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THE APPLICATION OF PASSIVE DESIGN STRATEGIES AS SUSTAINABLE OPERATION AND MAINTENANCE IN A MODEL CONFERENCE CENTRES (A CASE STUDY OF AMINU KANO CENTRE FOR DEMOCRATIC RESEARCH AND TRAINING (AKCDR&T))

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ABSTRACT: *This research sought to reduce uncomfortable conditions created by extremes of heat and dryness in order to achieve well balanced indoor and outdoor climate, through the application of passive design strategies in Conference Centre located in hot dry climate of Kano Nigeria. Passive design utilizes natural sources of heating and cooling breezes. It is achieved by appropriately orientating the building on its site and carefully designing the building envelope (roof, walls, windows and floor). External features such as fountain, soft landscaping and proper site planning improves micro climate which in turn helped in achieving good passive design. The methodology employed is case study and relevant information sourced from pertinent literature and the internet was taken into consideration. Research has shown that more than40% of energy consumption in any building is used for cooling and lighting in order to achieve comfort level. In the course of the research, the building was studied to evaluate the use of passive elements that relates to passive lighting and cooling which are the main source of energy consumption such as building envelop, natural lighting, natural ventilation, Site and external spaces, building form, building orientation, wall/window shading and existing of energy source on conference centre building. Research has shown that, the design parameters obtained from field survey are the principal factors responsible for any good passive design of most public building such as conference centre building.*

KEYWORDS: Passive strategies, Conference Centre, Material of Building Envelope, Shading device, Thermal Mass, Building Orientation.

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INTRODUCTION

Passive design maximizes the use of "natural" sources of heating, cooling and ventilation to create comfortable conditions insides buildings (Thomas, 2012).It harnesses environmental conditions such us solar radiation, cool night air and air pressure differences to drive the internal environment. Passive measures do not involve mechanical or electrical system. Today, creating a thermally comfortable environment is still one of the most important parameters to be considered when designing public buildings such as conference centre. Due to the rapid growth in urban areas and global warming, the issue of thermal comfort conditions has gained great attention in our conference centre due to nature of gathering hundreds of people at a time.

Conference centre is a large building that is designed to hold, a convention where individuals and group gather to promote and share common interest. (Tourism, 2006).It is also offer sufficient floor area to accommodate several thousand of attendees. Conference is simply defined as very large venue suitable for major trade shows which are sometime known as exhibition centre.

Conference centre building uses significant amount of energy in their operations; cooling, refrigeration, Vertical and horizontal circulation and lighting in order to provide comfortable services to participants. In other words, these active design approaches cost a lot and leaves the conference centre not functional. Consequently, majority of conference centers are not fully utilized, due to running cost which cannot be afforded by many conference centers' management.

Alternatively, passive designs are often valued for their simplicity and aesthetic appeal. They also tend to have zero operational costs. As they often contain no moving parts, passive design last for centuries. However, despite the effort by many researchers to incorporate passive design approaches into building design, there is still minimal consideration of these sustainable approaches especially during design stages of buildings and considering the conference centers as public buildings that require lighting, cooling, refrigeration and circulations. The above requirements can easily be achieve through sustainable design strategies. To this end, the aim of the research is to reduce over reliance in active design strategies in conference centers which are not cost effective and environmentally friendly through the application of passive design strategies. The first objective of the research is to evaluate impact of integrating building with climate. The second objective is to determine which passive design variables are the most effective and applicable to public buildings more especially conference centre in hot dry climate of Kano city Nigeria.

LITERATURE REVIEW

Passive design refers to a rigorous, voluntary standard for energy efficiency in a building, reducing its ecological footprint. It results in ultra low energy buildings that require little energy for space, heating or cooling similar standard (Chiras, 2012). Passive design is not attachments or supplement to architectural design, but a design process that is integrated with architectural design, although it is mostly applied to new buildings, it has also been used for refurbishments.

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Passive design utilizes natural sources of heating and cooling breezes. It is achieved by appropriately orientating the building on its site and carefully designing the building envelope (roof, walls, windows and floor of a home). Well designed building envelopes minimize unwanted heat gain and loss. Passive design varies depending on particular attribute of the site (Thomas, 2012).

Buildings must be adapted to extreme summer/winter and day/night conditions to achieve a well balanced indoor climate (IPCC1995). Not only cooling is needed; passive heating may also be needed in winter and during cold nights. Protection is required from intense radiation from the sun, ground and surrounding buildings, from dust, sand storms and insect (flies). Glare has to be reduced and dust penetration prevented. Settlements and buildings, therefore, have to be compact, providing shade and controllable ventilation.

In the last half century, technological changes have had a major impact on urban forms and housing throughout the world. The introduction of the car into settlements has also drastically altered the traditional urban pattern of hot arid regions. The new wide street reduces the potential for shading. In addition, the great amount of heat discharging air conditioners and large paved surfaces have contributed to changes in the micro climate of urban situation in Nigeria and particularly Kano state. In addition, to the proper handling of climatic devices, and the limitations of passive means are problems which should not be neglected.

Hot-dry climate

Countries that are found in such climates are Nigeria, Niger, Egypt, Syria, Malaysia, Saudi Arabia, and United Arab Emirates. The climate of Kano (north western city of Nigeria) is hot-dry for most periods of the year. The mean daytime temperature for most stations in the Federal Capital Territory (FCT) is about 38ºC. The highest temperature of about 40ºC is normally experienced between March and June while minimum of about 30ºC are recorded in December and January (Ahmed, 2012).

Impact of passive design: The importance of passive design cannot be overstated. Paying attention to the principles of good passive design suitable for your climate effectively results in thermal comfort, low heating and cooling that reduced green house gas emission for the life span of any building more especially public building like conference centre.

Good passive design ensures that the interior remain thermally comfortable with the climate where they are built (McGee, 2013).Passive design utilizes natural sources of heating and cooling, such as the sun and cooling breezes. It is achieved by appropriately orientating the building on its site and carefully designing the building envelope (roof, walls, windows and floors of home). The following are passive deign dependent variables:

1. Planning aspect
2. Building envelope

1. Planning aspects

Analysis of the building site should be made to determine the following:

i. Site Analysis

Analysis of the building site should be made to determine suitability in respect to certain factors such as topography to check if it can be used for a building type; accessibility to check routes to get to site whether via roads or waterways; usability if the site could be buildable.

ii. Building Form

Gut and Ackerknecht (1993) have suggested forms with large surfaces rather than compact buildings as large surfaces favour ventilation and heat emission at night-time. The building forms should thus be open, outward oriented and built on slits. Givoni, (1998) states that building form largely depends on whether the building is planned to be air-conditioned or if it is intended to rely on natural ventilation.

iii. Building Orientation

Properly oriented buildings take advantage of solar radiation and prevailing wind. According to Gut and Ackerknecht (1993), the longer axis of the building should lie along east-west direction for minimum solar heat gain by the building envelope. Openings should be avoided on the west and if they cannot be avoided, they should be adequately shaded by using verandas and tall trees.

vi. Landscaping

Raeissi and Taheri, (1999) acknowledged the beneficial effects of trees. They stated that planting of trees can result in energy saving, reduction of noise and pollution, modification of temperatures and relative humidity and psychological benefits on humans. They also noted that trees can act complementary to window overhangs, as they are better for blocking low morning and afternoon sun, while overhangs are better barriers for high noon sunshine. Simpson and Macpherson (1996) have shown that tree shades can reduce annual energy for cooling by 10% -50%.

II Building Envelope

i. External wall

As the main goal in building design of tropical climates is reduction of direct heat gain by radiation through openings and reduction of internal surface temperature, the building should be designed with protected openings and walls (Gut and Ackerknecht, 1993). The walls can be protected by designing the roof so that it extends far beyond the line of walls and has broad overhanging eaves. Gut and Ackerknecht, (1993) argue that the outer surface of the external wall should be reflective and light coloured. Wong and Li (2007) from their study concluded that the use of thicker construction on east and west external walls can reduce the solar radiation heat gain and hence, the cooling load can be reduced by 7%-10 % when the thickness of external wall is doubled (229 mm concrete hollow block instead of 114 mm concrete hollow block).

ii. Thermal insulation

According to Bolatturk, (2008), thermal insulation is one of the most effective energy conservation measures for cooling and heating in buildings because it reduces heat transfer to and from the buildings. However, this view portrayed by Bolatturk, (2008) seems to conflict with those of Gut and Ackerknecht, (1993) and Yang and Hwang, (1993). Yang and Hwang (1993) have added that in warm and humid regions, condensation might occur and this would demean the thermal performance of the building envelope and cause mildew problems. Moreover, Gut and Ackerknecht, (1993) also note that thermal insulation has a dual nature. It reduces daytime excess heat entering a building, but averts the building from cooling down at night. According to them, this dual nature makes insulation unsuitable for buildings with natural climate control.

iii. Building material

Gut and Ackerknecht, (1993) recommend using the following building materials in tropical climates:

a) Burnt clay bricks can be used in tropical climates because they have good thermal resistance and good regulating property against humidity.
b) Timber has good thermal resistance and is a good regulator of humidity.
c) Matting of bamboo, grass and leaves are good because they are not airtight and allow proper ventilation.

Though timber was once used as a vernacular building material, it is no longer used because of the costs involved in seasoning timber. Bamboo, grass and leaves are temporary building materials and are not used in urban settings.

iv. Roof

The roof is an important element of design when it comes to conserving energy because this part of the building receives most of the solar radiation and its shading is not easy. conclude that the heat entering into the building structure through the roof is the major cause for discomfort in case of non-air-conditioned building or the major load for the air-conditioned building (Vijaykumar et al. 2007; Alvarado and Martinez, 2008) However, Gut and Ackerknecht, (1993) argue that this is true for single storied buildings and the top floor of multi-storied buildings.

v. Windows

Openings are important design elements for admitting daylight, air flow, providing cross ventilation and views. Liping *et al.* (2007) claim that ventilation and indoor air quality can be improved by increasing the window to wall ratios (WWR), but it would also increase solar heat gain.

vi. Size

Openings sizes are relevant in regulating movement of light, heat, cold, airflow into the building.

vii. Shading device

Watson and Labs, (1983) categorized shading devices into three categories namely solar transmittance of glazing materials, interior shading and exterior window shades. Solar transmittance is defined as the heat admitting or rejecting characteristic of the glazing materials. Watson and Labs (1983) and Gut and Ackerknecht, (1993) advice against heat absorbing, heat reflecting and tinted glazing. According to Watson and Labs, (1983) heat absorbing clear and tinted glazing reduces solar transmission by absorbing heat within the material itself. They state that the absorbed heat can be uncomfortable to occupants because it adds heat to the interior by conduction and thermal radiation.

viii. Natural ventilation

Ventilation is the movement of air. According to Watson & Labs (1983), ventilation has three useful functions in the building sector. It is used to:

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i. Satisfy the fresh air needs of the occupants
ii. Increase the rate of evaporative and sensible heat loss from the body
iii. Cool the building interior by an exchange of warm indoor air by cooler outdoor air.

Challenges of integrating local climatic condition on Conference Centre design

In tropical countries such as Nigeria, according to the world summit held in Johannesburg, 2001, thermal comfort of a person in these regions lies between 19 ºC and 24 ºC. Providing thermal comfort in this range to occupants is a challenge for building designers especially if applied to public building capable of accommodating hundred peoples at one time. Most conference centers buildings use air-conditioning systems to achieve thermal comfort, which consume a lot of energy. The primary function of conference centre building envelope is to protect the occupants of the building from the heat of the sun, rains, dust and provide a congenial environment for the main goal of conference centre that is knowledge sharing.

To achieve this, it is necessary that the design measures adopted should result in the balance of natural ventilation, space conditioning, and lighting. The first step towards achieving thermal comfort in such a large scale building is to integrate suitable bio-climatic design principles with respect to the region while designing the macroclimate and microclimate of the site.

Conference Centre: Conference center is a specialized facility usually in a less busy but accessible location designed and built almost exclusively to host conferences, exhibitions, large meetings, seminars, and training sessions (Bala, 2014).

Historical Development of Conference Centre: The first convention centers can be traced back to mid -19thcentury in Britain. Commonly known as exhibition halls, the centers were designed to bring together their mutual interest of a subject. Also, among the first historical convention centers constructed was the crystal place in London's Hyde Park. Providing 92,000 m^2 of exhibition spaces, the building was erected in 1851 to house the great exhibition; a grand show case of modern industrial technology and design. The trend continued up to where the need for dedicated meeting spaces different from traditional corporate environment, to a new breed of meeting venue; conference centers.

In Africa, for example, Cape Town conference centre and its associated facilities in South Africa covers approximately 6.100ha on the city of Foreshore and is within easy reach of Victoria and Alfred water front; major hotel and rest city centre (Thabo, 2003). Moreover, in Nigeria, The Abuja International Conference Centre (AICC) is the largest conference centre in Nigeria located along Herbert Macaulay way covering approximately 7.000 ha. The environment is serene and very good for conference and other activities and is bigger than the South Africa's conference center. It serves as center for both national and international events.

Kano, being the largest northwestern city of Nigeria, houses Mambayya house conference centre. The Aminu Kano centre for Democratic Research and Training, Mambayya house, Kano was founded in November 2000 as a research and training unit of Bayero University, Kano, Nigeria in the premises vacated by the defunct Centre for Democratic studies (CDS), which was established by the Federal Government of Nigeria in 1989. When it was scrapped in 1996, the Federal Government donated the building to Bayero University, Kano. The then secretary to the Government of the Federation, Alhaji Gidado Idris GCON, MNI, formally

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handed over Mambayya House to the former Vice Chancellor, Bayero University, Kano, Professor Musa Abdullahi, on March 3, 1999. The aerial view of AKCDR&T is shown below in plate 1.0

METHOD

This is basically a qualitative research. The objective of this research is centered on achieving sustainable conference centre through application of passive design strategies. The study adopted the case study research method, because this allows the researcher to explore and understand complex issues (Zaidah, 2007).

POPULATION OF STUDY

The population of study is with respect to the building and not its users, this is due to the nature of the variables and research method which is qualitative or objective. A case study research could either be a single-case deign (in which the case typifies a particular character) or multiplex-case design depending on the nature of the research (Zaidah, 2007). This research adopted the single-case design due to the buildings representation as an urban convention Centre. Also, due to time constraint, proximity, geographical location (hot-dry climate) and ease of collection of data, Kano State was purposely selected because it was extremely atypical or representative, information-rich, and its location being the state harboring Aminu Kano Centre of Democratic Research and Training (AKCDR&T) in the hot-dry region.

SAMPLING

Case study selection was comparable to sampling in a qualitative research and in which cases were usually purposely selected (Veal, 2006). This meant that cases were identified for study due to their inherent qualities which were in consonance with the phenomenon under investigation (Oluigbo, 2010). The sampling method used was a purposive and the building chosen as typical example of the particular character. Aminu Kano Centre of Democratic Research and Training (AKCDR&T) was purposely selected.

CASE STUDY BUILDING

The Aminu Kano Centre of Democratic Research and Training (AKCDR&T) building was the case study building, which is situated in Kano, Nigeria. This building is a one storey and constructed in 1989. It has 500 seats capacity auditorium, six (6) conference/seminar halls, library, restaurants, museum, loading, open spaces/parking spaces and administrative offices. The building total site area is 54,000sqm, the area of auditorium /seminar complex is 4,200sqm, library complex is 2,970sqm, Restaurant is 3,250sqm, museum is 600sqm, lodging is 880sqm, landscaped and open spaces is 4,800sqm and administration block is 1,200 sqm. The building form is hexagonal and rectangular in shapes. The hexagonal shapes are: auditorium/seminar complex, library and restaurant. While the rectangular shapes are administration block, lodging and museum. The building is elongated on the north-south axis [see plate 1]. It has concrete block walls of 225 mm thickness with extensive use of concrete as shading device and parapet walls, steel and glass material. All the windows are made of tampered glass which is reflective and double glazed. The roof is made with steel members and aluminum roofing sheet although some portion of it is concrete plat roof and drained with pipes at the exterior (see plates 1,2,3,4,5,6, 7 and 8).

Plate 1, an aerial view of CDS&T, Kano
Source: Mambayya House(2015)

Site planning

The surrounding of the centre is covered by hard and soft landscape. Interlocking tiles were used for walkways and drive ways as well as linking building units as indicated in plates (3.2 and 3.3). Grassed areas and plants were also used to beautify as well as cool the environment.

Plate 2. An aerial view of AKSDR&T.
Source: Mambayya house (2015)

Plate 3. Showing an aerial view of AKSDR&T.
Source: Mambayya house (2015)

Administration block

Administration block consist of administrative office, accountant, chief clerk's office and waiting room at ground floor while assistant director, director, chief typist and committee room are located at first floor plan.

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Plate 4, showing an aerial view of CDS&T, Kano.
Source: Mumbayya House(2015)

Plate 5, showing an aerial view of CDS&T, Kano.
Source: Mumbayya House(2015)

500 seaters capacity Sa'adu Zungur Auditorium

Sa'adu Zungur Auditorium complex consist of 500 seat capacity auditorium, six committee/seminar hall, offices and toilets as in figures below.

Plate 6, showing library entrance of CDS&T, Kano.
Source: Mambayya House (2015).

Plate 7, showing library entrance CDS&T, Kano.
Source: Mambayya House(2015).

Interior sides of Sa'adu Zungur auditorium

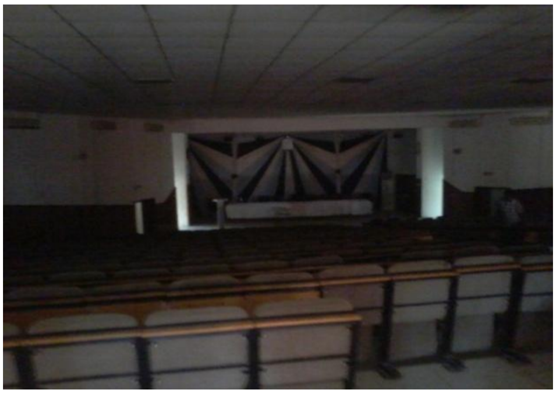

Plate 7, showing sitting arrangement, at auditorium Kano. Source: Mambayya House (2015

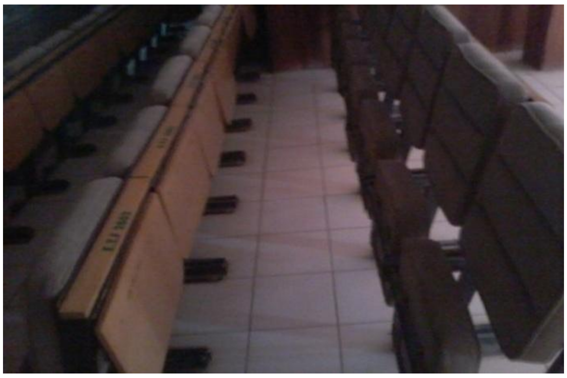

Plate 8, showing sitting arrangement, at auditorium Kano. Source: Mambayya House (2015)

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RESULTS

Data obtained from visual survey and pictorial analysis is presented in table and histogram chart was used to show the application level. The passive design variables are in y-axis while the level of application is on x-axis. Below is the table showing level of application of passive design strategies at AKCDR.

TABLE 1.0 PLANING ASPECT ASSEMENT
AMINU KANO CENTRE OF DEMOCRATIC RESEARCH AND TRAINING (AKCDR&T)
SCALE FACTOR; EXCELLENT =5, VERY GOOD= 4, GOOD =3, FAIR= 2,POOR=1 APPLIED AT

S/NO	VARIABLES	CHECKLIST	LEVEL OF APPLICATION					REMARKS
			1	2	3	4	5	
I	Site Analysis	Futures of site analysis such as: Trade wind, sun rise and sun-rise and sun set, accessibility to users, topography, services and climatic features ware all taken care to some appreciable extent.					✓	Administrative section of the centre was poorly oriented in which majority of building opening faces East and West direction.
II	Building form	Large surfaces provided at the centre favor ventilation and heat emission at night-time.				✓		Building form largely depends on whether the building is planned to be air-conditioned or if it is intended to rely on natural ventilation. Building form should improve natural ventilation.
	Building Orientation	The centre is oriented toward north and south axis, for longer sides.					✓	The centre achieved good orientation above average.
IV	landscaping	Pavement is used to demarcate the				✓		Water bodies should be introducing so as to lower and infiltrate the hot weather experienced in Kano city.
		soft landscaping applied improves micro climate				✓		
		Pedestrian circulation and soft landscaping improve the micro climate.			✓			

Source: (Researcher's work, 2017)

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TABLE 2.0 BUILDING FORM ASSEMENT
AMINU KANO CENTRE OF DEMOCRATIC RESEARCH AND TRAINING (AKCDR&T)
SCALE FACTOR; EXCELLENT =5, VERY GOOD= 4,GOOD =3, FAIR= 2,POOR=1 APPLIED AT

Source: (Researcher's work, 2017)

S/NO	VARIABLES	CHECKLIST	LEVEL OF APPLICATION					REMARKS
			1	2	3	4	5	
I	EXTERNAL WALL	Use of hollow block wall		✓				Thicker construction on east and west external walls can reduce the solar radiation heat gain and hence, the cooling load can be reduced by 7%-10 % when the thickness of external wall is doubled (229 mm concrete hollow block instead of 114 mm concrete hollow block).
		Use of massive concrete gutter				✓		
II	THERMAL INSULATION	Use polythene nylon		✓				Burnt clay brick and timber with coupled finishing Tyrolean should be used for optimal insulation.
III	ROOF	Use of long span aluminum roofing sheet.					✓	Green acoustic roof should be used for heat and sound insulation
IV	WINDOW SIZE	Use of wider openings from column to column and ordinary translucent glass was used.		✓				Tinted acoustic glass should be used.
V	.NATURAL VENTILLATION	Natural ventilation was not achieved more especially at sa'adu zungur Auditorium			✓			Acoustic control is paramount in auditorium than achieving natural ventilation.
VI	Natural lighting	Natural lighting was not achieved, due to poor planning more especially at Sa'adu zungur Auditorium.			✓			Design with climate should be adopted.

TABLE 2.0: SUMMARY OF FINDING FROM CASE STUDY AND INFORMATION GOTTEN FROM LITERATURE REVIEW GUIDED THE RANKING

S/NO	DESIGN VARIABLE	AKCDR&T	Percentage%
1	Design for Climate	9	25.7
2	Orientation	2	5.7
3	Shading Device	5	14.2
4	Passive Cooling	2	5.7
5	Passive lighting	3	8.6
6	Sealing building Envelope	3	8.6
7	insulation	3	8.6
8	Glazing	4	11.4
9	Sky light	3	8.6
	TOTAL	32	100%

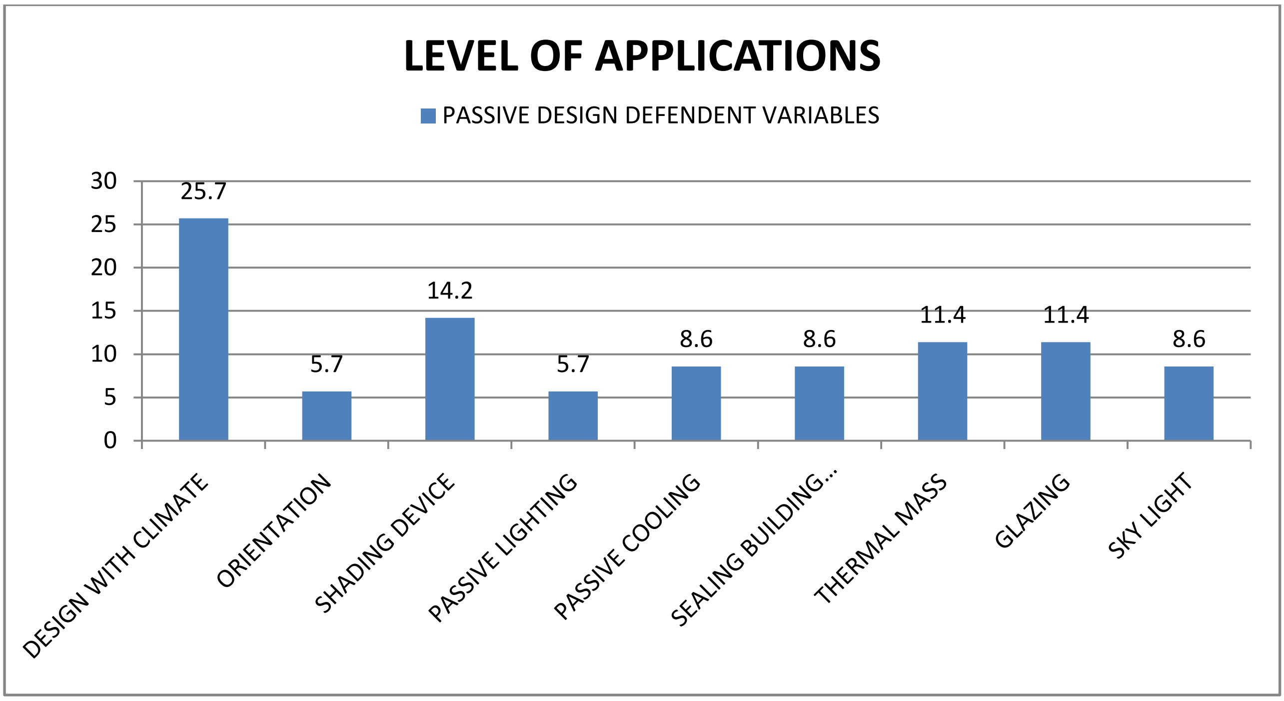

fig1. Showing passive design dependent variable applied at Aminu Kano Centre of Democratic Research and Training (AKCDR&T). SOURCE: Researchers work, 2017

FINDINGS FROM INTERVIEW

The researchers asked the following questions on Passive design parameters applied in Aminu Kano Centre of Democratic Research and Training (AKCDR&T). The respondent is the officer in charge of maintenance and general services to the centre.

1. Question no-1. What considerations were made during the orientation and planning of the building to help maximize use of renewable energy?

   Answer-Building was oriented toward north and south axis to avoid effect of sun rise and set. Overhang parapet wall and shading device were also used.

2. Question no-2. What considerations were made in the design of the building envelope which enhanced passive design application for sustainability purposes?

   Answer-little consideration was made at that point as hollow concrete blocks were used, although polythene insulation was applied. Long span aluminum Roofing sheet, aluminum, sliding window with ordinary translucent glass and plush doors were used.

3. Were there any considerations made to achieve adequate daylight in the center?

Answer-Day light was adequately achieved in administration block, restaurant and other facilities, but Sa'adu Zungur Auditor which is the heart of centre depend totally on artificial lighting.

4. What strategies did you employ to achieve natural ventilation?

   Answer- using large windows from column to column, except in auditorium which also depend to some extent on mechanical ventilation.

5. To what extent does the shape and form of the building help to minimize energy consumption?

   Answer. The building shape is not plat, thus help in reducing indoor overheating, which in turn requires energy for cooling.

6. What is the energy source of this facility and the consumption rates?

   Answer- The PHCN and Standby generators are main energy sources.

7. How sustainable is the current energy source of the facility?

   Answer-The current energy source is not sustainable as the PHCN is not reliable and standby generator consumes 5000 liters average/month.

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TABLE 1.0 ACTIVE DESIGN STRATAGIES USED AT
AMINU KANO CENTRE OF DEMOCRATIC RESEARCH AND TRAINING (AKCDR&T)
SCALE FACTOR; EXCELLENT =5, VERY GOOD= 4, GOOD =3, FAIR= 2,POOR=1 APPLIED AT

S/NO	VARIABLES	CHECKLIST	LEVEL OF APPLICATION					REMARKS
			1	2	3	4	5	
I	Orientation and Planning	Building was oriented toward north and south axis to avoid effect of sun rise and Set. Overhang parapet wall and shading device ware also used.					✓	The centre has good orientation.
II	Building Envelope	Little consideration was made at that point as hollow concrete blocks were used, although polythene insulation as applied. Long span aluminum Roofing sheet, aluminum, sliding window with ordinary translucent glass and plush doors ware used. .		✓				Densely bunt brick/ Tyrolean insulation should be used.
III.	Day light	Day light was adequately achieved in administration block, restaurant and other facilities, but Sa'aduZungur Auditor which is the heart of centre depend totally on artificial lighting.			✓			The Auditorium needed to e integrated with climate to achieve day lighting.
IV	Natural ventilation	using large windows from column to column, except in auditorium which also depend to some extent on mechanical ventilation				✓		The Auditorium needed to e integrated with climate to achieve natural lighting.
V.	Source of Energy and Consumption	The current energy source is not sustainable as the PHCN is not reliable and stand by generator consumes 5000 liters average/month.		✓				Renewable energy s
VI.	Sustainability of Energy	Energy source is not reliable.	✓					

Source: (Researcher's work, 2017)

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DISCUSSION

The following design parameters helped the author to evaluate the results obtained from field case study; these influences are explained in more detail in the following paragraphs as good passive design is critical to achieving a lifetime of thermal comfort, low energy bills and low green house gas emissions. Below is list of steps followed to arrive at good passive design:

I. Design for climate;
II. Orientation;
III. Shading;
IV. Passive solar heating and cooling;
V. Sealing building envelope;
VI. Insulation;
VII. Installation;
VIII. Thermal mass;
IX. Glazing and
X. Sky light.

I.Design for climate, good passive design ensures that the occupants remain thermally comfortable with minimal auxiliary heating or cooling. The research area is located in hot dry climate. These climates are characterized by a high diurnal temperature range and low humidity with discomfort caused either by high or low temperature. The design of walls roof should therefore moderate temperature fluctuation. Also soft landscaping more especially in eastern and western side of Sa'adu Zungur auditorium should be applied.

II. Orientation and planning: From the research, it was established that the longer sides of openings should ace North and South direction and minimize openings in east and west direction. This was achieved as longer side of AKCDR&T administrative block was oriented toward north and south direction (See plate 1.0).

III. Shading of the building envelope and outdoor spaces reduce summer temperatures, improve comfort and save energy (Ahmed, 2012). High temperature values experienced indoor in the Sa'adu Zungur Auditorium is seen to be with regards to limited number of openings (See plate 7.0). Horizontal and vertical shading devices were correctly applied at eastern and western sides of building envelope.

IV. Passive lighting. Inappropriate openings provided at Sa'adu Zungur Auditorium contributed to inadequate natural lighting which contributed to over reliance on artificial lighting. Larger windows from column to column should be provided to reduce the cost of using artificial means of lighting within the Auditorium (see plate 7.0).

V. Passive cooling; the factors that affect air flow through buildings are external features and factors, number and size of openings, position of openings and opening components. Air flow around building is determined by the shape, height, and orientation and planning of buildings. Inline to these, openings of Sa'adu Zungur Auditorium were good in orientation. Although number and sizes should be increased in the southern part of auditorium especially for effective natural ventilation. This will drastically reduce the amount of energy needed for cooling.

I. Sealing the building envelope. Air leakage account for 15-25% of winter heat loss. Buildings can contribute to significant loss of 'cool' in climate where air conditioners are used. Sealing the building envelope against the air leaks is one of the simplest upgrades to undertake to reduce energy bills and green house gas emission. Hence good insulation materials like fiber glass should be used.

II. Thermal mass is the ability of a material to absorb and store heat energy. A lot of heat energy is needed to change the temperature of high density materials such as concrete, bricks and tiles: these materials have high heat storage capacity and are therefore said to have high thermal mass. Light weight materials such as timber have low thermal mass.

III. **Glazing**. Glazed windows and doors bring in light and fresh air and offer view that connect interior living spaces with the outdoors. However, they can be a major source of unwanted heat gain in summer and loss in winter. Up to 40% of a building heating energy can be lost and to 87% of its heat gained through glazing (McGee, 2013).

IV. Skylight can make a major contribution to energy efficiency and comfort. They are an excellent source of natural light, perhaps admitting more than three times as much light as vertical window of the same size and can improve natural ventilation. However can be source of unwanted heat gain in summer and heat loss in winter. Factors to be considered when selecting from the many skylight option available in Sa'adu Zungur Auditorium include sizing and spacing (to control glare and heat gain), energy efficiency and appropriateness for climate.

CONCLUSION

This study revealed that the effect of passive design strategies was almost the same for all building in hot dry climate as investigated. This is because most conference building, orientation and design as well as building envelope considered less passive design strategies or had been constructed with concrete block except in rear case where mud blocks were used. It was also seen that good application of passive design variables and use of building materials with high thermal storage capacity could improve thermal performance of buildings in Hot-dry climatic conditions of Kano state, which in turn improve micro climate of the conference centre. Furthermore, other design parameters had an influence on integrating climate with the case study building where, the location of spaces and size and type of glazing, open courtyard system, vegetation, open sky atrium and shading or sun control devices.

There are many design approaches aimed at improving building climatic design, such as, environmental design, climate responsive design, energy efficient design, passive solar design, passive and low energy architecture etc. All these design approaches aim to integrate building with climate as well as improve the occupant's thermal comfort and thermal performance of the buildings without using excessive energy. [The results of this research helped to highlight the bioclimatic response of the case study building]

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