



**SCHOOL OF ENVIRONMENTAL TECHNOLOGY,
FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA, NIGER STATE, NIGERIA**

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**SETIC
2020
INTERNATIONAL
CONFERENCE**

BOOK OF PROCEEDINGS

MAIN THEME:

Sustainable Housing And Land Management



3RD -5TH MAY, 2021



**SCHOOL OF ENVIRONMENTAL TECHNOLOGY COMPLEX,
FUT, MINNA, NIGER STATE, NIGERIA**

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**School of Environmental
Technology International
Conference
(SETIC 2020)**

3RD - 5TH MAY, 2021

**Federal University of Technology Minna, Niger
State, Nigeria**

CONFERENCE PROCEEDINGS

EDITORS IN CHIEF

R. E. Olagunju

B. J. Olawuyi

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ISBN 978-978-54580-8-4

SETIC 2020 International Conference:

“Sustainable Housing and Land Management”

School of Environmental Technology, Federal University of Technology, Minna
3rd – 5th, May 2021.

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**Proceedings of
The 3rd School of Environmental Technology International Conference
(SETIC 2020)**

Published by

School of Environmental Technology,
Federal University of Technology Minna.
PMB 65, Minna,
Niger State Nigeria.

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ISBN 978-978-54580-8-4

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3rd – 5th, May 2021.

PREFACE

The School of Environmental Technology International Conference (SETIC 2020) is organised by School of Environmental Technology, Federal University of Technology Minna, Nigeria. In collaboration with Massey University New Zealand, Department of Civil Engineering Faculty of Civil Engineering and Built Environment Universiti Tun Hussein Onn Malaysia, Malaysia Centre For Professional Development and Industrial Project Development School of Professional and Continuing Education (SPACE) UTM-KL Malaysia, Global Academia, Department of Architecture, Faculty of Engineering and Architecture, Istanbul Gelisim University Istanbul Turkey, Sustainable Environmental and Technology (SET) Research Group, Department of Architecture, Universiti Sains Islam. The main theme for this year conference is “SUSTAINABLE HOUSING AND LAND MANAGEMENT”. This promotes and encourage innovative and novelty for policy issues for inclusive and sustainable housing, access to finance for housing and land development, sustainable building materials, building cost management, sustainable and resilient cities, geoinformatics for land management, rapid urbanization, sustainable land use and spatial planning, gender issues in access to land.

The responses from participants for this conference are overwhelming, well attended, and successful. The operation mode was Virtual for all participants who choose the oral presentation mode. While, Physical for all poster medium presenters. Our participants are from various Universities and other sector across the globe, from countries like United State for America (USA), Turkey, Malaysia, China, Saudi Arabia, Kenya, New Zealand just to mention a few. Hence, this conference provides a good platform for professionals, academicians and researchers to widen their knowledge and approach on latest advances in research and innovation. Papers presented in this conference cover a wide spectrum of science, engineering and social sciences.

Finally, a note of thanks must go to SETIC 2020 Local Organizing Committee (LOC) for their remarkable dedication in making this conference a success. We hope the event will prove to be an inspiring experience to all committee members and participants.

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Passive Design Strategies for Sustainable Operation of NYSC Camp Buildings, Minna, Nigeria

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Abstract:

Niger State is characterized by tropical dry climate of minimal rainfall and dry hot periods, with an average temperature of 33°C at its hottest months. The NYSC orientation course takes place four times in the year which cuts across the dry temperate periods of the year. This extreme dry, dusty and hot weather results in asthma, cough and other related sicknesses for building users. As a result, several corps members seek redeployment. Observation shows that NYSC camp buildings are designed with little or no consideration for passive comfort of the users. Lectures, trainings and other social activities are largely dependent on mechanical energy for cooling, which are insufficient and not cost effective. The aim of the paper is to investigate users comfort in the buildings, with the objective to promote low energy architecture, using passive design strategies. Quantitative methods were used to collect data on the users' perception of comfort within the buildings. Findings suggests insufficient natural ventilation, inappropriate building orientation, absence of shading devices as contributors to thermal discomfort of the users. The paper recommends passive design strategies among which are landscaping elements, to achieve users comfort and low energy consumption in the NYSC camp buildings. It concludes that there is a need for redirection in the design of NYSC camp, which puts into consideration the climatic condition of the environment where the camp is situated.

Keywords: *Comfort, Low Energy, Operation, Passive Design, Sustainable Building.*

INTRODUCTION

The evolution of building designs that generate self-indulgent solutions to habiting challenges has been a focus of research in the field of modern architecture. The users of a building may change over time, even whilst the building maintains its purpose. According to studies by Kaitilla, 1993, Ukoha and Beamish, 1997, Zeiler and abaoxem, 2008, Meir et al., (2009) standards and specifications have largely varied with the need of building users, thus causing an increase in the dissatisfaction of users with the building performance. User thermal comfort has been a crucial area of concern in most tropical regions to improve this building performance and ensure a desirable comfort condition in buildings. The study discusses how the thoughtful make-shift strategy of mechanical ventilation which is energy intensive can be drastically reduced. Furthermore, how energy use in buildings can be controlled, as it results in continuous release of carbon dioxide (CO₂) into the air resulting to rising temperatures and climate change globally (Akande, 2015).

Passive design principles approach heat, lighting, mechanical power distribution and implementation using environmentally conscious strategies. Heat is efficiently collected and distributed using natural means, making thermal comfort become very crucial in a building, as it impacts productivity and improve user's health (Huizenga et al., 2006).

Danfulani and Aja (2008) discusses how the antecedents in Nigeria's history emanated the NYSC program by decree No. 24 of 22nd May 1973 to promote national unity among youths. Building facilities have been constructed to accommodate the activities. These building facilities are at optimum use during hours of intense solar radiation of the savannah region climate. The research focuses on the implementation of passive building design principles that aid user's thermal comfort for the design of the NYSC orientation camp in Paikoro, Niger State,

with the assessment of the passive design elements in the orientation camp. The design thus integrates approaches using forms of materials such as Masonry (concrete, bricks and stones) and water, "attached greenhouse" which makes use of both direct and indirect gain of sunlight, building orientation, orientation of openings, building shape, use of water walls, use of thermal and trombe walls, shading devices in providing thermally satisfactory spaces. This suggests the need for more thermally comfortable spaces.

Case studies and research data shows the congestion as a result of increased number of occupants for spaces designated for lower number of occupants resulting in thermally dissatisfactory spaces. The NYSC orientation camp facility is facing the problems of thermal comfort, inadequate ventilation and excessive heat during hot climate, due to congestion of limited spaces, and lack of a proper and permanent camp facility purposely designed to cater for the category of users and participants of the camp programme. The use of active measures (mechanical equipment) to achieve users' comfort has currently become a matter of necessity, as a result of harsh weather conditions of the North Central region.. This active means of achieving thermal comfort have incurred the challenge of high cost of maintenance, unavailability due to insufficient funds and government support to provide them and thus should be brought to minimal requirement by the support of passive elements and design principles.

Passive Design Principles

Passive design principles have remained a traditional part of vernacular architecture for thousands of years in many countries before the integration of mechanical cooling and heating into buildings (Crosbie, 2008). The ancient Roman, Greek and Chinese were the ones who redefined and modified the major principles of passive design who positioned their buildings toward the south to offer a considerable amount of warmth and light (Butti *et. al.*, 1980). The primitive idea and lack knowledge of houses made them turned buildings to face the winter sun. Later on, the European technological improvements were abandoned after the fall Rome but persistent in China where astral traditions associate the south with summer, warmth and health (Xenophon, 1979).

Passive Design Features

Passive design features are architectural design or planning attributes or element used to enhance or achieve comfort and cooling within the building. They are features that used to achieve a desirable comfort condition and maintaining user's well-being without the use of active means (Brown, 2011). These features are highlighted under the following;

1. Building orientation
2. Building shape and massing
3. Vegetation
4. Openings (windows, court yard and atrium)
5. Solar shading
6. Building materials

Deductions

The study will only research into assessing the amount of comfort experienced by the previous and current camp users which includes both the Corp members, staffs and officials and auxiliary users of the camp facility, and also examine passive design measures that can improve subsequent users' thermal comfort in the proposed permanent NYSC camp facility. The passive design strategies or principles in this research build a focus how the design of the NYSC orientation camp buildings can be designed to achieve thermal comfort of the users, thing inherent energy from strategies employed. This is against the active strategies used to and thermal

comfort, which employs random number of external energy sources such as electricity, natural gas etc. the passive design strategies implement an energy efficient building, which is also a recertify for buildings which have a flexible number of occupants.

The aim of the study is to investigate the problems associated with thermal comfort of users (Corp members and officials) of the NYSC orientation Camp buildings with a view to propose design with the integration of passive design principles.

METHODOLOGY

The research makes use of a descriptive research effort to systematically describe the relevant information relative to the situation, problem and circumstances that surround the Camp Design. Using the qualitative and quantitative data for measuring thermal comfort and its extent in the NYSC Orientation Camp paikoro Niger State. Justifiable conclusions and recommendations are then drawn from the derived data. The case studies examined are existing NYSC Orientation Camps located around Nigeria.

Random selection method of subjects was done, and some of the NYSC CAMP case study locations include; Plateau State, Anambra, Kogi, Ogun, Lagos, Nasarrawa, Oyo, Bauchi etc. Variables used to measure thermal comfort were assessed using observation schedule. Photographs taken during physiographic observation were taken to show some of the variables observed in the field. Physical Instruments such as measuring tapes, scale rule was used on the field work to take measurements where necessary. Both the primary and secondary sources of data are used to derive the necessary information required to make analysis and conclusions. Primary data used for the purpose of the research was obtained from fieldwork and descriptive survey carried out in randomly selected NYSC orientation camps including the existing NYSC Orientation camp used in the proposed site.

Observations were carried out to understand the passive design features used to achieve thermal comfort. Focus questions used to obtain the data are directed towards the passive thermal comfort. Interviews were carried out alongside Observation Schedule in the collation of data gathered during the field work.

Table 1: Overview of primary data on passive design

S/N	DATA	TYPE	SOURCES
1	Site Orientation	Qualitative	Observation
2	Building Shape	Qualitative	Observation
3	Massing	Qualitative	Observation
4	Landscape Consideration	Qualitative	Observation
5	Solar Shading Devices	Quantitative	Observation
6	Thermal Mass and Insulation	Qualitative	Observation
7	Openings (Windows, Courtyard and Atrium)	Qualitative/Quantitative	Observation

(Source: Author's Research Work, 2021)

Secondary data used for the purpose of the research was also gathered from existing NYSC journals and magazines, published NYSC literatures and articles. Relevant literatures are reviewed as a basis for a comprehensive theoretical background on which the research decisions were made.

Current information about passive design principles used in camp facilities obtained from internet such as; preferred window types, landscape alternatives etc. Data generated from the research provides the criteria and variables used for the observation, planning, organizing and designing of the proposed NYSC Orientation Camp with an intention of achieving thermal comfort.

Table 2: Data Obtained from Secondary Data Sources

S/N	DATA	TYPE	SOURCE	
1.	Research Documentaries		Qualitative	Literature
2.	Population Estimate		Quantitative	Interview
3.	Maps		Quantitative	Internet
4.	Psychological effect of thermal comfort on occupants		Qualitative	Interview
5.	Site Location of NYSC camps		Qualitative	Interview
6.	Allocations, prototypes and past records of NYSC		Qualitative	Literature

(Source: Author's Research Work, 2021)

Data Collection

A close ended questionnaire and a structured observation schedule were used to obtain a data. Corp members and officials were randomly selected from existing NYSC camp locations, and questionnaires administered to them. The questionnaire was organized to obtain relevant data on passive design elements / considerations used to achieve security within the facilities. A structured observation schedule was also employed to determine passive design element/considerations used for security and the application of these elements/ considerations in mixed use buildings.

Population of the Study and Sample Frame

Thirteen States across Nigeria was selected as areas of study. The NYSC Orientation camps are located across the 36 states of Nigeria. The Niger State NYSC Orientation camp at Paikoro local government Niger State which has the proposed site was the first area of study. Major research work commenced there. The 13 NYSC Orientation camps were randomly selected in different states. The camp locations were visited and relevant data instruments were applied to access needed information.

A sample size of three NYSC Orientation camps was drawn for the research. Questionnaires were administered to corps members, camp officials, camp marketers and other camp users. Based on convenience sampling method employed by the researcher, The Niger state camp, Abuja Camp and the Nassarawa State Camp were the samples selected for the research. Also based on Judgmental sampling method, the three samples selected are characterized by the Dry sub-Saharan climate which ranges between 19 to 38 degree Celsius during the dry season. The high temperature these areas are characterized with makes the subject of thermal comfort a basis of observation in this area.

Observations and Interviews were carried out and shared at the sample locations. One of these sample locations include the Abuja camp. It is located in the Kubwa district of the FCT. Interview with camp officials reveals an average of 4000 Corp members which are posted to the camp in every stream. The Niger state Orientation camp which is the site location for the proposed new camp was also selected to take samples. The camp is located in Paikoro along the Minna/Abuja road. Interview reveals an average of 2000 to 2500 accommodated on the site. The Nasarrawa State NYSC camp located along the Abuja/Keffi expressway has an accommodation capacity of 3000 Corp members. The Nasarrawa camp also has its weather as the Sub-Saharan dry climate of the North Central. It also has its current location as its permanent site. Secondary data obtained by study of literature reveals that Magaji Dan Yamusa. Nasarrawa is a newly constructed site.

Variables of the Study

This shows a record of Interview guide, physical observation records and an analysis of each of the orientation camps studied. The Interview guide is subdivided into sections.

1. The first section contains participant's information.

2. Relevant data for the camp is filled in this section. Perceptions and personal opinions about comfort as a result of thermal condition of the NYSC camps. These entails a total of 12 questions which were administered across corp members, camp officials and users of the camp facilities.

3. A structured observation schedule was also used for the assessment of passive principles that aid thermal comfort in the Orientation Camp facilities. The following are some of the variables used in this assessment.

DISCUSSION OF RESULT AND DATA ANALYSIS

The primary source for obtaining data for the research work include the use of questionnaires and observations, especially in the examination of thermal comfort in the NYSC Camps. Statistical analysis is used to analyze the data obtained from the field work to get quantitative result. Microsoft Excel spreadsheet was used for analysis in this study.

The data obtained from field work is analyzed and discussed in this section. Google forms and Microsoft Excel Spreadsheet are used to get a descriptive statistic of data obtained from field survey of some NYSC camps. The results obtained were evaluated based on the research objectives.

The research objective which is to determine the perception of comfort of the current NYSC orientation camp facilities users was carried out by the researcher through administering questionnaire. A well-structured questionnaire was administered to camp facility users using Google forms. A hundred and one (101) form was submitted online and was analyzed. Data collected shows 52.5% of the respondent are female while 47.5% are male.

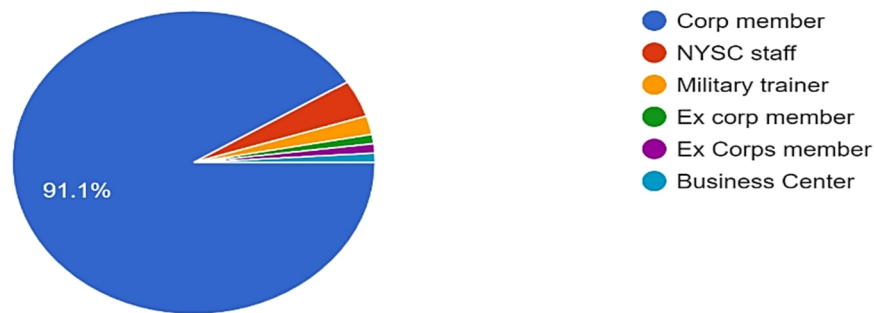


Figure 1: Categories of User in NYSC camp facilities
(Source: Author's fieldwork, 2021)

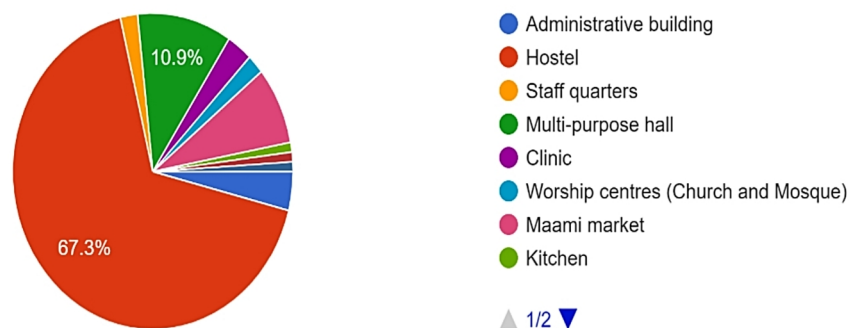


Figure 2: Buildings often used in the orientation camp
(Source: Author's fieldwork, 2021)

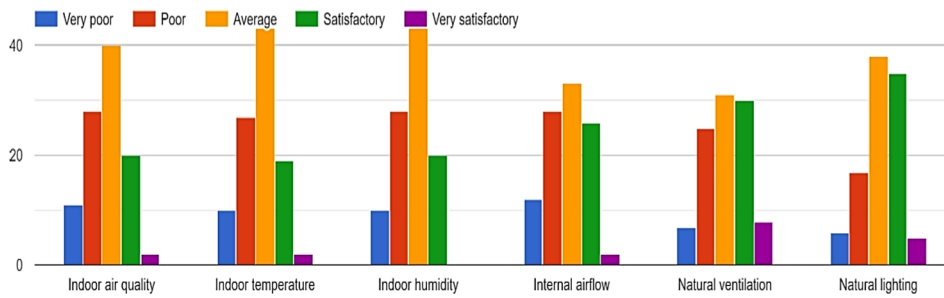


Figure 3: Users Experience on indoor environmental quality within the orientation camp (Source: Author’s fieldwork, 2021)

9. How would you describe the comfort condition of the building you primarily use in the NYSC camp?

101 responses

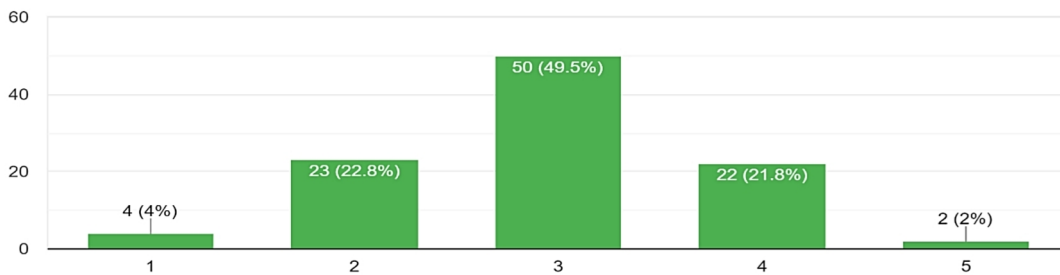


Figure 4: Comfort Condition of camp facilities (Source: Author’s fieldwork, 2021)

CONCLUSIONS AND RECOMENDATIONS

This research exposes the degree to which existing NYSC camps have some passive thermal comfort design elements which were integrated in them. It was therefore researched how most of the principles adopted were not very effective as some of these measures were not primarily for cooling purposes only. It is therefore worthy of note that the proposed NYSC camp facility incorporates effectively the design features to reduce dependency on active or mechanical means of cooling and ventilation. One of the major benefits of this research is the reduction in the emphasis of the need for high energy demands or mechanical provisions for achieving thermal comfort. Thermal comfort within the NYSC Camps makes the users of the space psychologically satisfied and productive. Hence, the need for passive design features for thermal comfort on buildings to carve a pleasing and comfortable living, learning and training environment for the Corp members. In order to provide a thermally comfortable training environment and precinct where user’s needs are met, and are maximally satisfied with the indoor conditions, the following are recommended:

- i. Number of corp members allocated to the NYSC Orientation Camp locations should be restricted to the facilities and space provided as in the design.

- ii. Passive design principles for thermal comfort should be integrated effectively on all buildings mainly with the aim of providing comfort and improving indoor air quality and not for aesthetic purposes.
- iii. The Provision of courtyards with open roof design allows natural ventilation and crossed ventilation.

Table 3: Passive design principles adopted in orientation camp facilities

S/N	NYSC Orientation Camps	Building Orientation and Shape	Use of Building proper materials	Provision of sufficient openings windows	of	Presence of spacious lobbies, Courtyards	Form of Landscapes features and Vegetations	Form of Solar Shading device	of
1	Niger Paikoro	No	Cement Blockwalls, Aluminium roofing sheet	Louvres		N/A	N/A	N/A	
2	Kubwa Abuja	Rectangular Bungalows	Sandcrete walls, Aluminium roofing sheet	Sliding windows	Glass	Courtyards	Scanty Vegetation		
3	Magaji Dan Yamusa	Rectangular Building Shape	Cement blockwalls, Aluminium roofing sheets	Sliding windows		Presence of Lobbies	Shrubs and Shading trees, good landscape	Roof Eaves, Absence of fins	
4	Ede, Osun State	Rectangular Bungalow buildings	Block walls, Aluminium roofing sheets, ceramic floor tiles.	Slidng windows	glass	Verandas, lobbies	Shrubs, Hedges, Scanty Trees	Horizontal fins	
5	Black Gold Kaduna	Rectangular Bungalow Buildings	Blockwalls, Terrazo floorings,	Sufficient Openings, louvre windows		Presence of lobbies	Scanty vegetation and landscape features	Presence of deep verandahs, Roof eaves and Horizontal fins	
6	Kabba Bunu Camp, Kogi State	Rectangular Bungalow Buildings	Stone walls, Blockwalls. Aluminium roofing sheets, ceramic tiles, Terrazo floor cover	Double Glass window for ventilation	Swing	Insufficient Lobbies	Shrubs, Trees	Horizontal fins	
7	Sagamu Camp, Ogun State	Rectangular Planned Bungalow buildings	Sandcrete Blockwalls, Ceramic Floor Tiles, PVC ceilings	Sliding and windows	Glass Swing	Spacious Lobbies, Courtyards	Insufficient Trees and Vegetations	Eaves, Absence of fins	
8	Ipaja Agege, Lagos	Multi-Storey Building	Concrete pavements, Sandcrete blockwalls, Aluminium roofing sheets,	Louvres		Lobbies,	Absence of Vegetations	Horizontal fins	
8	Akwa Ibom	Rectangular Bungalow Buildings	Aluminium Roofing Sheets, Blockwalls, Terrazo floor cover	Louvre window types		N/A			
9	Plateau	Bungalow Buildings	Sandcrete Blockwalls, Aluminium Roofing Sheets	Sliding mirror glass windows		Presence of Courtyards and Atriums	Interlocking tiles for hard landscape,	Roof Eaves, Absence of external wall fins in hostel buildings	

(Source: Author’s Research Work, 2021)

- iv. Proper landscaping of the indoor and outdoor environment with aesthetically pleasing plants and trees to improve indoor air quality and conditions.
- v. The choice of building materials should be done with consideration for thermally insulated properties.
- vi. Proper building Orientation improves lighting results, ventilation of spaces and effect of sunlight.
- vii. The research recommends the use of deep verandas or balconies to serve as shading elements to reduce direct solar radiation impact on the building.

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