Proceedings of the 3rd Biennial Africa International Renewable Energy Conference

(SOLAR AFRICA 2018)

Uusmanu Danfodiyo University, Sokoto Nigeria

18th – 20th December, 2018

3rd Biennial Africa International Renewable Energy Conference (Solar Africa 2018)

18th- 20th December, 2018

Sokoto Energy Research Center, Usmanu Danfodiyo University, Sokoto, Nigeria

BOOK OF PROCEEDINGS

Proceedings of the 3rd Biennial Africa International Renewable Energy Conference (Solar Africa 2018)

EDITORS

Prof. A. S. Sambo
Sokoto Energy Research Centre, UDU, Sokoto
Dr. Mahmoud M. Garba
Sokoto Energy Research Centre, UDU, Sokoto
Prof. Musa Momoh
Physics Department, UDU, Sokoto
Dr. Samaila Buda
Sokoto Energy Research Centre, UDU, Sokoto

SPONSORS

Sokoto Energy Research Centre, UDU, Sokoto
Federal University Dutse, Jigawa State
Umaru Musa Yar'adua University, Katsina

PUBLISHED BY:
Sokoto Energy Research Centre, Usmanu Danfodiyo University, Sokoto, Nigeria.

CORRESPONDENCE:
All correspondence pertaining to the Solar Africa 2018 should be sent to: The Coordinator, Solar Africa 2018, Sokoto Energy Research Centre, Usmanu Danfodiyo University, Sokoto.
solar.africa@udusok.edu.ng

Organizing Committee

Name	Affiliation	Position
Prof. A. S. Sambo, OON	Usmanu Danfodiyo University, Sokoto	Chairman
Prof. S. M. Dangoggo	Sokoto State University, Sokoto	Member
Prof. B. G. Danshehu	Usmanu Danfodiyo University, Sokoto	Member
Prof. Musa Momoh	Usmanu Danfodiyo University, Sokoto	Member
Prof. Mumtaz Ahmad Sohag	Federal University, BirninKebbi	Member
Prof. H. N. Yahya	Usmanu Danfodiyo University, Sokoto	Member
Dr. Muazu Musa	Usmanu Danfodiyo University, Sokoto	Member
Dr. M. M. Garba	Usmanu Danfodiyo University, Sokoto	Member
Dr. A. D. Mambo	Nile University, Abuja	Member
Dr. G. M. Argungu	Usmanu Danfodiyo University, Sokoto	Member
Abubakar Atiku Nuhu Koko	Usmanu Danfodiyo University, Sokoto	Member
Engr. Ashiru M. Rabiu	Usmanu Danfodiyo University, Sokoto	Member
Ahmad Isah Chafe	Usmanu Danfodiyo University, Sokoto	Member
Kabir Ahmed Dabai	Usmanu Danfodiyo University, Sokoto	Asst. Sec.
Garba Saidu	Usmanu Danfodiyo University, Sokoto	Member
Dr. A. D.Tambuwal	Usmanu Danfodiyo University, Sokoto	Member
Dr.Sani Aliyu	Usmanu Danfodiyo University, Sokoto	Member
Saidu M. Maishanu	Usmanu Danfodiyo University, Sokoto	Member
Engr. I. I. Rikoto	Usmanu Danfodiyo University, Sokoto	Member
Dr.Sani Salihu	KSUST, Aliero	Member
Lawal Umar Kangiwa	Usmanu Danfodiyo University, Sokoto	Member
Rep. UMYU	Umar Musa Yaradua Uni., Katsina	Member
Rep. FUD	Fed. University, Dutsinma	Member
Rep. Sokoto State University	Sokoto State University	Member
Hassan Yusuf	Usmanu Danfodiyo University, Sokoto	Member
Barrister Muazu M. Yabo	Usmanu Danfodiyo University, Sokoto	Menber
Dr. Samaila Buda	Usmanu Danfodiyo University, Sokoto	Secretary

TABLE OF CONTENTS

Proceedings of the 3rd Biennial Africa International Renewable Energy Conference, 2018: 448 – 455

Optimising Thermal Comfort for Sustainable Shopping Centres in Nigeria: Towards A Passive Design Approach

*Abdulaeez, M. J and Akande, O. K.
Department of Architecture, Federal University of Technology Minna, Niger State
[*Corresponding Author: Email: abdulazeezjamaz@gmail.com]

ABSTRACT

Globally, shopping centers trends have been changing from open precinct to larger shopping malls. This transition is heading towards a more enclosed and air conditioned environment as compared to the older forms of shopping centers such as arcade and plazas, which were designed opened. Shopping centers in Nigeria are therefore evolving into high consumption area of electricity as a result of reclusive design approach due to minimum or no use of natural ventilation. The aim of this paper is to investigate the passive design strategies used to achieve passive cooling in shopping centres. The objectives are to assess the existing shopping centres and evaluate the passive cooling design measures used to reduce the effect of excessive heat aside the use of energy consuming devices. A descriptive survey method shall be adopted with the use of an observation schedule where selected samples within the study area will be examined to determine the frequency of use and effectiveness of passive cooling design strategies used in the sample. Indicative findings from the samples are analyzed and interpreted to show if the design strategies are appropriately incorporated to serve the purpose of achieving thermal comfort or are rather used for aesthetics. It is also worthy of note that this paper will emphasize on the design strategies to reduce dependency of artificial means of enhancing passive cooling. These can be achieved through proper building orientation, adequate planting and installation of green landscape elements, effective use and proper positioning of shading devices and careful selection of building material that allow for proper thermal insulation.

Key words: Shopping centres, Passive cooking, Design Strategies, Natural ventilation, Thermal comfort

INTRODUCTION

With increased environmental awareness in built industry in Nigeria, contexts like energy conservation and passive design strategies have tremendously gained high importance and considerations in building designs. Built environment professionals are not restricted to creating shelter alone but also providing therapeutic and comfortable environment. Creating a healthy and comfortable shopping environment is not only to protect public health, but also help to improve the economic effects of business. Therefore, it is essential to pay attention to the environmental quality both inside and outside the shopping centers to protect both the health of shoppers and staff of the centers (Hu and li 2015). According to the American Society of Heating, Refrigerating and Air Conditioning Engineers, The mechanical equipment has a higher maintenance and low replacement regime generally than natural ventilation approach. ASHRAE (2004). one of the ways of preventing high rate of dependence on active energy system for indoor comfort is for the designers to cater for the extreme temperature which is a major challenges of the dry-hot climate from the design stage. (Akande, 2010).

A passive cooling design approach encourages the use of the natural ventilation and reduces the level of dependency on the mechanical equipment which are more cost intensive and less durable at the same time. This makes it an important factor to be considered in large commercial developments like shopping centres.

Passive measures, specifically natural or hybrid ventilation rather than air conditioning, can significantly reduce the energy intake (Hatamipour and Abedi, 2008).

This study will assess and evaluate the design features for passive cooling in shopping centres to

help architects and other built environment professionals achieve the desirable indoor environmental quality. This would motivate innovative trend of shopping mall design and encourage the use of passive cooling design techniques in mall designs especially in the hot-dry climatic region.

METHODOLOGY

Description of the study area

Minna is located in the north central region of Nigeria at latitude of 9.62 and longitude 6.55 situated at elevation 243 meters above sea level. the city is characterised by a tropical climate which has a high temperature and low relative humidity in the dry season. the average annual temperature is 27.5°C. in minna and an average annual rainfall of about 1229mm. the least amount of rainfall occur in January the average in this month is 1mm.the temperature are highest on average in march at about 30.5°C and the coldest month is august with an average temperature of 25.3 °C the variation in the precipitation between the driest and the wettest month is 259 mm. throughout the year temperature varies by 5.2 °C

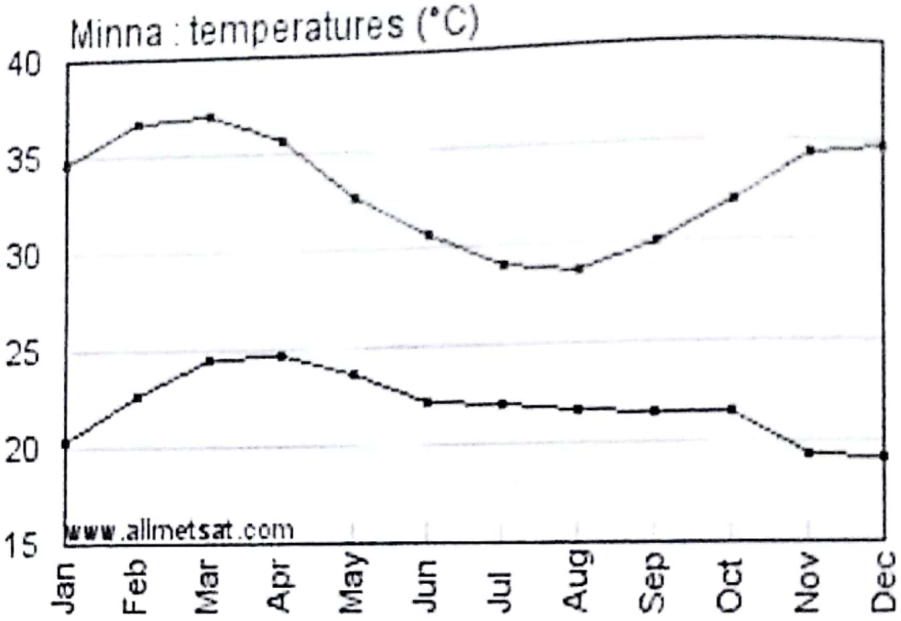


Figure 1.0: showing The average monthly min (blue) and max (Red) temperature of Minna, Niger State.
Source: www.allmetstat.com

Research Method and data collection

The research method adopted for this study is descriptive survey method.Data collected for the research were obtained from both primary and secondary data collection methods and these include:

1. Case studies.
2. Articles and journals.

The case study were carried out on existing shopping centre facilities within the study area. Variables on thermal comfort were evaluated using observation schedule. Also, photographs of the buildings were taken in order to show the variables observed on the field. Instrument such as measuring tapes, scale rule were used on the field work to take measurement where necessary. Some pictures taken for the case studies are displayed in the plates below.

Plate 1: Showing the use of deep verandah at NUT Endwell plaza Minna

Plate 2: Showing a vegetative cover at the NUT Endwell plaza Minna.

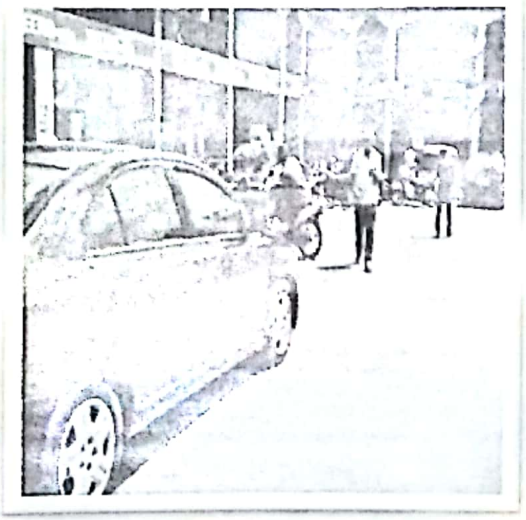


Plate 3: showing the use of a wide courtyard at OBJ shopping complex, Minna.

Plate 4: Showing the use of deep verandah to shade the windows at Blue Mart Minna

Sampling Technique and Sample size

The research employed the use of purposive sampling based on the size of the shopping centres, the ten samples were observed as the biggest shopping shopping centre and were obtained from the study area within Minna. Observation schedule was used for the ten shopping centres, out of which nine are open shopping centres and one of them is an enclosed shopping centre

Table 1.0 showing sample size and address (Source: Researcher's Fieldwork, 2018)

S/N	SAMPLE POPULATION	ADDRESS
1	NUT Endwell plaza	Broadcasting road tunga, minna.
2	Nuldge shopping complex	Tunga, Minna.
3	Blue mart supermarket	Tunga, Minna.
4	Mardona plaza	Gbaganu junction Kpakungu, Minna
5	Shehu usman plaza	Opp. Flailas Kpakungu, Minna.
6	Golden age shopping complex	Kpakungu round-about, Minna
7	Usman kontagora plaza	Bosso road, Minna.
8	Obasanjo commercial complex	Mobil, along Bosso road, Minna
9	Sardauna plaza	Stadium junction/Bosso road, Minna.
10	Alh. Bello hussain complex	Beside Skye bank, Bosso road, Minna.

Variables for the study

The data collection instrument used in this study to assess thermal comfort design features in shopping centres is a structured observation schedule. The variables used for the assessment are listed as shown below in table 2.0.

Table 2.0 Parameters used for assessing thermal comfort design features in shopping centres.

S/N	PARAMETER
1	Materials used for construction
2	Building Orientation
3	Shading Device
4	Openings (windows, courtyard and atrium)
5	Vegetation

RESULT AND ANALYSIS

The two tables above shows the selected shopping centres in minna and the parameters used to access them respectively, an assessment is done to determine the degree of presence of thermal comfort design features in the selected buildings and the procedures involved in the assessment are discussed together with the result of the assessment given in the tables below.

Table 3.0 : showing the selected shopping centers with the code for the respective buildings.

S/N	SAMPLE POPULATION	ACRONYM
1	NUT ENDWELL PLAZA	NUTEP
2	NULDGE SHOPPING COMPLEX	NUS
3	BLUE MART SUPERMARKET	BMS
4	MARDONA PLAZA	MARD
5	SHEHU USMAN PLAZA	SHUP
6	GOLDEN AGE SHOPPING COMPLEX	GOLD
7	USMAN KONTAGORA PLAZA	UKP
8	OBASANJO COMMERCIAL COMPLEX	OBJ
9	SARDAUNA PLAZA	SARD
10	ALH. BELLO HUSSAIN COMPLEX	ALBEH

Table 4.0: showing the extent to which the elements are present with respective score.

S/N	THE DEGREE OF PRESENCE OF ELEMENT	SCORE
1	Very high	5
2	High	4
3	Moderate	3
4	Low	2
5	Very low	1
6	Not available	0

DATA REPRESENTATION AND ANALYSIS

Landscape Elements

The various types of landscape element (vegetations) was assessed to evaluate their degree of effectiveness on the selected facilities

Solar Shading Element

The shading elements used at the selected facilities were closely observed and a chart was projected to show the analysed result. Majority of the selected shopping centre uses deep verandas (balcony) and landscape element for shading which were scored on their effectiveness.

Thermal Insulation

The thermal insulation used at the selected facilities were closely observed and a chart was projected to show how effective they are utilized.

Thermal Mass

The materials for thermal mass used at the selected facilities were also observed and a chart was projected to show how effective they are utilized.

Windows

The various types and form of windows was assessed and likewise the height and position of windows was checked for window effectiveness on the selected facilities

Courtyard

The forms of court yard used at the selected facilities were also observed and a chart was projected to show how effective they are utilized.

Plate 5: The effectiveness of various landscape elements (vegetation) at the selected facilities

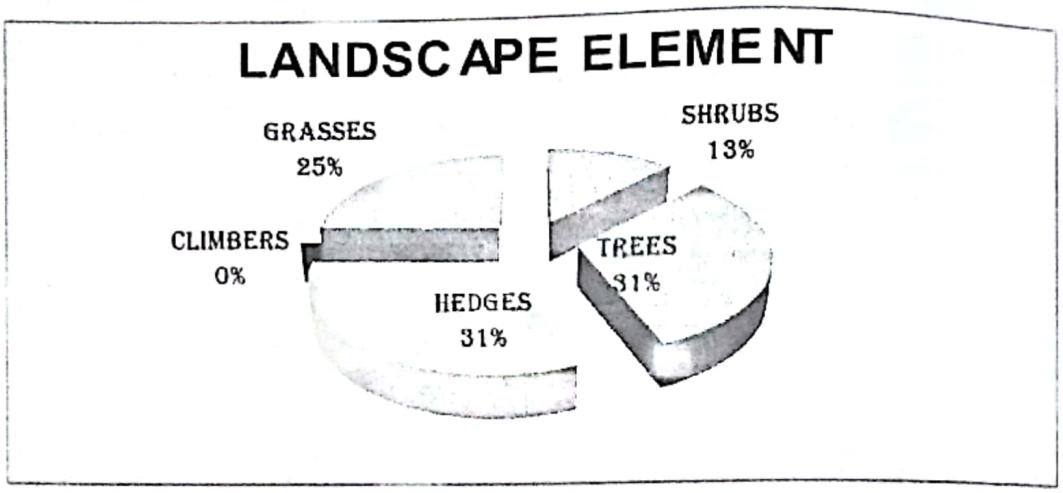


Plate 6: Showing how effectively the shading devices are used on selected facilities.

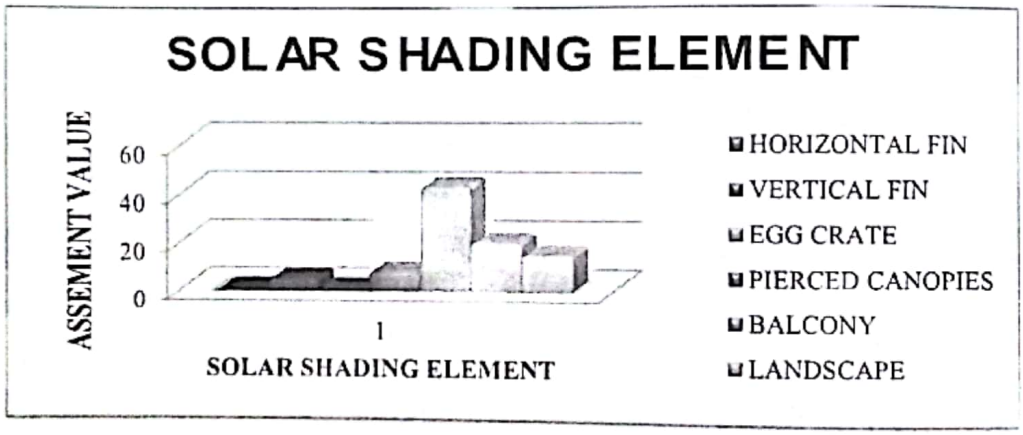


Plate 7: showing how effectively thermal insulation materials are used on the selected facilities

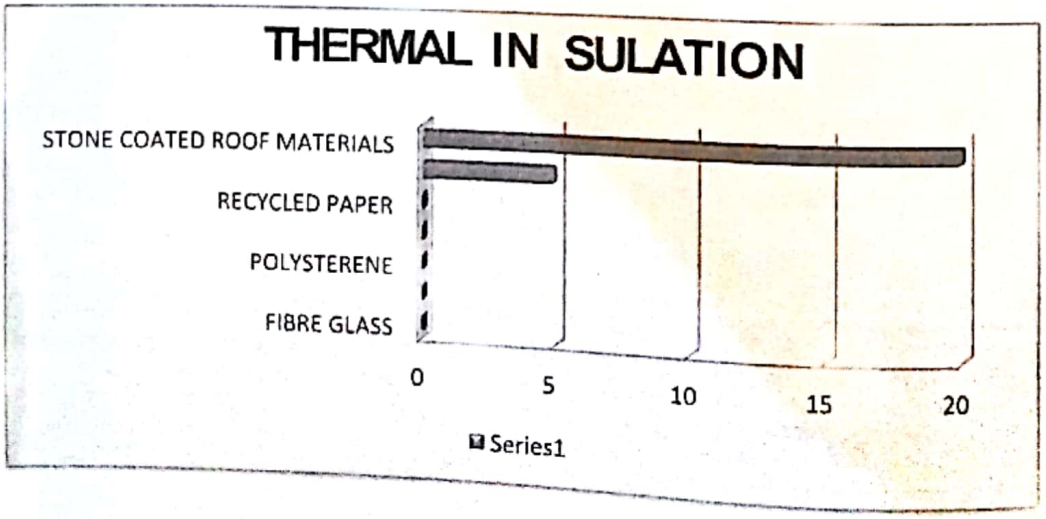


Plate 8: Showing how effectively thermal mass materials are used on the selected facilities

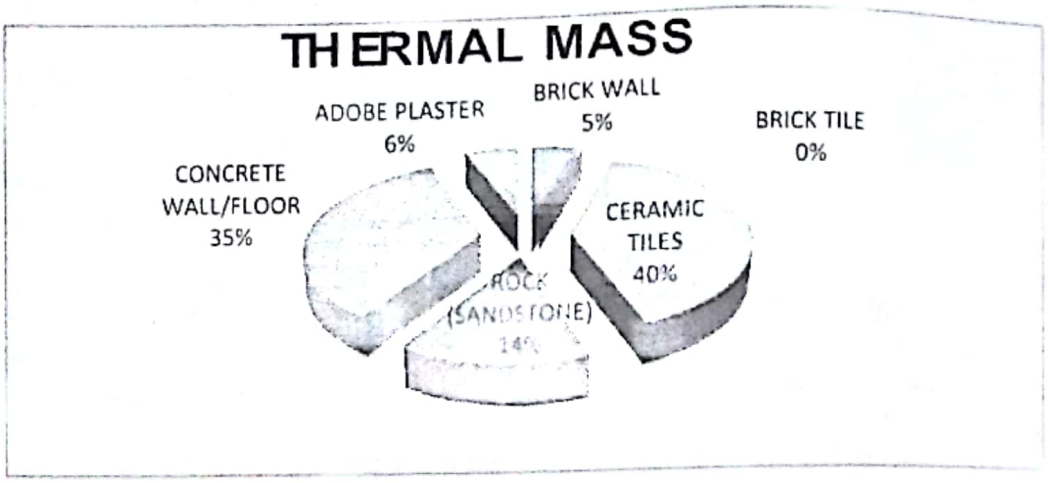


Plate 9: Showing the effectiveness of various form windows at the selected facilities

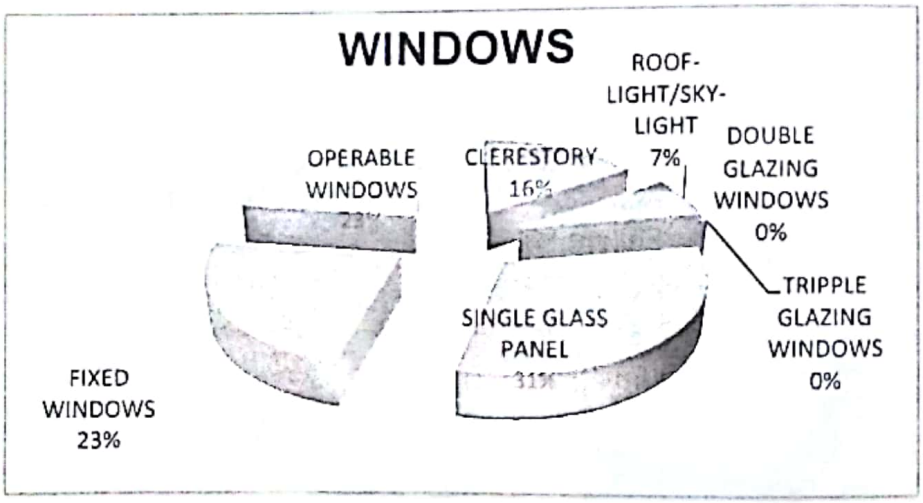
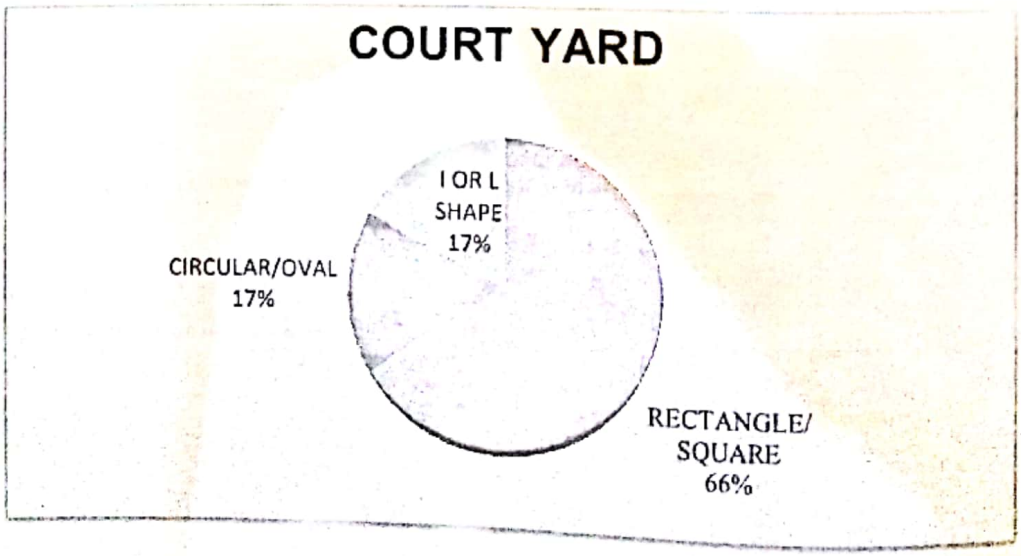


Plate 10: Showing the effectiveness of various form of courtyard at the selected facilities



FINDINGS

From the above tabular and statistical illustration, it is observed from the selected existing shopping centers in minna that architects and other building professionals have the highest consideration for building orientation, and solar shading elements, in terms of enhancing thermal comfort of the users of the facilities, that is, both the customer and the shop keepers or staff of the centre, but on the contrary they have lowest consideration for landscape element and thermal insulation materials, while other parameters like windows, courtyard and thermal mass are moderately considered.

CONCLUSION

Buildings can cause thermal discomfort if an effective design strategies are not considered to reduce the excessive heat that goes into the building especially in hot dry climate, outside the numerous passive design strategies that have been employed by architects and other building practitioners in different climates, the variables and parameters used in the course of this study can help designers to know the reasons why some existing facility especially in the hot dry climates gets hotter in the dry season and hence leads to thermal discomfort for the building users, so it is very important to take into consideration the passive cooling design approach from the design stage of a building construction in the hot dry climatic area of Nigeria.

REFFERENCES

Akande, O. K. (2010). Passive design strategies for residential building in a hot dry climate in Nigeria. WIT transaction on ecology and the environment 128, 61-71.

ASHRAE. (2004). Thermal Environmental Conditions for Human Occupancy: standard 55-2014: American Society of Heating, Refrigerating and Air Conditioning Engineers, ASHRAE, Inc. Atlanta.

Hu, J., Li, N. (2015). Variation of PM2.5 Concentration in Shopping Malls in Autumn, Changsha. 9th international symposium on heating ventilation and air conditioning (ISHVAC) and the 3rd international conference of building energy and environment. (COBEE), 692-698.

M.S. Hatamipour, A. Abedi (2008), Passive cooling systems in buildings: Some useful experiences from ancient architecture for natural cooling in a hot and humid region, Energy Conversion and Management, 49, 2317–2323