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**SUSTAINABLE BUILT ENVIRONMENT
AND CLIMATE CHANGE:
THE CHALLENGE OF POST 2015
DEVELOPMENT AGENDA**

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VENUE:
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TIME:
9:00AM - 5:00PM
DAILY

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OF TECHNOLOGY, MINNA

HOST:
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ASSESSMENT OF BIOCLIMATIC PRICIPLES IN THE DESIGN OF PUBLIC SPACES IN MINNA

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In the design of buildings for the past few decades, Architects have made attempts to develop or create strategies where human requirement and the building as a whole can adapt to the design of such buildings. Apart from building materials which these building enclosure are composed of, other factors like orientation have also been used to achieve a sustainable built environment. Other methods employed include the development of buildings Bioclimatic charts because different regions have different kinds of strategies adopted by them respectively. Bioclimatic architecture deals with the connection of a building to nature, how building takes into account the climate and environmental conditions to favour comfort within the buildings. The aim of this paper is to adopt the building Bioclimatic principles in order to assess the most appropriate building design strategies for office buildings in Minna. These will be achieved by assessing office buildings mainly within Minna city to find out the environmental impact associated with the buildings due to climatic change. The paper proves that, in a long term, Bioclimatic Architecture is profitable, Architects and the society need to be aware that in order to achieve the desired Sustainability, we need to respect the environment and the changes that occur in the climate, so that we can build based on these bioclimatic principles.

Keywords: Built Environment, Office Buildings, Bioclimatic, Sustainability.

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INTRODUCTION

Buildings constitute major parts in any city, be it public or private building. This is because buildings are major elements in the development of these cities and owing to the fact that people dwell and spend time within the confines of one form of building or the other. Buildings here refer to shelter. Shelter is a basic need and every individual in a city has a right to shelter. Its provision and adequacy should therefore aim at considering good quality in terms of protection, comfort, ventilation, lighting, privacy, amongst others. Various types of buildings have been identified such as, Federal government buildings (secretariats, offices), State Government buildings (State houses, offices), public buildings (private and government owned), airports, seaports, health buildings (hospitals, clinics, pharmacies), institutional buildings (Nursery and primary schools, Universities, colleges), commercial buildings (markets, supermarkets), residential buildings (High rise, detached, duplexes), office buildings (banks) and religious buildings (Mosques and Churches). It is worthy to say that residential buildings is highly dominated by humans and second to the residential buildings are office buildings where time is been spent outside the home to work. Therefore certain factors such as adequate space, flexible space, electrical systems, water system, and conducive environment all contribute to achieving comfort within these office spaces. According to Adedeji & Fadamiro (2012), the internal and external aspects of the workplace environment affects the workers level of comfort (visual comfort, spatial arrangement, security and overall workstation comfort). The general comfort and wellbeing of workers can greatly be influenced by the environment where they work; it is therefore needful to provide buildings and the spaces within these buildings with basic needs to get the best productivities for workers. The aim of this paper is to adopt the building Bioclimatic principles in order to assess the most appropriate building design strategies for office buildings in Minna. These will be achieved by assessing office buildings mainly within Minna city to find out the environmental impact associated with the buildings due to climatic change. Bioclimatic architecture deals exclusively with building design and materials to achieve energy efficiency. For building to be termed as sustainable, a creation of a comfortable environment is the most important factor. According to Jose (2015), it was identified that different from the past age when architecture required an environmental sacrifice, in this century of the environment, an architectural design which lessens the burden on the environment by using natural energy and can also be sustainable to time is required. The design and construction of these buildings are mostly done by professionals; architects, planners, builders as well as engineers. In design of these buildings, a number of factors influence the type of buildings, such as building materials, availability of land, building regulations and codes, concepts, climatic conditions, as well as environmental factors. Adedayo, (2010) stated that seeking users view in creating liveable environment for potential owners assist in meeting up their needs and aspiration, thus their satisfaction is expected to have been captured. Nowadays, what is common practice is that architects are forced to assume

the needs of the user of these offices, and design based on that and expects the users to get used to the offices provided for them, which in turn might affect the productivity of the workers.

BIOCLIMATIC DESIGN PRINCIPLE

Bioclimatic architecture is the type of architecture that connects with nature, the building in this type of architecture takes into account, the environment as well as climate, which in turns helps to achieve optimal comfort within the building space. It avoids every mechanical system, often regarded as support. Bioclimatic architecture therefore is not new; most of the traditional buildings work according to the principles of bioclimatic. These principles have worked over the years and still working, modern designs could benefit from careful integration of bioclimatic concepts and principle, making use of natural ventilation, passive solar design, and sustainable materials.

Passive Bioclimatic Design

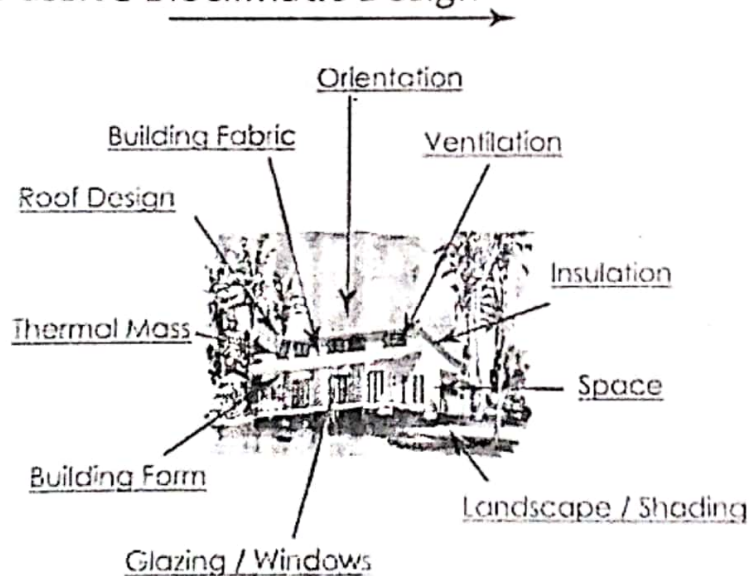


Fig 1 . Passive Climatic Design Principle. Source: www.eastcoastdesigner.com

Passive Solar Architecture

As seen in Fig 1, Passive solar architecture can be referred to as to housing design that makes use of efficient solar energy. As it does not use mechanical systems (thus the term passive), it is closely related to bioclimatic architecture, though the later also

deals with other non-solar climatic elements. That is why the term bioclimatic is a little bit more general, and inclusive, although both work in the same direction.

Active Solar Architecture

Active solar architecture refers to taking advantage of solar energy by the means of mechanic and/or electric systems for heating (solar collectors) and electric conversion (photo-voltaic panels). They may complement a bioclimatic house and off-set energy loads of the building's users.(Kane, 2012)

Renewable Energy

Renewable energy is Sources of energy that cannot be exhausted. Bioclimatic architecture incorporates solar radiation (renewable) for heating and cooling. Other kinds of renewable energies include wind or water (hydro), and methane generation from organic waste (biomass).

SUSTAINABLE ARCHITECTURE

Sustainable architecture uses the concept that aims to a minimum environmental impact of all the processes implied in building, from materials, building techniques (for a minimum environmental damage), building location/siting and its environmental impact, energy consumption and its impact, and the recycling of materials when the building has accomplished its function and is demolished. Bioclimatic architecture helps reduce the energy consumption of the building is in use, and can be enhanced when coupled with sustainability architecture techniques. Bioclimatic design measures are centered primarily on the climate of a specific area as thus:

- 1. Building envelope and orientation:** The orientation of the building and materials used can reduce the heat gain into a building especially during the hot periods. Therefore the building needs to be protected.
- 2. Sun shading devices:** the use of shading devices, either vertical or horizontal as the case may be can reduce heat gain into the building during periods of heat and the use of paints that do not allow solar rays from the sun to penetrate into the building can also be adopted.
- 3. Window openings:** the use of large window opening and type of window that will allow for balance and exchange of heat accumulated during the day for the natural and cool breeze at night. Also windows or other devices that collect solar energy should face within 30 degrees of true south and should not be shaded during the heating season by other buildings or trees from 9 a.m. to 3 p.m. each day. (Diana 2014)

4. **Indoor air quality:** The use of air locks installed in doors to reduce effect of heat as well as the introduction of green walls can improve the indoor air quality of the building.

5. **Landscape:** the climate around and within the building can be enhanced when trees and shrubs are planted, as well as the introduction of either natural or artificial water bodies around the building. (Kane, 2012).

BUILDING BIOCLIMATIC CHARTS

Building bioclimatic charts offers a convenient way to predict whether or not a passive cooling technique is likely to improve the level of comfort in a building. (NAI-Azri, Zurigat, and Nal-Rawahi, 2013). Bioclimatic charts facilitate the analysis of the climate characteristics of a given location from the viewpoint of human comfort, as they present on a psychometric chart, the concurrent combination of temperature and humidity at any given time. They can also specify building design guidelines to maximize indoor comfort conditions when the building's interior is not mechanically conditioned. All such charts are structured around, and refer to, the 'comfort zone'. The comfort zone is defined as the range of climatic conditions within which the majority of persons would feel thermally comfortable.

in the early 50s", different bioclimatic charts were developed among which are the Olgays bioclimatic chart as well as the Givoni's bioclimatic chart, just to mention a few, (Olgays 1963)

Olgays Bioclimatic Chart

Olgays Bioclimatic chart was one of the first attempts at an environmentally conscious building design. It was developed in the 1950s. The chart incorporated the outdoor climate into building design. The chart indicates the zones of human comfort in relation to ambient temperature and humidity, mean radiant temperature (MRT), wind speed, solar radiation and evaporative cooling. In order that comfort can be retained within the indoor spaces, wind speed can be offset to increase the indoor temperature. Another factor worthy of note with this concept was the use of Evaporative cooling, which was a means to retain comfort at high temperature values but at low humidity. This bioclimatic chart is applicable for hot humid climate such as Minna, because there is minimal fluctuation between the indoor and outdoor temperature. The concept of the chart was based on the outdoor climatic conditions. This resulted in some limitations in analyzing the physiological requirements of the indoor environment of the building. Therefore the chart is applicable to a hot humid climate since there are no high range fluctuations between indoor and outdoor conditions, (Olgays 1963)

Givoni's Bioclimatic Chart

It was aimed at predicting the indoor conditions of the building according to the outdoor prevailing conditions. He based his study on the linear relationship between the temperature amplitude and vapour pressure of the outdoor air in various regions. In his chart and according to the relationship between the average monthly vapour pressure and temperature amplitude of the outdoor air, the proper passive cooling strategies are defined according to the climatic conditions.

Prevailing outside the building envelope. The chart combines different temperature amplitude and vapor pressure of the ambient air plotted on the psychometric chart and correlated with specific boundaries of the passive cooling techniques overlaid on the chart. These techniques include evaporative cooling, thermal mass, natural ventilation cooling, and passive heating. It can be applied mainly to residential scale structures which are free of any internal heat gains. In 1970 he published his analysis of the Index of Thermal Stress, which was followed by Humphreys in 1978 and Auliciemes in 1982 with their Thermal Neutrality equations. All of their thought was brought together and they developed the concept that, depending on the location and the people of that location, there are, in fact, two comfort zones rather than one. The zones are based on thermal neutrality correlated to the outdoor mean temperature, (Givoni, 1963)

SUSTAINABLE OFFICE DESIGN

Sustainable design is an exciting area of architecture and building which is moving into the main stream (Martinez 2012). Productivity is gained in terms of better quality of work where office buildings have been designed to be more sustainable. A modern office building always manifests economic strength and a belief in the future, the office for majority, is the daily work environment for an employed citizen of the society, because an employee spends more than 40 hours per week within his office. The office space should then be designed to influence employees and their organization. Public office buildings here refers to a place open to the general public, they can have access to it and because different kinds of people can come and transact business within the offices. Office space can be grouped to be either an open office system or enclosed office system or a combination of both, what matters most is to provide an enabling environment for workers to be productive. The common practice of most public offices in Nigeria is a combination of both office systems.

STUDY AREA

Minna falls within the temperate humid region of the country. These conditions contribute to discomfort in both homes and offices. Public buildings are found next to residential development within the city. It is necessary when designing to reduce the amount of heat gain into these public spaces during the day as Minna is located within the tropics, in most cases the outdoor condition that is air velocity is low and this contributes to inefficient comfort ventilation. It is imperative to seek out designs strategies that will be efficient in office buildings within Minna as well as to maximize evaporative cooling to achieve thermal comfort for users of the public spaces, A survey was carried out within the Federal secretariat of the city, because of the number of offices found within the buildings. 37 parastatals within the city have their offices within the Federal Secretariat like the Civil Defense Commission, National population Commission, Public Control Commission, National Commission for Museum and Housing, NAFDAC, as well as the Prison Commission. Offices are allocated based on the strength of each parastatals. The least office space allocated to a parastatal is 6 different office types and the parastatal with the high population of staff like the Civil Defense Commission has about 15 office spaces allocated to them. The office types ranges from single office, to partitioned offices, double offices for heads of each parastatals.

RESEARCH METHODOLOGY

Primary and secondary data were used for this research. The primary data was gotten through the use of observation directly. The Federal secretariat was selected based on the population of the staff within this secretariat as well as the number of offices found within the building. The observation carried out was done with the use of an observation schedule. The schedule looked critically at the following parameters;

1. The number of people within the office buildings
2. Types of offices within the building
3. The heat gain into the building through the use of these element glazing, roof , wall, floors and windows.

The secondary data were collected from review of related literature

DISCUSSION OF FINDINGS

Table 1 : showing types of offices and number of staff in the office.

Office types	No of staff			
	1-5	5-10	10-15	15-20
Single office		•		
Partitioned single office	•			
Double office	•			
Large Office			•	
Partitioned large office		•		

Source: Author's fieldwork (2016)

From the table above, it can be deduced that, partitioned offices carried the least number of staff, the number of staff with the office space ranged between one to five. Next to that is the single office, which has staff between the range of five to ten, while the office with the largest population is the Large Offices which ranged between ten to fifteen staff. This implies that the number of staff within an office space contributes to the comfort within these spaces.

Table 2 : Rating of comfort within office spaces by staff of the National Museum and housing parastatal.

Office type	Very poor	Poor	Indifferent	Good	Very good	Total
Single office	0	1	0	5	2	8
Partitioned single office	0	0	1	4	0	5
Double office	0	0	0	3	0	3
Large office	2	3	1	6	0	12
Partitioned large office	0	1	2	5	1	9
Total	2	5	4	23	3	37
Percentage (%)	5.4	13.5	10.8	62.1	8.1	100

Source: Author's fieldwork (2016)

From the table 2 above, it can be observed that the number of staff who share office space can contribute to the indoor air quality of such an office. 62.1 % staff rated comfort within their office space as Good. While 5.4% rated very poor for the office space. The windows used within the complex building contribute to the amount of in air quality of the offices. Window used range from top hung projected window as can be seen in Plate 1, as well as louvers window as seen in plate 4, which contributes to about 90% of good window ventilation. Although over time, these windows have been said to be outdated . No matter the kind of window used, it should be located in such a way that the prevailing wind is been used to the advantage of the building.

Units That Allow Heat Gain

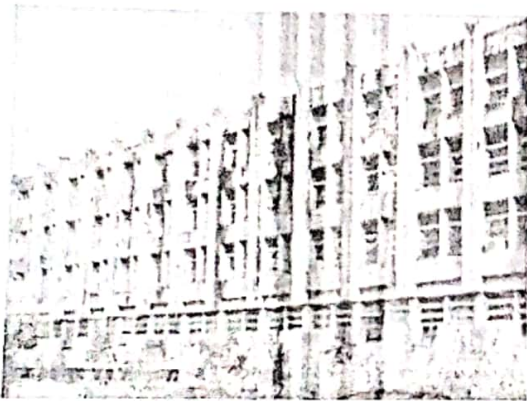


Plate 1: exterior view showing vertical Fins

Source: Author's fieldwork (2016)



Plate 2: interior view showing horizontal

Source: Author's fieldwork

From the observation carried out, solar radiation that gets in to the building is minimum because of the vertical fins used on the exterior of building as well as horizontal sun shading devices used within the interior of the complex. The use of courtyard has also been used to enhance the outdoor temperature, this implies that heat gain into the building has greatly not been influenced because of the external element used in the construction of the building,

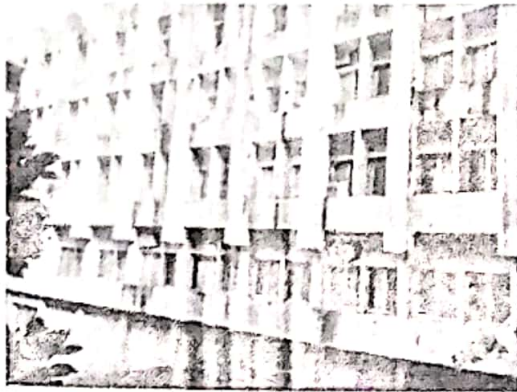


Plate 3: sliding windows
Source: Author's fieldwork (2016)



Plate 4: louvers window
Source: Author's fieldwork (2016)



Plate 5: interior view showing wooden partition
Source: Author's fieldwork (2016)

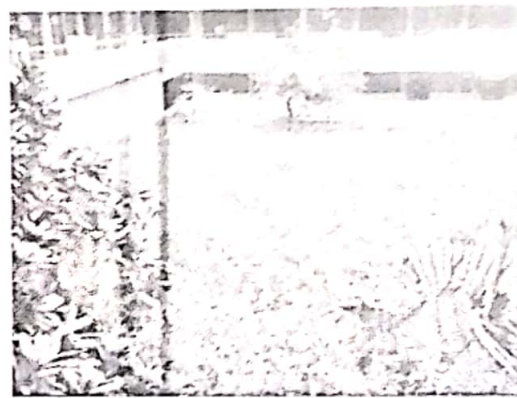


Plate 6: courtyard showing soft landscape
Source: Author's fieldwork (2016)

From plate 3 and 4, it can be observed that heat is accumulated indoor from the glazing of the building, but the type of windows used within the complex is the top hung projecting window, sliding window as well as louvers which gives 90% of air movement within the office space. It was also observed that sun has a direct impact on the roof; therefore the type of material used can help reduce heat gain into a building. The roof used at the federal secretariat is flat with parapets around it, making the roof hidden. Walls are also major source of heat gain for indoor spaces, although wooden partitions have been introduced to partition some large offices . it can be seen in Plate 5, that the rate of block walls used was high, this can retain heat during the day.

CONCLUSION

From the observation carried out in the research, the staff in the single partition offices and double offices have very good rating for the level of thermal comfort within their spaces. The large offices were very poor because of the number of occupants of their office. It was also observed that windows and type of doors used within the building has helped to a large extent the amount of heat gain into the building. This should be recommended for effective design and good thermal achievement in public buildings in Minna. Although the federal secretariat was poorly maintained, the use of courtyards and landscape have helped to improve the surrounding air and it has helped to cool the environment. However, before public buildings are designed or even built, the environmental impact of the building to the occupants as well as the environment should be greatly considered, because a healthy working environment determines the welfare and productivity of the users of the offices. The research has shown the need to consider users of these spaces while designing the magnitude of such a public building.

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