire life-cycle of a building and design decisions taken at the inception affect all phases of a building project. It must be pointed out that decisions taken at the pre-building phase is critical since it largely determines what becomes of the other phases (building and post building).

The pre-building phase include the following; site selection, material selection, design integration, energy efficiency, water efficiency. Oluigbo (2015).

(a) Site Selection:

Site selection indicates the practice of new facility location, both for business and government. It involves measuring the needs of a new project against the merits of potential locations.

The Architect must make conscious effort to advice his client appropriately on the selection of site for his project; a site is selected on the basis of the demand of the construction-the demand being to achieve environmental sustainability. Choosing a site on which to locate a new home, office, commercial building etc, is not a simple task. Countless factors – natural, man-made, social and economic must be examined. Where we choose to build and how we build on a site have an impact on the local and global environments, ongoing costs (utility bills, maintenance) and on physical and psychological well-being. Whether selecting a site or working with an existing site, and whether the site is urban, suburban or rural, there are many aspects that can be examined with respect to how 'Green', that is how healthy for people and planet, the home on that site can potentially be.

(b) Material Selection:

Architects must contribute to the creation of more resilient and environmentally responsible structures through innovative strategies such as the use of sustainable materials. The common sustainable building materials are clay and sand. When mixed with water and usually, straw or another fibre, the mixture may form a cob or adobe. Udomiaye, et al (2021). Other materials commonly used are earth (as rammed earth or earth bag), wood (cordwood or timber frame/ postand- beam), straw, rice husks, bamboo and stone.

The characteristics of the green building material itself make up the design for Architects when planning sustainable design projects.

- Materials prescribed should be natural and be friendly to the environment.
- With regards to manufacturing, distribution, construction, renovation, demolition, the impacts should be relatively small.
- Sustainable materials should be those that can be re-cycled.

(c) Design Integration:

This involves the coming together and working together of the different professionals in the building industry namely; architects, structural engineers, contractors, electrical and mechanical engineers, quantity surveyors, manufactures of building materials etc, with the aim of designing and constructing a building to meet an expected goal or set standards. What is gained is higher quality and efficiency. Measures for sustainable design integration are as follows;

- Familiarization of design team members with sustainability concepts and basic sustainable building practices and philosophy.
- Exploration of opportunities for innovation with a collaborative, multi-disciplinary team.
- Incorporation of sustainability into the earliest design discussion.
- Inclusion of inputs from user groups, tenants, maintenance staff, and stake holders, to confirm design criteria. (Oluigbo, 2015).

(d) Adoption of courtyard system in design

A courtyard is an area outside a building that is framed and somewhat enclosed by walls. They provide small, private outdoor areas and are often nestled between buildings or tucked away behind them; Courtyards are common elements in both Western and Eastern building patterns and have been used by both ancient and contemporary architects as a typical and traditional building feature.

Courtyards are modifiers that improve comfort conditions of the indoor spaces and surrounding environment, they are considered as passive architectural techniques in desert environments which help to maintain indoor thermal comfort. One of the courtyard effects is in affording better natural ventilation to the building by providing space for air exchange between indoor and outdoor spaces. Idowu O.M et al (2016).

Courtyards serves as air wells, whereby the dense night air sinks. Also through convection current between the heated air that rises during the day and cool dense night air, the building is properly ventilated and warmed. Eketi (2015).

(e) Energy Conservation and Improved Energy Efficiency:

Architects must contribute to the creation of more resilient and environmentally responsible structures through innovative strategies such as the integration of renewable energy sources. Energy efficiency issues include energy conservation and improved building performance and comfort through effective use of controls and technologies, efficient lighting strategies and presence of on-site renewable energy systems. Oluigbo, (2015).

Energy conservation and improved energy efficiency can also be achieved through primary water source such as rainwater, rainwater re-use by use of cisterns for water storage, proper drainage systems by use of aqueducts to convey water from one location to another. The knowledge of energy use in buildings and its assessment framework is fundamental to understanding sustainable or green Architectures Energy consumption throughout the life cycle of buildings consists of embodied energy, operating energy, and demolition or decommissioning energy. Udomiaye et al (2021).

The Architect should involve energy efficiency measures aimed at reducing the amount of energy consumed while maintaining or improving the quality of services provided in the building. These measures can lead to;

- Reduced energy use for space heating and / or cooling and water heating.
- Reduced electricity use for lighting, office machinery and domestic type appliances.
- Lower maintenance requirements
- Improved comfort
- Enhanced property value.

CONCLUSION

Building and the associated practices of design, construction, operation, refurbishment, and demolition provide a platform through which one can observe the impact of humans on the planet earth and the dynamic conditions of human existence, hence the ideas of sustainability. Human beings are the architects of the adverse environmental problems the world is facing today. The burning of fossil fuels releases gases into the atmosphere which go to impact on the ozone layer, hence the global warming. Large areas of the natural ecosystem are set on fire for farming, industrial complexes and in the process natural habitats are destroyed and if the trend is left unchecked, the future generations may not have a place to call their own. The paper found that there seems to be an agreement among Architects, Engineers, clients with regards to the importance of addressing sustainability but though there are contradictions the paper was able to establish the nexus between environmental sustainability and Architectural design practices. Notably, specification and use of sustainable materials are a part of sustainable development, hence building material selection, building forms, space design, site design/management, and energy efficiency are the fundamentals of the sustainable architectural process.

RECOMMENDATIONS

The paper recommends as follows;

- Governments should encourage the policy of green building designs by including them in the national building code.
- Corporate bodies, institutions should domesticate the sustainability practices in their day-to-day business to contribute to making for a greener environment.
- Architects, Engineers and other players in the built environment should begin to make a paradigm shift in the manner of their designs by making conscious efforts to prescribe those materials and practices that make for a greener environment.

REFERENCES

- Acres Architects, (2015): *What is Eco-Architecture?* <https://www.acresarchitects.co.uk> 02-03-2024. 16:05.
- Cambridge Dictionary: *Environment / English meaning.* <https://dictionary.cambridge.org> 11-02-2024. 13:38.
- ClimateEarth communications (2022). *Fossil fuels and climate change: the facts.* <https://www.climateearth.org/news>. 14-02-2024. 14:54.
- Concepts and components of environment* <https://www.dspmuranchi.ac.in> 12-02-2024. 15:16
- Courtney Lindwall (2020): *Single-use plastics 101* www.nrdc.org. 27-02-2024. 11:24.

- Courtyard-Definition, Meaning and synonyms vocabulary. Com <https://www.vocabulary.com>cour>.....25-03-2024. 11:08.
- Donald Wuebbles, 2024: *Ozone layer/Description, importance and facts*. <https://www.britannica.com>sciences>. 09-02-2024. 12:53.
- Egbon, P.C, Morvarldi B., (1996): *Environmental Policy Planning*.
- Ekete, I.E. (2015). *Green Architecture as a means towards the implementation of 'Sustainable Development' in Nigeria*. Archysphere maiden edition, 2015.
- Elizabeth Coleman, Rebecca Gillarey (2023): *Environmental sustainability/Definition, Objectives and examples*. <https://study.com>lesson>enviro>..... 21-02-2024. 14:39
- Environmental Sustainability: Definition, Examples and more*. <https://simple.m.wikipedia.org>wiki>..... 13-02-2024. 08:55
- Environmental Impact: *Energy education* <https://energyeducation.ca>enviro>.....13-02-2024. 08:11.
- Francis A. cavey (2023): *chlorofluorocarbons (CFC)* <https://www.briotannica.com>science> 10-02-2024. 14:20
- Green building – *Basic information* <archive.epa.gov> 02-03-2024 17:51
- Idown, O.M.; Umar, B; Humphrey, S. (2016): *Effects of courtyard-vegetation on indoor air temperature in student hostels in a hot-dry climate* *Journal of the Nigerian Institute of Architects*, Abia State Chapter.
- Jerry A. Nathanson (2024): *Pollution* <https://www.britannica.com>science> 13-02-2024. 18:19
- Kiara, (2024): *The Benefits and Barriers of Building Green*. <https://www.greencitytimes.com> 04-03-2024. 15:50
- Learn Biology Online: *Environment – Definition and Examples*. 11-02-2024. 14:20.
- Maulina, D.P, Ima, R.N. (2022): *Concept of Ecological Architecture on the Design and Conservation of Lake ISTN Jakarta* <https://dinastipub.org>article> 27-02-2024. 13:49
- Melissa Denchak (2022). *Fossil fuels: The Dirty facts*. <www.nrdc.org> 14-02-2024. 15:30
- Merriam-Webster Dictionary: *Environment*. <https://www.merriam-webster.com> 11-02-2024. 12:25.
- Morgan Stanley. (2023): *Deforestation – national Geographic Society*. <https://www.nationalgeographic.org> 14-02-2024. 15:40
- National grid (2023): *what are greenhouse gases? GHG explained*. <https://www.nationalgrid.com>what>..... 14-02-2024. 15:10
- National Geographic Society: *Human Impacts on the environment*. <natyionalgeographic.org> 13-092-2024. 14:55.
- National Institute of Environmental Health Sciences: *Air Pollution and Your Health*. <https://www.niehs.nih.gov>agents> 14-02-2024. 13:06
- Oluigbo, S.N. (2015). *Sustainable Architectural Design Practice in Nigeria. An evaluation of the pre-building phase implementation in Lagos*. *Journal of the Nigerian Institute of Architects*. September, 2015. Vol. 1 and 2.
- Oxford Dictionary of Architecture and landscape Architecture*, 2nd edition, 2006. Pacific Northwest national Laboratory (PNNL): *what are green building?* <https://www.pnnl.gov>green-building> 27-02-2024. 16:11
- Press Room (2024): *Benefits of green building/U.S. Green Building*..... <https://www.usgbc.org>press> 04-03-2024. 15:35.
- Reducing Single – *use plastic pollution/ U.S Department of the interior* <https://www.doi.gov>reducing-sin>..... 27-02-2024. 11:08.

- Sonia Madaan (2020): *What is overpopulation?* Issuesonline.co.uk 13-02-2024. 17:18
- Sdngnet. Com/files/lecture 04-03-2024. 10:31 Sustainability: *Its meaning* <https://en.m.wikipedia.org> 18-02-2024. 12:43
- Udomiaye E; Edidiong U; Cheche, K.K; Muoghara R; Nwabuna N.P (2021). *Sustainable development: The Architect's Perspectives*.
Book title: *Sustainable Built Environment in Nigeria – concepts, theories and practices*.
- United Nations (1987). *Sustainability: What does it mean?* <https://www.twi.global.com>faqs> 20-02-2024. 12:19
- US EPA (2024): *Introduction to indoor Air Quality/ Us EPA*. <https://www.epa.gov>introductio>..... 04-03-2024. 14:36.
- What is Environmental Sustainability?* <https://www.microsoft.com> 21-02-2024. 13:50.
- What is sustainability? How sustainability's work, benefits* <https://www.investopedia.com> 18-02-2024. 14:01
- What is a green building?* <https://www.iberdrola.com>sustain>..... 02-03-2024. 17:26.
- Wikipedia: *Sustainability* <https://an.m.wikipedia.org>wiki> 20-02-2024. 12:49.
- Wikipedia: *Site Selection* <https://en.m.wikipedia.org> 05-03-2024. 9:58.
- Wikipedia: *Chlorofluorocarbon* en.m.wikipedia.org. 10-02-2024. 13:43.
- Youmatter, (2020). *What is Deforestation, Definition, Causes, Consequences, Solutions*. Youmatter.world. 10-02-2024. 13:43.