A COMPARATIVE ASSESSMENT OF HUMAN THERMAL COMFORT OF SARKIN-PAWA AND LIMAWA-MINNA, NIGER STATE, NIGERIA, USING THE EFFECTIVE TEMPERATURE INDEX

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF TECHNOLOGY IN GEOGRAPHY WITH ENVIRONMENTAL MANAGEMENT (ENVIRONMENTAL DEVELOPMENT PLANNING)

JUNE 2008

DECLARATION

I, MUHAMMAD, HAMEED BABA (M.Tech/SSSE/2005/1464), hereby declare that this research project titled: A COMPARATIVE ASSESSMENT OF HUMAN THERMAL COMFORT OF SARKIN-PAWA ANDM LIMAWA-MINNA, NIGER STATE, NIGERIA, USING THE EFFECTIVE TEMPERATURE INDEX has been conducted by me under the guidance of DR P.S. AKINYEYE, of the Department of Geography, Federal University of Technology, Minna and have neither copied someone's work nor have someone else done it for me. Credit has been given to writers whose works have been referred to in the project

MUHAMMAD, HAMEED BABA
(M.Tech/SSSE/2005/1453)

DATE

CERTIFICATION

This thesis titled: A Comparative Assessment of Human Thermal Comfort of Sarkin-Pawa And Limawa-Minna, Niger State, Nigeria, using the Effective Temperature Index by: MUHAMMAD, Hameed Baba (M.Tech/SSSE/2005/1464) meets the regulations governing the award of the degree of Master of Technology (M.Tech) of the Federal University of Technology, Minna and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

To my father Mallam Muhammad Kutuna Ukata and my mother Zainab. To my wife, Zuwairatu and children, Zayyad, Zainab, Abubakar-Sadiq and Habiba for their support and unrelenting understanding. May the All Mighty Allah bless them . Amin.

ACKNOWLEDGEMENT

In the name of ALLAH, the compassionate the merciful, years ago I knew little about Environmental Management. That I now possess a knowledge of the subject is due to many people unfortunately far too numerous to mention here individually. Nonetheless I am in their debt. However, many thanks to all those who have taught me, to those who taught me knowing they were doing so, and to those who taught me without knowing they were doing so. Al-hamdulillahi wa shukrulillah- praise belongs to Allah and thanks belongs to Allah.

ABSTRACT

People learned by trial and error the influences of weather on their dwelling design. Building form part of mans environment. This research work specifically deals with human thermal comfort in relation to their existing and future dwellings. The general idea behind the proposal was to measure the level of human stress using effective temperature index, questionnaire and physical assessment of the study area were utilized in the collection of data's relevant to the research proposal taking into cognizance the climatic elements of the study area and inconsideration of different building designs and building materials used in the construction, as it affects their socio- economic performance and to provide data's for future designs (planning) and protection of the environment. The findings show that population, Poor ventilation, direct influence of solar radiation, windy rains, terrain finishing's and buildings orientation are examples of such problems that lead to discomfort. The dwellings mainly rely on mechanical systems to separate conditions inside from those of outside. The environment of Limawa and Sarkin- Pawa are rarely within acceptable comfort limits, 66.6% of the people in Sarkin-Pawa were comfortable as against 6.6% in the Limawa-Minna. It is recommended that, Planners and Architects should have climatic data, to have a clear picture of the year- round, every moment of the day, and performance of climate to achieve desired human comfort.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

The study of mans environment is the central theme of GEOGRAPHY; While land-use is the most important way by which man is related to the environment. The earth system or earth's environment owes its ability to support life to a complex and delicate balance between all things (living and non living) that make it up. These are land (soils, rock, mineral), air, water and plants and animals (including man). When we talk of the environment, we are referring to these components and the interaction processes or mechanisms which link them. These components collectively constitute the resource base anywhere on the surface of the earth and consequently determine the standard of living attainable. Man builds houses, roads and walk on land. He tills the soil to grow food crops and utilizes minerals to make industrial products of various types. He breathes air (oxygen) and finds protection under the atmosphere (the envelope of air around the earth), and from harmful radiation from outer space. He finds comfort in the evolution of weather and climate made possible by the atmosphere. The atmosphere also enables transportation and communication. Water on earth is important to man for domestic (drinking, cooking, washing, bathing etc) agricultural (rain-fed) and irrigation farming, livestock keeping),

industrial (Cooling, processing and packaging) power generation (hydro-electric power generation e.g. shiroro, Jebba and Kainji Dams). Fishery (fishing and aquaculture), and recreational/ transportation (boating, swimming, river transport) water in addition is the basic building block of all living cells. Plants and animals provide man with food, fibre, clothing, medicine, building materials, furniture, paper and industrial raw materials. In addition to these, plants perform other important environmental roles. Namely, they protect the soil from erosion, allow for infiltration of rainwater (necessary for groundwater recharge) enhance convection through reduced reflection of incident radiation and through evapotranspiration, maintain the nutrients cycle through the shedding of their parts, and moderate micro-climate.

The linkages between these components are so intricate that the exact nature of each of them is dependent upon the nature of the other's. In other words, if any of them were to change, all others will change and the set-up or system will subsequently attain a new state of equilibrium or balance. Having established the nature of the environment in terms of its components and linkages and man's complete dependence on them for survival, it is pertinent to remember that while every resource is ours for use, it is our responsibility to ensure that some of it is left for future generation's use. It is now recognized that, of all

factors and variables that affect, shape and influence life, man's activities and the very survival of man on the Earth, none is as significant and overwhelming in its impact as climate. Although, man has no control over climate he is the "Architect of climate change". Climate affects the soil, vegetation and water resources, which are man's basic natural resources on which life depends and constitutes an agent of economic advancement. Human comfort is assumed that under equitable climate is guaranteed. There exists therefore a delicate relationship between man, climate and environment, which is synonymous with "Balanced or Stable ecosystem".

Increase in human population witnessed during the last century and the resultant increase in human needs (food, shelter, energy, industrial products etc) has resulted in a rapid disruption of this equilibrium. Various land-use practices, infra-structural designs, massive water impoundment especially in semi-arid areas for agriculture and domestic water requirement in human habitats have depleted natural resource endowments. In the Nigerian context, the discovery of oil have led to great increase in wealth and the desire to import Architectural designs that are not environmentally friendly and the resultant effect is imbalance in the environmental system. Often climatic factors have been ignored in the planning, design and construction of cities to the detriment of

human comfort, well-being and the urban environment. On a metropolitan scale, land-use and design have implications for urban air quality, energy consumption and the rational use of resources. At the same time the design features of each building influence the health and physical comfort of household. Generally, it can be deduced that excessive climatic change in any form has an unpleasant influence on the biophysical comfort of human beings and they are naturally curious in finding solutions to their problems instead of acclimatizing. It is only where a solution could not be affected that they start thinking of acclimatization. In the present global climatic changes, which are characterized by extreme conditions at both seasons, man has been trying to adjust to his habitat by alleviating the conditions. The steps adopted include change in building orientations, use of sun-shading devices as well as mechanical means of ventilation. All these are in addition to careful and critical application of specific building materials depending on the peculiarity of the situation. It's a well known fact that each climate region is associated with its peculiar problem. For the purpose of this project, emphasis is basically laid on warm humid climatic region of limawa and Sakin- Pawa. Various weather monitoring techniques using thermometer; wind anemometer & Dry-Wet thermometer are employed for the purpose of this research.

1.2 STATEMENT OF THE PROBLEM

Sulphate attack on sand Crete blocks and concrete is a known phenomenon and thermal conductivity of any building material is an important parameter especially in the tropics because of its important on the total cooling system and energy conservation. A study of the thermal conductivity of the materials used is also essential in order to relate the strength and qualities of these buildings to the corresponding thermal comfort. It's necessary to improve the quality of the environment for sustainable comfort. The waves of concern is on environmental problems vis- a-vis on man and the environment. Myriad of these environmental problems varied in magnitude with serious consequences on both man and the environment.

Limawa area part of Minna the Niger State Headquarters is highly populated. It has a lot of buildings ranging from residential to institutional buildings including religious buildings (Mosques and Churches).While Sarkin-Pawa is a village/town with less number of habitant/population. A critical survey carried out in these areas show that majority of these buildings at Limawa are not weather friendly and are not basically suitable for the prevailing weather condition. But, the structures at Sarkin- Pawa are much friendlier compared to Limawa. This is because Limawa is now over-populated and the orientation and

planning was done by the colonial masters in the 50s. Limawa falls under warm humid climatic region. As such, all designs meant for tropical dry sub humid or semi-arid –climatic zones can fit in Limawa – Minna. A critical survey and analysis shows that it is easy for one to ascertain that most of the buildings in Limawa are basically for another climatic region especially the modern structures set-up, where the designer's created beauty impressive neglecting the future implications i.e. parapet walls that are suitable for dry sub-humid and tropical region of Nigeria (where rainfall is relatively low and wind pressure is relatively high), it constitutes problem to the humid tropical region of Nigeria (where rainfall is relatively high and wind pressure relatively low).; most of the buildings with parapet wall roofing's leaks and deteriorate faster than those with well-defined pitched roof. Proper landscaping designs helps to reduce the radiant heat, filter air, and prevent penetration of sun (as sun breakers) and as wind breakers.

1.3 AIM AND OBJECTIVES

The inhabitants of Limawa and Sarkin-Pawa areas of Niger State, are engaged in activities such as; farming, trading; fishing e.t.c. to earn a living. The concept of climate and human comfort are important parameters in measuring the productivity ratio of human activities under a prevailing climatic condition. The

human thermal comfort has been the concern of environmentalists and has led to research carried out on this aspect of environmental development/planning.

The major aim of this project is to establish to an extent various weather control techniques that will take care of a large number of existing buildings and proposed buildings in Limawa and Sarkin-Pawa for the maximum comfort of the occupants.

The objectives of this project are:-

1. To highlight the design consideration and implications of different weather control techniques.
2. To highlight to a great extent, the various ways or techniques by which these climatic effects on building can be controlled to achieve optimum comfort for the inhabitant of Limawa and Sarkin-Pawa.
3. To assess the impact of climatic factors e.g. Solar radiation, precipitation, winds etc. on buildings as a structure with reference to warm humid climatic region by means of survey using Limawa and Sarkin –Pawa as the case study.
4. To make recommendations on ways of achieving weather friendly designs to enhance human socio-economic performance.

1.4 JUSTIFICATION FOR THE STUDY

This research is set out to reconcile urban planning and building climatology as two related disciplines that centre around mans activities on the environment. This study will enable the planner and architect at planning and design stages to analyze the effect of thermal comfort of man in relation to his habitat and the likely socio-economic consequences. It will also draw Architects to employ climatic design for the enhancement of human health as well as to minimize climatic modification. The climatic elements determine the building pattern and choice of building materials.

Sarkin-Pawa is at the verge of its growth. Therefore, at its developing stage there is the need to make use of appropriate climatic data at planning and design stage by Munya Local Government Council, while Limawa is fully developed without taking cognizance of the climatic data. People's ideas most at times, are limited to the aesthetic appearance of building and level of wealth without caring or minding about how environmentally friendly the building may be.

A careful survey has been made by the researcher to examine how human comforts are being regulated by the external climatic condition. Therefore there is the need to achieve a balance in buildings where most of man's activities are carried out.

1.5 SCOPE AND LIMITATION

The researcher basically emphasizes on warm humid climatic region where Limawa and Sarkin-Pawa are located. The principal climatic elements considered to human comfort and building design includes: - temperature, wind, humidity, radiation and precipitation. However, the detailed description of these elements, their distribution, interaction and measurements is beyond the scope of this research. A general description and brief introduction are highlighted for a better understanding of the subject matter. In addition to the foregoing, the scope to this research is also limited to natural and structural consideration of weather control in buildings. (I.e. that the full and elaborate materials schedule and specification are not given)

1.6 THE STUDY AREA

Niger State was created by the Late General Murtala Mohammed regime. It was curved out of the former North Western State in 1976; the state is part of the middle-belt region of Nigeria. The area is generally sparsely populated.

1.6.1 GEOGRAPHY: - This research is confined to Minna town (Limawa area) which lies at latitude $9^0$37' North and Longitude $6^0$33' East on a geological base of undifferentiated basement complex rock of mainly igneous.

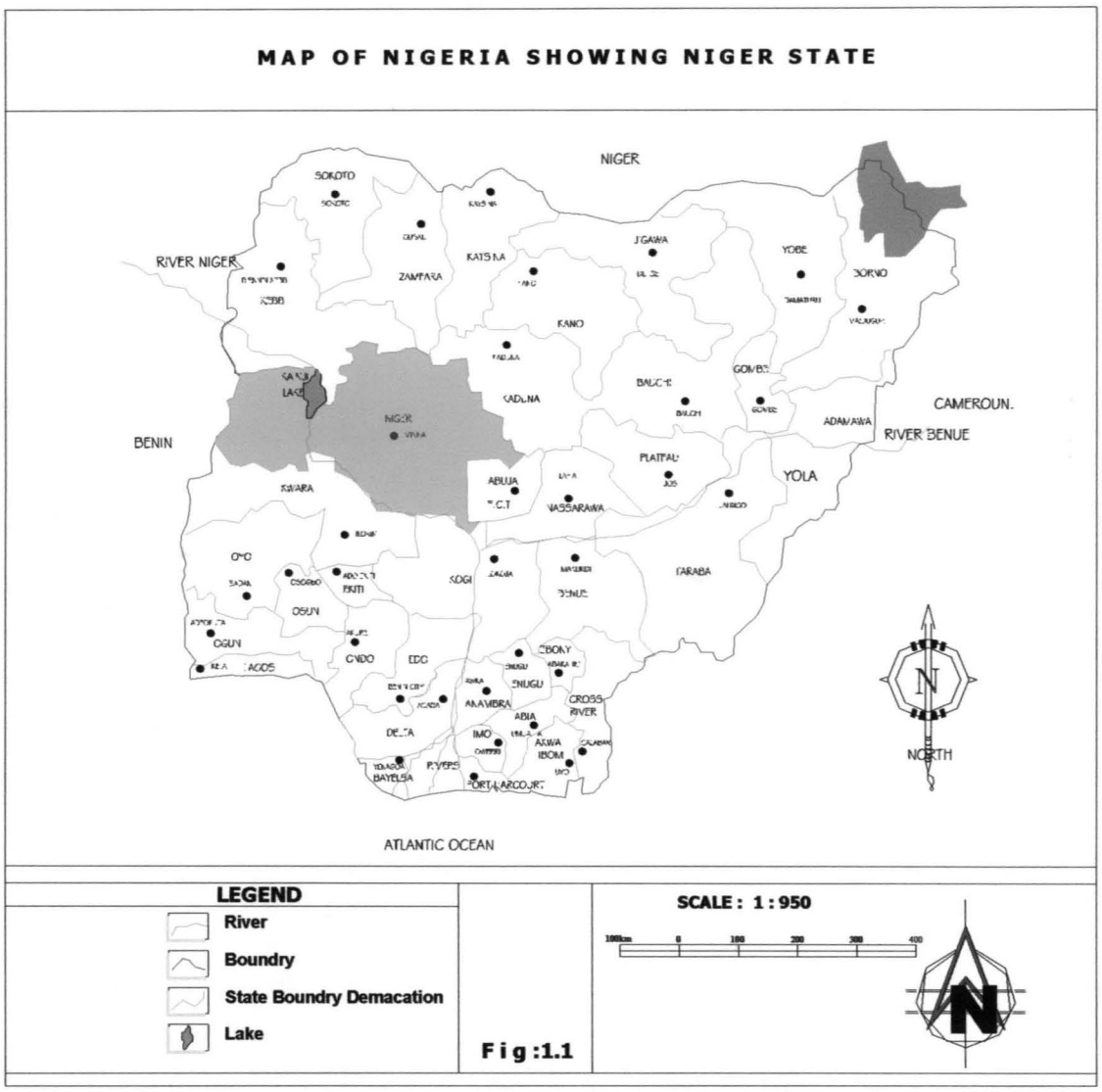


FIG 1:1 ADMINISTRATIVE MAP OF NIGERIA SHOWING NIGER STATE

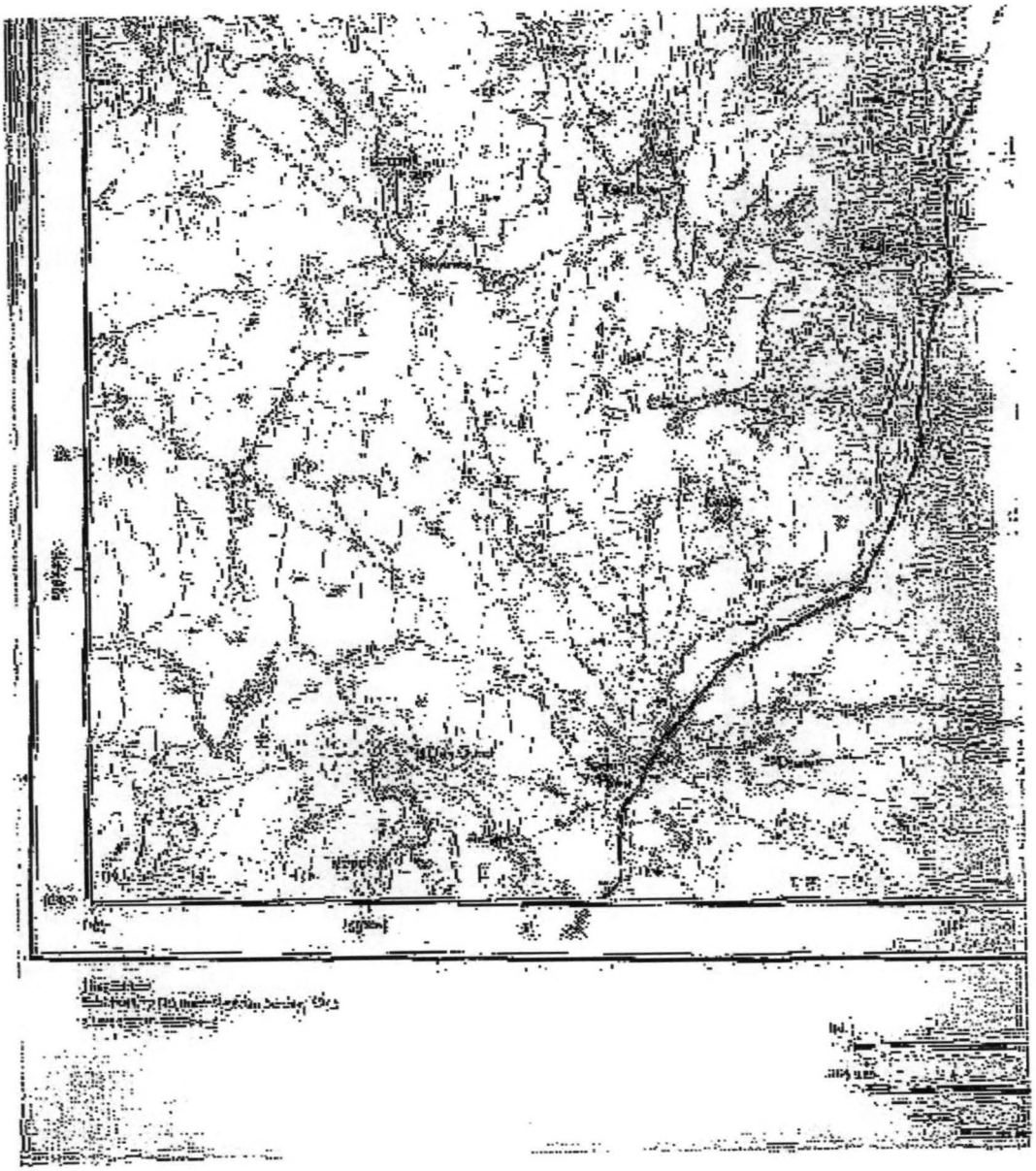


FIG 1:3 TOPO AREA OF SARKIN-PAWA

FIG 1:3 LAY-OUT OF LIMAWA-MINNA

To North-East of the town is a continuous steep out crop of granite rock which limit any urban development in that direction. Sarkin-Pawa is on latitude 10^0.2' North and Longitude 7^0-6' East. The terrain is relatively flat and the soil is loamy and favorable for farming. Limawa and Sarkin-Pawa experiences distinct dry and wet seasons, the wet season decreasing in length and amount of rainfall from eight to seven months. The mean annual rainfall of Minna and Sarkin-Pawa varies, however, the mean annual rainfall recorded are 1334mm and 1346mm respectively. The rainy season in most cases starts in April and last between 190 to 200 days. The mean monthly temperature is higher in March at 30.5^0c and lowest at 25.1^0c in January. The hill to the south and east of Sarkin-Pawa is steeply sloping rocks outcrops. A major drainage valley flows from the outskirts of the town at South East and North East respectively with many minor drainage channels feeding into it. There are storm water runoffs from the hills to the east. There are also large and isolated rock outcrops in this landscape and also some areas of scattered rocks.

1.6.2 TEMPERATURE: - Mean temperature is relatively constant throughout the year. It is around 25^0c with maximum temperature being experienced in the December to March period and minimum between June and September. During the long dry season time temperature at night can be noticeably cooler.

1.6.3 RELATIVE HUMIDITY: - Relative Humidity of these area's in question, are generally high throughout the year between 79% or 80 % ref. Professor Adefolalu (1977). Although as expected, the highest figure is experienced during the wet season and lowest during the dry season.

1.6.4 WIND: - Limawa and Sarkin – Pawa is under the influence of two winds namely:-

1. The Northeast trade wind and
2. South west monsoon wind.

The former is characterized by high velocity, dry and it carries dust particles. It is quite predominant in the day time and very powerful between the months of December and February. The later on the other hand is characterized by it low velocity (gentleness), humid nature and its dust free. It originates from the coast hence its wetness. It is predominantly at night and flows all year round.

1.6.5 VEGETATION: - Sarkin-Pawa generally has farm land vegetation. However, human activities have reduced it to some extent. While in Limawa there is no vegetation of all kind due to urbanization. It is completely built- up with tarred roads and paved compound.

1.6.6 POPULATION: - Following the 1991 population figure Limawa (Minna) has a population of about 4000 and Sarkin-Pawa has about 1500. But with the current population growth rate, the figure has been exceeded tremendously.

1.6.7 ECONOMY: - Limawa is dominated by civil servants and traders. Only very little fraction are farmers while at Sarking-Pawa, they are dominated by farmers. Very few are civil servants and traders.

CHAPTER TWO

LITERATURE REVIEW

2.1 ORIGIN OF BUILDING

The concept of building as form of shelter arose as a result of permanency in man's settlement. Settlement has to be distinct in such way to accommodate human population and human activities. The need for a clear knowledge of the origin of human settlement can not be over emphasized. Origin of every human settlement can be traced with the help of history. According to historians, human beings wondered from one place to another in search of food and shelter, this led to the growth of villages/towns and cities (urbanization) when man acquire and have reserve. A number of factors led to the origin and growth of human settlement, which includes"- Social, economic, political and physical factors. As earlier mentioned, early man were known to be moving from one place to another in search of food and shelter. Their main occupation was hunting and fishing the early man was not stable at a particular place. It was a problem for a family group to come together at a specific locality for a period of time to interact and discuss matters affecting them. During the period of discussions they also mapped out strategies that will enable them fight against external aggressions. Subsequently, as the population of human beings expanded, hunting and fishing became inadequate to meet the challenging

population. Then, cultivation of plant became the appropriate supplement. The initial temporary settlement then graduated to permanent settlement. The Bronze Age also led to the domestication of animals and plants. This development in the production of food supply encouraged a higher level of permanence of settlement. The interest by architects and historians in the primitive and vernacular form is according to RykWert (1992) a universal manifestation of a search for roots. It is a validation of what we do, in terms both of what has gone before and of where we are going. "Paradise is a promise as well as memory", certainly virtuous shows these in terms. He describes the beginning of a house as being connected with the discovery of fire and indeed of language. A storm cause the branches of trees to rub together, they catch fire and cause a forest conflagration. On it subsidence the savage creatures drew near, form comfort both in the fire and in each other's houses. At first these were in caves, bent troughs and even rests (in initiations of births). Soon they set up forked stakes, connected with twigs and covered in mud for the walls. The flat roofs were pitched and had eaves, reads and leaves were used as a cover. Vitruvius finds confirmation of his theory in the survival of such in various part of Europe. He notes the pit dwellings of the Phrygians (dug the soil, on account of the lack of forest and, hence, timber, but never the less having roofs of logs covered with reads and brush wood. Other roofs he notes

are of mud and he then goes on to describe the beginning of real house with proper foundation, using brick or stone walls and roofs of timber with tiles. From wondering and uncertain judgments, the builder's now proceed to the assured method of symmetry. So architecture was born from an elaboration of the elemental shelter.

So far some historical and more recent notions of buildings as shelters, i.e. Structures which intervene by acting as barriers and as responsive filters between the natural or urban environment and the range of environments required for human activities. Buildings serve many purposes. The four which are commonly recognized are being functional, social symbolic and artistic. These are interwoven in the language of built form-that is, in both designs of building and in the use and experience of buildings. The need for shelter arises from the basic objectives which a building is designed to attain. Then attainment needs a pattern of activities and these take place within an environment which is the outcome of the performances of the building hardware system. This hardware is the fabric, the services and contact of a building continuously affects the physical more specifically the thermal environment, variation in which both in space and in time, may be needed perhaps aesthetic experience based on thermal sensations.

According to Albert (1955) the books on Architecture, in the beginning men looked out for settlements in some secure country; and having found a convenient spot suitable to their occasions, they made themselves a habitation so contrived, that private and public matters might not be confounded together in the same place but that, they might have one part for sleep, another for their kitchen, and other's for their necessary uses. They then began to think of a covering to defend them from sun and rain; and in order thereto, they erected walls to place this covering upon. By this means they knew they should be more completely sheltered from piercing colds and strong winds. Lastly in the sides of the walls from top to bottom, they open passages and windows, for going in and out, and letting in light and air and for the convenience of discharging any wet or grass vapors which chance to get into the house.

2.2 BUILDING AND CLIMATE

Climate is the weather condition of a place or an area .i.e. condition of temperature, rainfall, wind etc. the climate of a given region, which not only play a great part in the composition of the soil but also affects the character of plants and animals and the energy of men, has come to be regarded as a description of the prevailing condition and is determined by the pattern of several elements and their combination and interaction. The principal climatic

elements when human comfort and building design are being considered are, solar radiation, long wave radiation to the sky, air temperature humidity, wind and precipitation (rain, snow, etc). Climate of a region is assess according to the long-term averages for the levels of each of the factors but as conditions may vary greatly from day to day and from year to year deviations from the average should be taken into account for a more realistic view when dealing with climatic problems for, many applications, the extreme conditions and their expected frequency may be of greater importance than the average conditions.

Naturally, Buildings in the tropics should differ from one situated in the temperate zone. But it is less obvious that even in the same area, city/ town, village or rural area there are micro climatic differences which should be recognizes in the design and construction of building. As a result various influences the air temperature in an urban area, for example can be as much as 800c higher than in the surrounding country side. While the relative humidity can be 5-10 percent lower. Climate design is based on typical or normal weather condition and it is usually relatively easy for the designer to obtain the necessary meteorological data for any given region from a variety of published material. Unlike regional climate data, however, site climatic information is not readily available and will have to be acquired through personal observation and local experience.

It is natural that design based on a better climatic understanding will change and improve the quality of built forms. Many designers believed that variety, complexity and cultural meaningfulness of much that we admire from the past was partly the outcome of a rational and sensitive relationship to the land and its climate, a relationship which we should seek to re-establish. Climate analysis may introduce criteria for acceptable shared values into environmental design. To build and maintain in cold air or hot climate, this maintenance can be a major burden on occupants and there is evidence that the old, the poor and those with large families are the deprived sections of the community of acceptable standards of climate control. The achievement of any of these objectives will require a scientific analysis of climate which will be brought about only by a continuous reminder, by and to all concerned of the shelter function of buildings. Before the necessary measurement and theoretical method were developed, the application of climatic knowledge to building design was based by the theorists of the elements, on personal observation and to some extent, the living, vernacular tradition which the author's observed. Vernacular climatic building designs, on the other hand, was entirely based on the availability of well tried models and on personal experience in which climate, materials, form and comfort were integrated. The gaps between architecture and the vernacular and between the architects own theories and their actual practice, were quite

large in this pre-scientific age and exist today as much as they did then (contemporary critique of the vernacular forms is largely devoid of anything but the most simple climatic generalization. The brief examination of those attitudes at various times which follows may help in the understanding of the theoretical standpoint within which the design principles and aids can be placed.

In Vitruvius book "The Ten Books on Architecture" translated by F. Granger, Vitruvius's work was deeply influenced by climatic awareness and advice. This starts from principles of site choice and town lay-out to avoid the funneling of prevailing winds, the avoidance of scorch wind, sound heat, as well as of excessive humidity in the choice of sites. He described climate as a determinant of the style of the house. Houses should conform to diversity of climate, being of southerly explosive, and roofed in the north and the northerly exposure, and more open in the south. There follows a short discourse on how the pitch of human voice changes with latitude the southerner's have high and shrill voices, the Northerners speaking in heavier tones. Bodies and minds correspond to these climatic effects too-the Northerner's being of vest height, fair and grey-eyed, unable to withstand heat or fever but brace; the southerner's more stocky,

robust in heat but tumid. Hence Vitruvius, considered human comfort as the major factor to be determined when designing.

In the book "House Form and Cultures, by Rapoport (1969) A numerous examples are quoted to show that climatically inappropriate form are often used where cultural, symbolic or social factor's are the potent crucial ones. The technical ones may act as mediating filters or "possibility" influences. He illustrates a number of cases where migrations from one climate to another have not resulted in a change of form or even construction (although new materials may have to be used to build in the old methods), the survival in the same climate of entirely different forms side by side-an outstanding example of which is the public Indian group dwelling and the Navajo Hogan. Nevertheless he sees various house types as responding to climate very well; however, from time to time there seems to be a curious contradiction in his analysis which reduces the force of his own argument.

2.3 THE CLIMATE OF CITIES

A relatively large spatial and temporal variation in conditions takes place in and around the building surfaces. These effects can significantly alter the thermal response pattern of a building. When multiplied by the presence of several

hundred or thousand buildings in urban chipsets-the effects are more marked and give recognizable different climates to the urban region from that of its rural hinter land. The effects have been studied for some years- perhaps the outstanding contribution being chandler's study of the climate of London.

Wind velocity gradients are different over the rough urban terrain and over open country, although, in general, lower wind speeds are experienced in he city, because of the nature of building blocks, streets, and squares, there is a great deal of complex turbulence, especially at the based of tall building. Wind deflected downward by the facades of buildings joints that flow horizontally to create high velocity and turbulence at the side, downward wind flow on the leeward side. Streets often become wind tunnels, collecting spillage from adjacent surfaces and creating high velocities near the ground. These conditions will often create conditions of considerable discomfort dust and in low temperature, wind-chill.

Another major urban effect is on the radiation and temperature. The buildings and surfaces between them are generally of higher reflectively than those in rural area, but on the other hand, the radiation they do absorb is more slowly released by these high thermal capacity materials. The protection from wind and the emission of heating air-conditioning and other forms of energy from

buildings all combine to create the well-studied "Heat Island" of cities. This is particular marked at night and in cold weather, when the main city temperature may be as much as 40^0c above that of the suburbs and country side. Radiation and sunshine hours in cities are substantially less than those outside, due to the extra turbidity caused by smoke, dust and other pollutions. In cold climates in spite of decreased sun and radiation, city climate is likely to be higher temperature than rural areas the difference is about 10 percent according to chandler.

2.4 THERMAL COMFORT

Thermal comfort relates to the ability to eliminate discomfort and irritation, due to excessive heat or cold. In other words, it connotes a state of pleasantness. Two separate and independent causes of discomfort have been established: the thermal sensation of excessive heat and sensation resulting from wet skin. Givoni (1976) specified air and radiant temperatures and the air velocity over the body as the two major environmental conditions that affect the thermal sensations. A state of thermal balance is therefore essential for comfort. Comfort zone is thus a range of conditions through which thermal comfort can be experienced. Physiologically, a comfort zone is the range of conditions under which the thermoregulatory mechanisms of the body are put in a state of

minimal activity. The primary function of any building is to contract the main disadvantages of the climate in which it is situated. It should be able to filter, absorb or repel climate and other elements according to their adverse or beneficial contribution to the comfort of its inhabitants or user's. Human Comfort cannot be measured in terms of psychological factor alone, it includes the primary requirements (and this is particularly true in the hot climatic zones) of maintaining thermal balance between the human body and its environment. This involves keeping the internal temperature of the body within a certain range, regardless of the relatively wide variations in the external environment. The conditions under which such balance is achieved, and the state of the body when it reaches equilibrium with the surroundings depend on the combined effect of many factors, some, such as the activity, acclimatization and clothing are subject to individual radiation characteristic, while others such as the air temperature, radiation, humidity and air movement are environment factors. The body maintains a constant internal temperature by releasing superfluous heat to the environment and there is, as a result, a continuous exchange of heat between the body and its surrounding which may take place in four physical different ways: conduction, convection, radiation and evaporation. These physical processes depend on the climate and are influenced in particular by the

four aforementioned environmental factors, each of which may aid to impede the dissipation of surplus heat.

The contribution that conduction makes to the heat exchange process depends first and foremost on the thermal conductivity of the materials in immediate contact with the skin. A clothed person does not normally lose any great amount of heat by conduction and the physiological significance of heat loss by this process is limited to the local cooling of particular parts of the body when they come in contact with the cold materials. The body exchanges heat with surrounding air by convection. The form of heat exchange depends primarily on the temperature difference between the skin and air, and how much the air is moving. Long-wave radiation on the other hand, takes place between the human body and surrounding surface such as walls and windows. In this process the temperature, humidity and movement of the air have practically no influence on the amount of heat transmitted, which depends on the differences in temperature between the skin and the surfaces that surround or enclose it. The body may gain or lose heat by these processes depending on whether the environment is colder or warmer than the body surface. In cold condition the skin temperature is higher than the air temperature, while in hot countries the situation is reversed. When the surrounding temperature (air and walls) is above

25^0c, the clothed human body cannot get rid of enough heat by either convection or radiation and lost of perspiration becomes the sole compensatory mechanism. Water consumes heat in order to evaporate, and as human normally lose about one litter of water a day in perspiration; a fair amount of heat is taken from the body to evaporate it. The extent to which heat is lost by evaporation depends, on the clothing worn; the levels of surrounding vapour pressure and the amount of air movement. The lower the vapour pressure the more the air movement, the greater will be the evaporative potential and increase the humidity over the skin.

2.5 COMFORT ZONE

The term comfort zone simply refers to the range of conditions in which thermal comfort is experienced. It differs with individuals and is affected by the clothing worn, geographical location, age and sex. Comfort zone is defined as a subjective assessment of the environmental condition, the limits of the zone do have a physiological basis, the range of conditions under which the thermal-regulatory mechanisms of the body are in a state of minimal activity. Comfort, which is also dependant on not only the air temperature and that of the surrounding surfaces, but also on the relative humidity of the air and air movement cannot be expressed in terms of any one of them as they effect the

body simultaneously and the influence of any one depends on the levels of the other factors. Several attempts have been made to evaluate the combined effects of these factors on the physiological and sensory response of the body and to express any combination of them in terms of a single parameter or "thermal index" which can be set out on a monograph.

2.6 CLIMATE AND COMFORT.

Orgy (1963) in his book (Design with the Climate) was the first to propose a systematic procedure for adapting the design of a building to human requirements and climatic conditions. His method is based on a bioclimatic chart on which comfort zones for summer and for winter can be determined for the climatic region to which it is to be applied. Once this has been done any climatic condition determined by its dry-bulb temperature and humidity, can then be plotted on the chart; comfort requirements can be evaluated by deviations from the comfort zone and whether these can be eliminated by natural means, can be ascertained. The relation of indoor to outdoor conditions varied widely with different characteristics of building or design. As Givoni points out in his book; Man, Climate and Architecture, the bio-dogmatic chart is therefore limited in its applicability as the analysis of physiological requirement is based on the outdoor climate and not on that expected within the

building in question. He has proposed an alternative method, which was one of the thermal indices to evaluate the human requirements for comfort, from which the necessary features of building design to achieve this comfort are determined. The method involves estimation of the indoor climate expected and for practical use the suitability of ventilation, air temperature reduction, and evaporation cooling- for ambient condition combining different temperature ranges and vapour pressures- are plotted on an involved diagram chart.

Well designed buildings can provide comfortable conditions without the use of expensive energy consuming mechanical equipment. This is only possible, if climate is taken into account from the onset; if it is taken into account when deciding on the over-all concept, on the layout and orientation, and on the shape and character of structures among other things. Unfortunately most of the methods which the designer can use to help to solve the climatic problems are cumbersome and time consuming and to overcome this difficulty the Mahoney tables were developed by the department of development and tropical studies of the Architectural Association. With this method a number of the most easily accessible climatic data are assembled and entered in simple tables which help the designer to formulate recommendations for those features that must be decided during the schematic design stage.

CHAPTER THREE

MATERIALS AND METHODS

Two methods of survey were used in the process of gathering data in relation to the assessment of the existing buildings, utilities and services of the study area. They are reconnaissance and questionnaire survey methods. These methods were both used to collect two distinct types of data namely primary and secondary data through primary and secondary sources respectively. The whole processes were tailored towards the objectives of the study.

3.1 RECONNAISSANCE METHOD USING INSTRUMENTS.

Data were collected at two different locations Sarkin-Pawa (Station A) and Limawa (Station B). The purpose is to obtain a comparative analysis of the micro-climate in these locations and to see how much influence the ocean flow has on these locations. Data were recorded at selected intervals of time (30 minutes interval) between the hours 9.00am to 5.00pm. Data were obtained during the months of October and November 2007 for a period of three weeks by random sampling at Sarkin-Pawa and Limawa respectively. Data were recorded twice a week on Tuesdays and Saturdays. Data were noted at each location during the interval of time, other variables such as radiation, effect of clothing has been purposely held constant. The wet and dry bulb temperatures

of the different locations were taken. The weather conditions were noted all through the study period.

3.2 INSTRUMENTS USED

The dry and wet bulb thermometers and the sling psychrometer were used to record the dry and wet bulb temperatures. The wind speed was taken using the two different types of anemometers. All the instruments were in good conditions as at the time of measurements.

3.3 TYPES OF INDEX USED

There are many types of indices of comfort. These range from the use of body temperature which was found to be very unused because body seeks to prevent any change in body temperature. Sweat loss is sometimes used as an index but it tends to depend on the nature of the environmental stress rather than on the total thermal effects of the stress. Skin temperature has also been used by some as a comfort index, though it is less reliable than most other indices, because of the variability of skin temperature to the body. Effective temperature which was developed by Houghton and Tag Lou (1923) was used in this research. It is defined as the temperature of the skin and saturated atmosphere which has the same general effect upon comfort of the atmosphere. A particular conditioned

temperature, humidity and wind velocity produce the same thermal sensation to an individual is said to have the same effect temperature (Mather, 1974).

To compute effective temperature the following equations are used

ET $= 0.4. (Td + Tw) + 4.8^{0}c$ or

ET $= 0.4. (Td + Tw) + 50$

Where Td is dry or air temperature, Tw= bulb temperature and ET= effective temperature. The effective temperature will be used to compute the collected data in this research.

The second type of index used in computing the thermal comfort of the study area is rather more sophisticated and was developed by Lee and Henschel (1966). This index is known as the relative strain index.

The formula is:-

$$R.S.I = \frac{107 + 0.74 (Ta - 35)}{44 - ea}$$

Where Ta = air temperature and ea = vapour pressure.

The Heat strain index is defined as the ratio between the amount of perspiration, which must be evaporated from the skin to maintain thermal comfort and the maximum amount of evaporation, which can occur under the particular conditions. (Belding and Hatch, 1955) The above, definition was modified to

relative strain index, which takes account of the insulating efforts of clothing and net radiation of heat of the body.

Table 3.1 and Table 3.2 are effective temperature and relative strain index comfort classifications by Gaffney which are used in this research to determine human comfort in the study areas.

Table 3.1: Effective Temperature Comfort Classifications

Effective Temp. (^{0}C)	Comfort Class
28.00	High Discomfort
25.0-28.0	Discomfort
17.0-24.9	Comfort
15.0-16.9	Transitional (Cold)
15.0	Discomfort

SOURCE: (After Gaffney 1973)

Table 3.2: Relative Strain Index Comfort Classifications

Relative Strain Index	Comfort Class
0.1-0.25	Discomfort
0.26-0.29	Transitional
0.3- 0.4	Discomfort
0.4	distress

Source (After Gaffney 1973)

3.4 QUESTIONNAIRE SURVEY METHOD

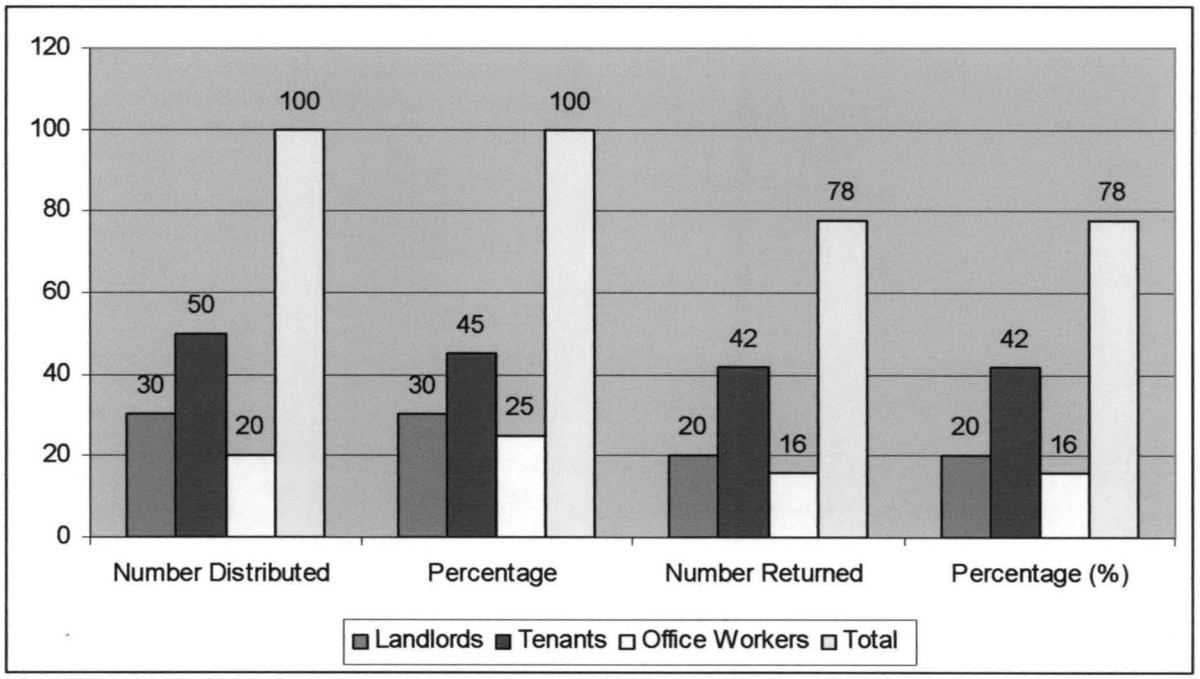
This method of survey involved the use of prepared questions, which were in printed form and distributed randomly to the occupants for their response. Data gathered through this method included, the residents perception of the existing designs and materials used, infrastructures in terms of their adequacy, quality, thermal comfort, the population of household distribution and characteristic. The socio-economic and cultural status of the residents were measured using the part of the questionnaire which required to know their economic and social background as these would determine type and quality of comfort required and the ability to value and maintain them. From 500 households at Limawa-Minna, 200 at Sarkin-Pawa my study areas, 80 house holds were chosen from 50 buildings as sample by means of random samplings at Limawa Minna, while at Sarkin – Pawa, 50 houses holds were chosen from 30 buildings as sample by means of random sampling.

3.5 SYSTEMATIC RANDOM SAMPLING

This method was adopted at the field to collect the required data as time and the size of the study area could not allow total coverage during questionnaire administering exercise. The systematic random sampling involves a systematic way of choosing a set of variables from a total to represent same whole

variables. In the application of the method the study area Sarkin-Pawa and Limawa were divided into wards and sampled according to category i.e. landlords, tenants and office workers.

Figure 3.1: Questionnaire Distributed and Response Collected

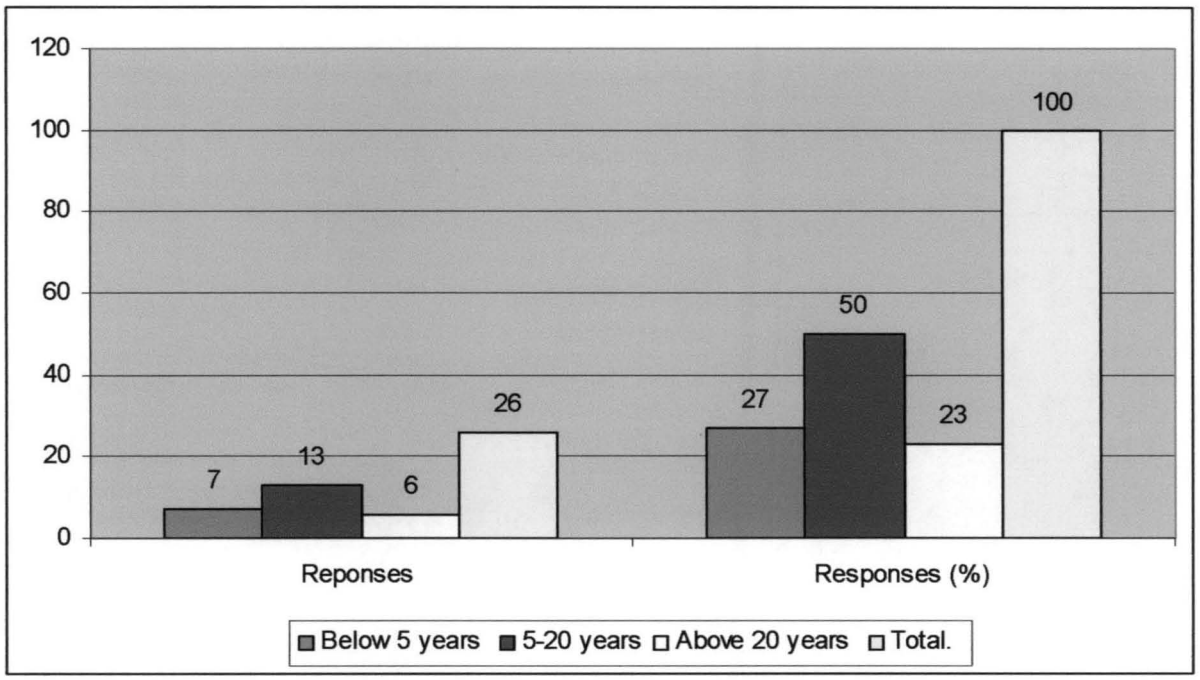


Source: Field survey November 2007

From the above figure, 30 questionnaires representing 30% of the sampled population were issued to landlords and 20 were returned completed. Also 50 questionnaire representing 50% of the population were issued to various residential tenants and 42 were returned completed 20 questionnaires representing 25% of the sampled population were issued to office workers from different establishments, 16 were returned completed.

SECTION "A" RESPONSE OF LAND LORDS/HOUSE OWNERS

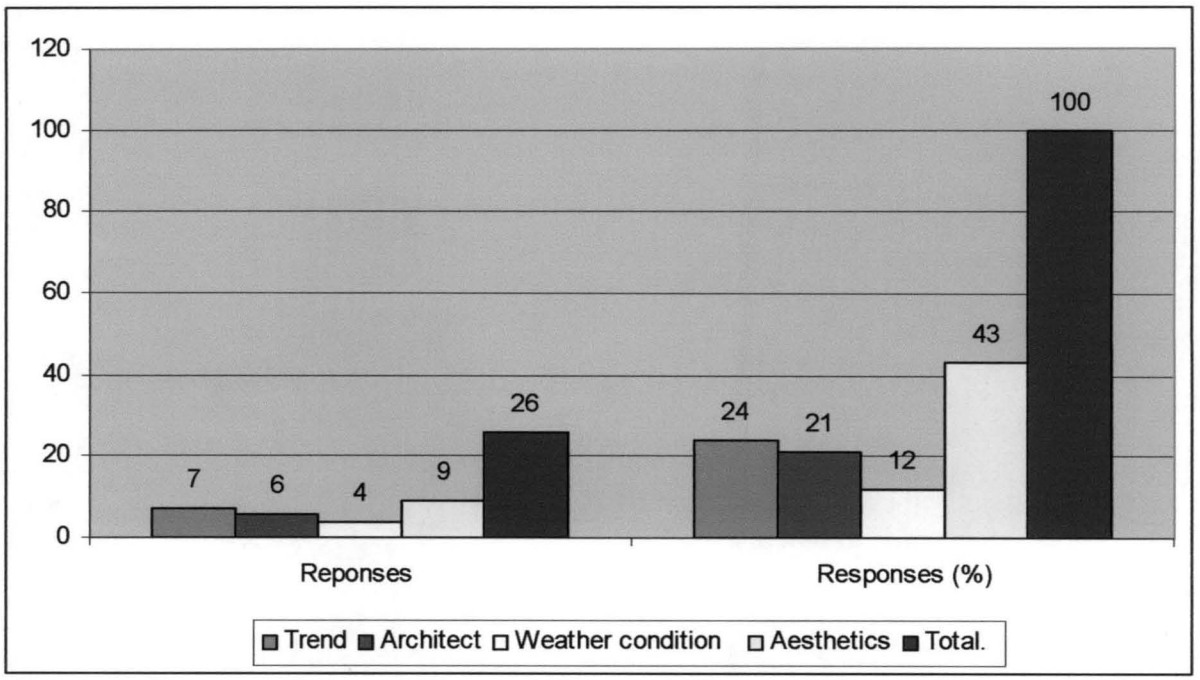
Figure 3.2: Age of Building



Source: Field survey November 2007

From the above figure, 7 respondents representing 27% stated that their buildings are below the age of 5. Thirteen (13) respondents representing 50% claimed that their buildings are within the range of 5 to 20 years. While 6 respondents representing 23% stated that their buildings had stood for more than 20 years. This shows different age grades of building in Sarkin- Pawa and Limawa respectively.

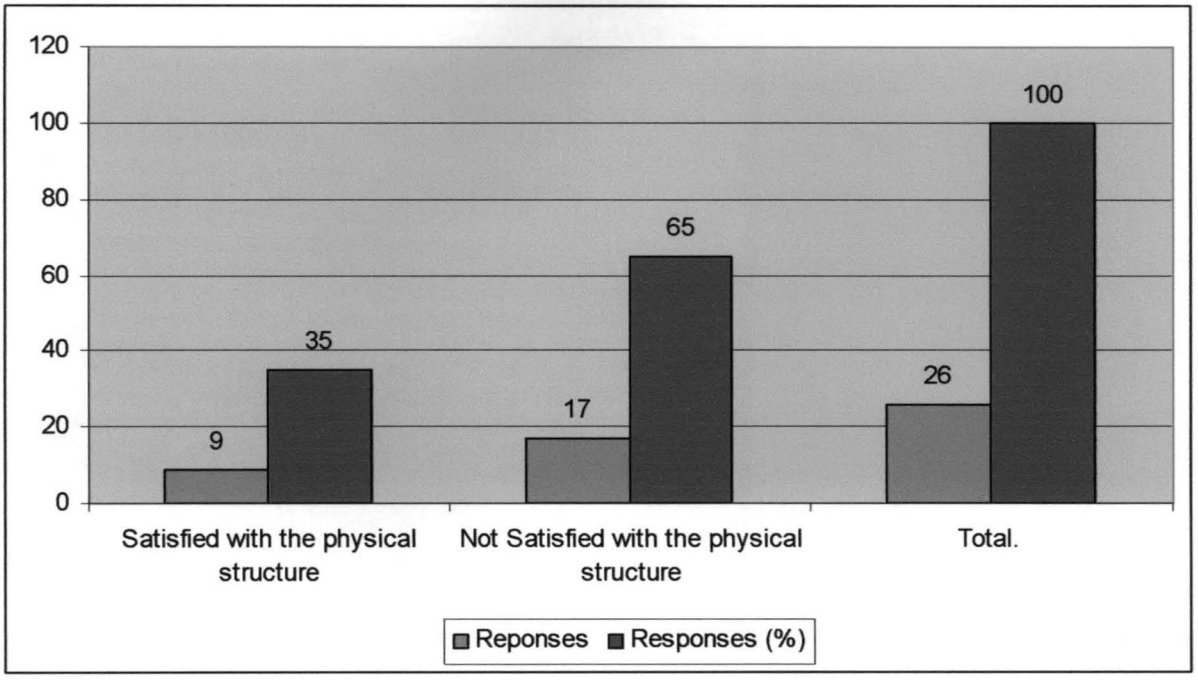
Figure 3.3: Factors that Influenced Choice of Building Type and Orientation



Source: Field survey November 2007

From figure 3.3, 7 respondent representing 24% stated that building styles in vogue of trend influenced their choice of building type. 6 respondents stated that they gave their designers free hands to give them a good design in terms of functionality and aesthetics, this represent 21%. Only 4 respondents representing 12% stated that prevalent weather condition influenced their choice and orientation of building types. While 9 respondents representing 43% stated that their major concern was the aesthetic values of their buildings. The above data shows the level of climate consciousness of people in their choice and orientation of building. Only few people also seek for professional advice.

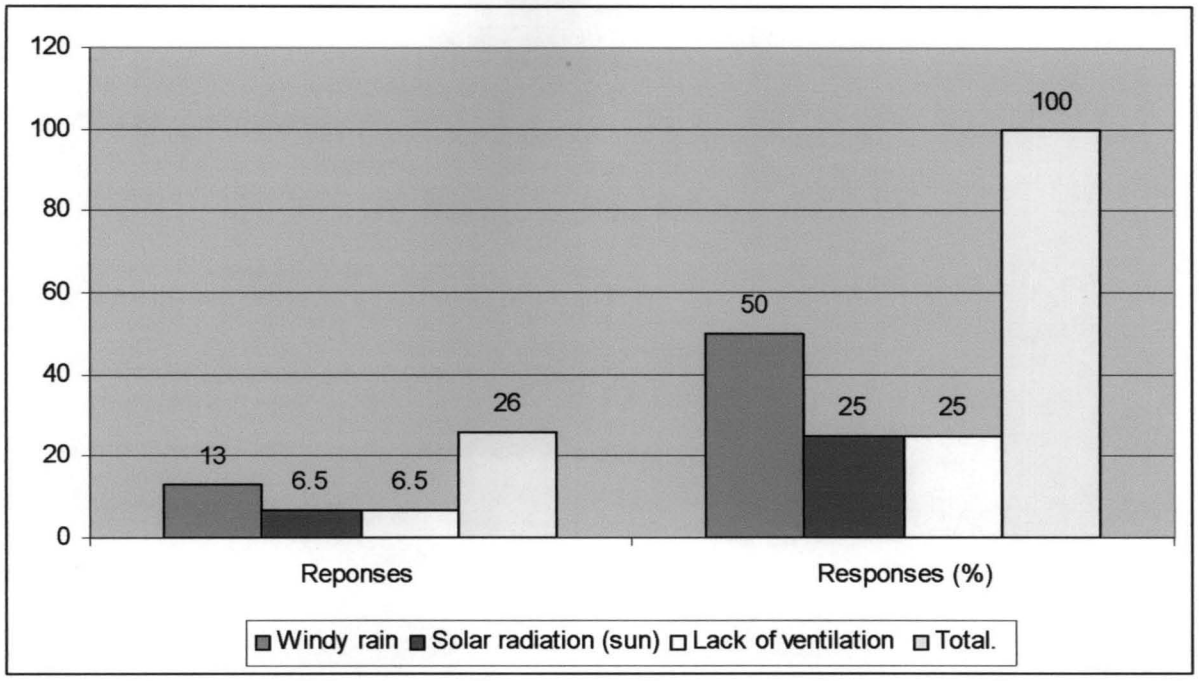
Figure 3.4: State of the Building



Source: Field survey November 2007

From the above figure, 9 respondents stated that they are satisfied with the physical state of their buildings. This represents 35% while 17 respondents representing 65% stated that they are not satisfied with the physical state of their buildings. The implication is that the buildings do not provide the needed comfort for the people.

Figure 3.5: Problems Encountered by the Tenants

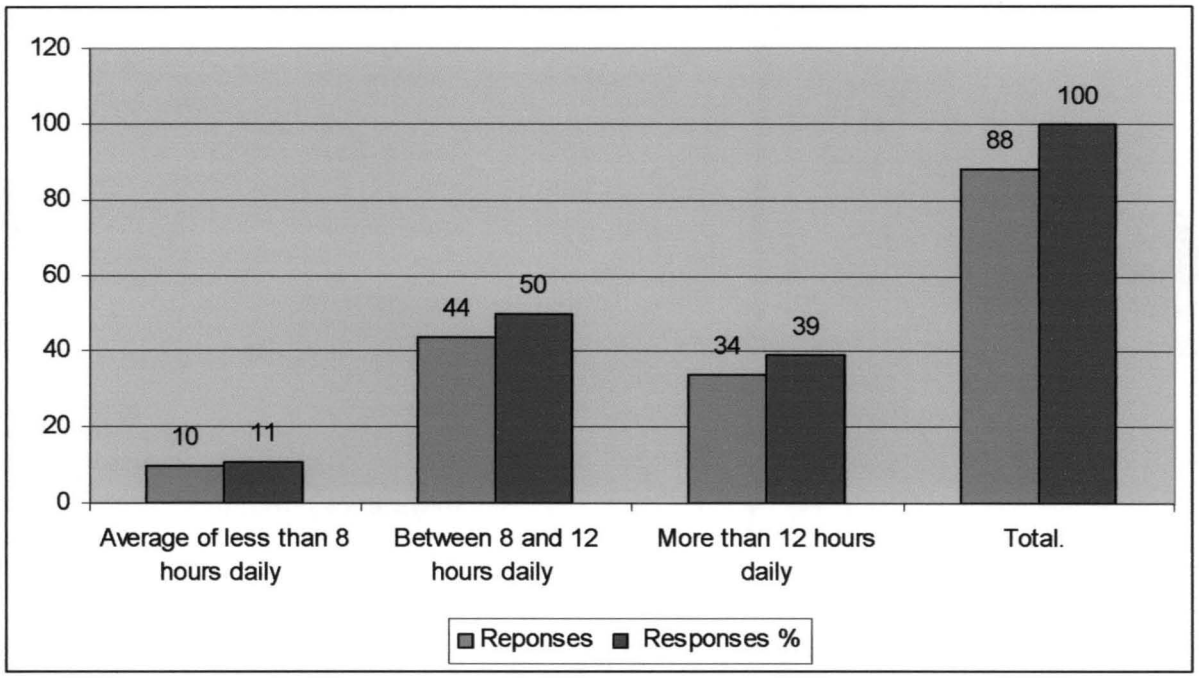


Source: Field survey November 2007

From the above figure 3:5, 13 respondents representing 50% stated that windy rain is the common complaint from their tenants. 6.5 respondents representing 25% each claimed that the common environment related problem encountered by their tenants are solar radiation and lack of proper ventilation respectively. This also implies that the tenants are in most of the period not very comfortable.

SECTION "B" RESPONSE OF THE OCCUPANTS

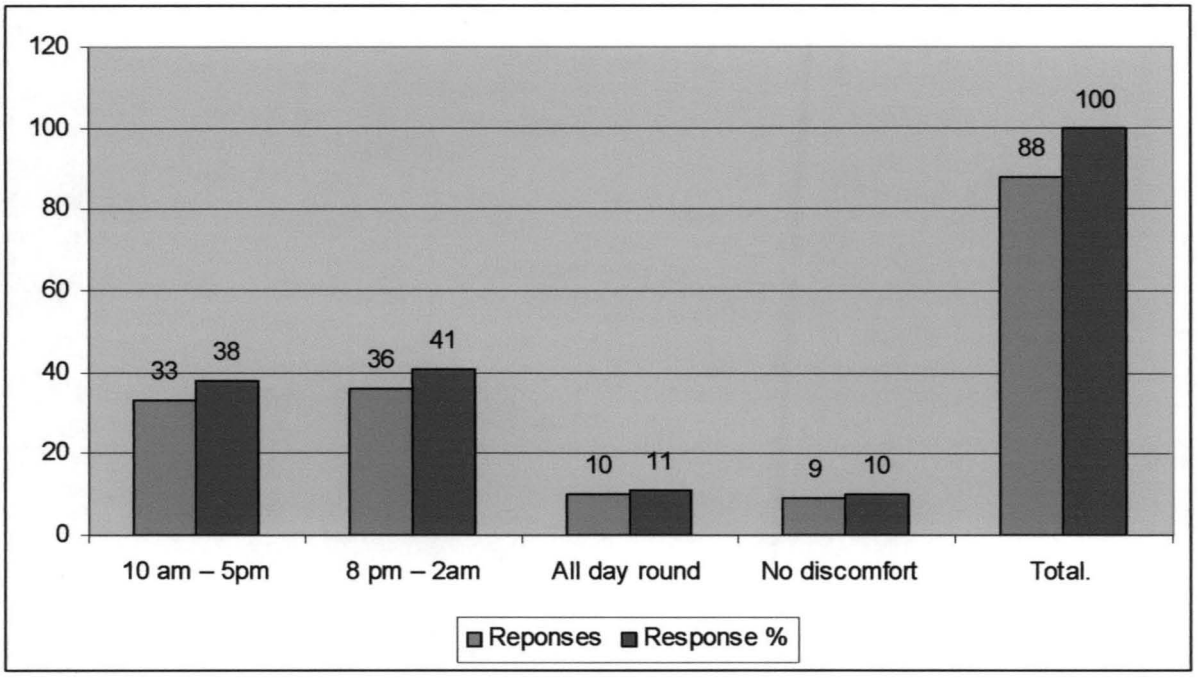
Figure 3.6: Time Spent in the House



Source: Field survey November 2007

In this section eighty-eight (88) questionnaires were returned as can be seen in figure3.6. The numbers of hours an individual spent in his house varies and this depends on the environment in which the building is sited or located. From figure, 10 respondents representing 11% spend less than 8 hours in their houses daily. 44 respondents representing 50% spend between 8 and 12 hours daily in their houses. This shows that greater number of sample population spend at least 8 hours in their houses.

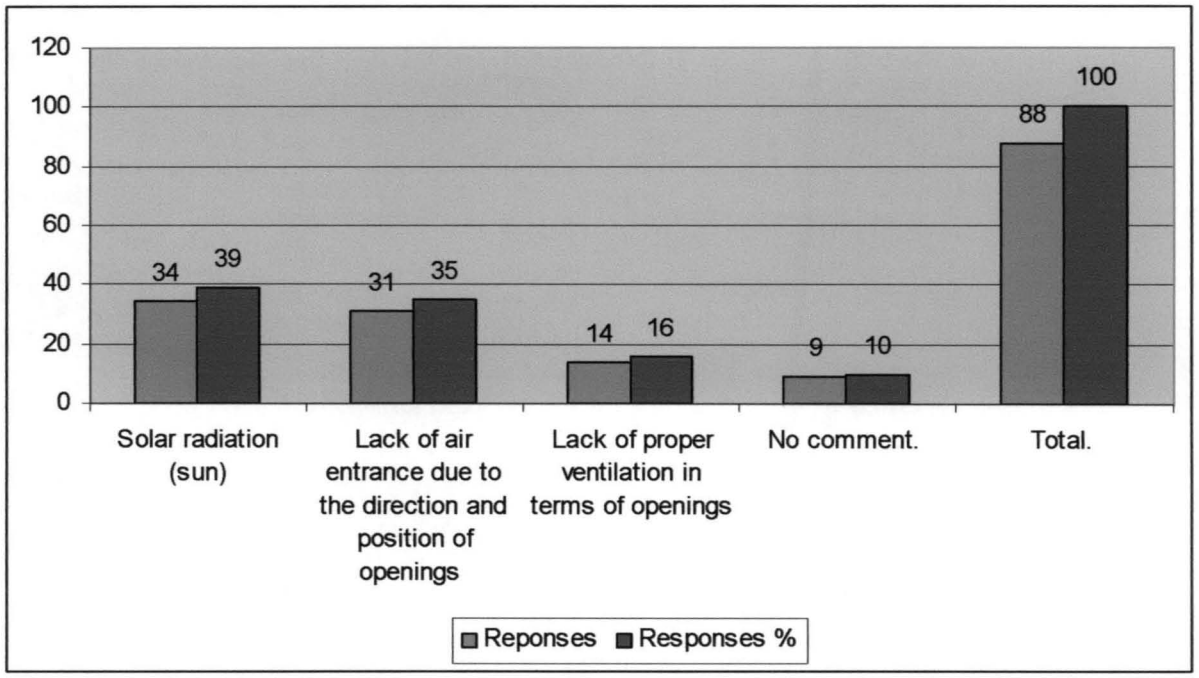
Table: 3.7 Time Within Which Major Discomfort is Experienced



Source: Field survey November 2007

From the figure above, 33 respondents representing 38% stated that they experience major discomfort between 10am and 5pm. This is because the heat from the sun is being trapped on the surface. This heat envelope the surface and the building ascribed the heat and the absorbed heat is then released to the environment, this making the people very uncomfortable. About 41% stated that they experience their major discomfort between 8pm to 2am. 10 respondents representing 11% stated that they have discomfort both night and day. While 9 respondents claimed that they have no discomfort at all and this represents 19% of the sampled population.

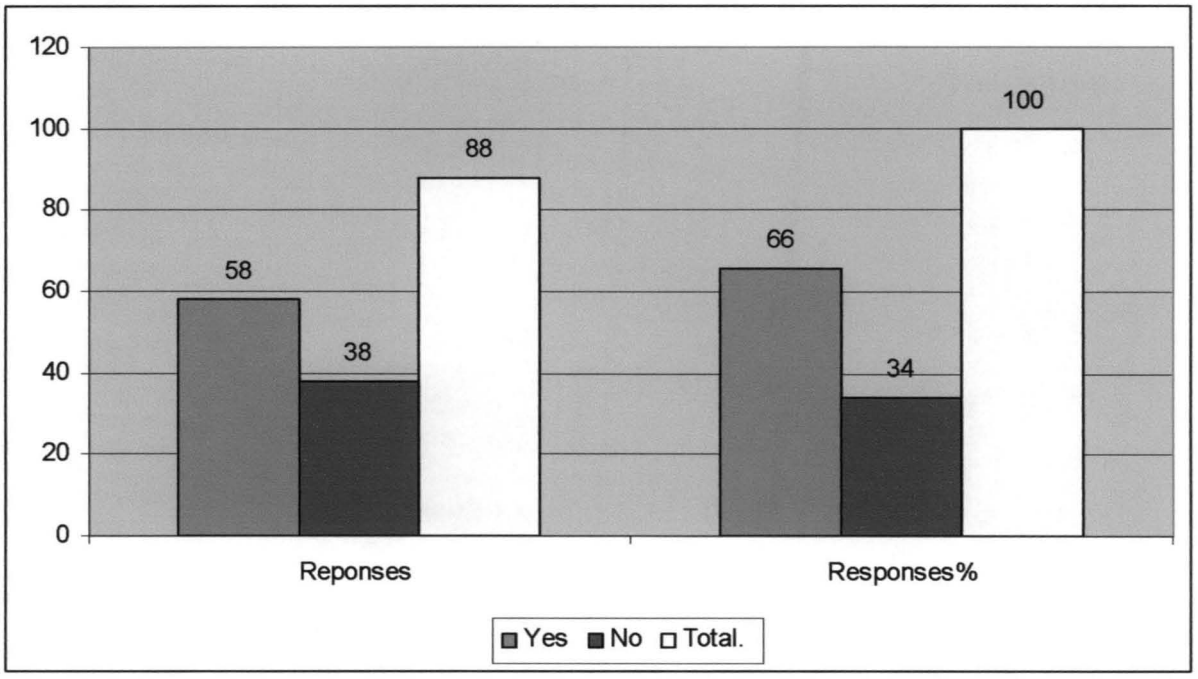
Figure 3.8: Causes of Discomfort



Source: Field survey November 2007

From the figure above, out of the 88 respondents representing 90% of the sampled population accepted discomfort at various time. 34 respondents stated that solar radiation is the main cause of their discomfort, this represents 39%. 31 respondents representing 35% stated that their rooms windows were not positioned in the direction of air flow, while 14 respondents representing 16% stated that their rooms lacks cross ventilation hence poor air circulation. The major course of discomfort is solar radiation emission and improper positioning of the building. Most of the buildings in the study area are not well planned.

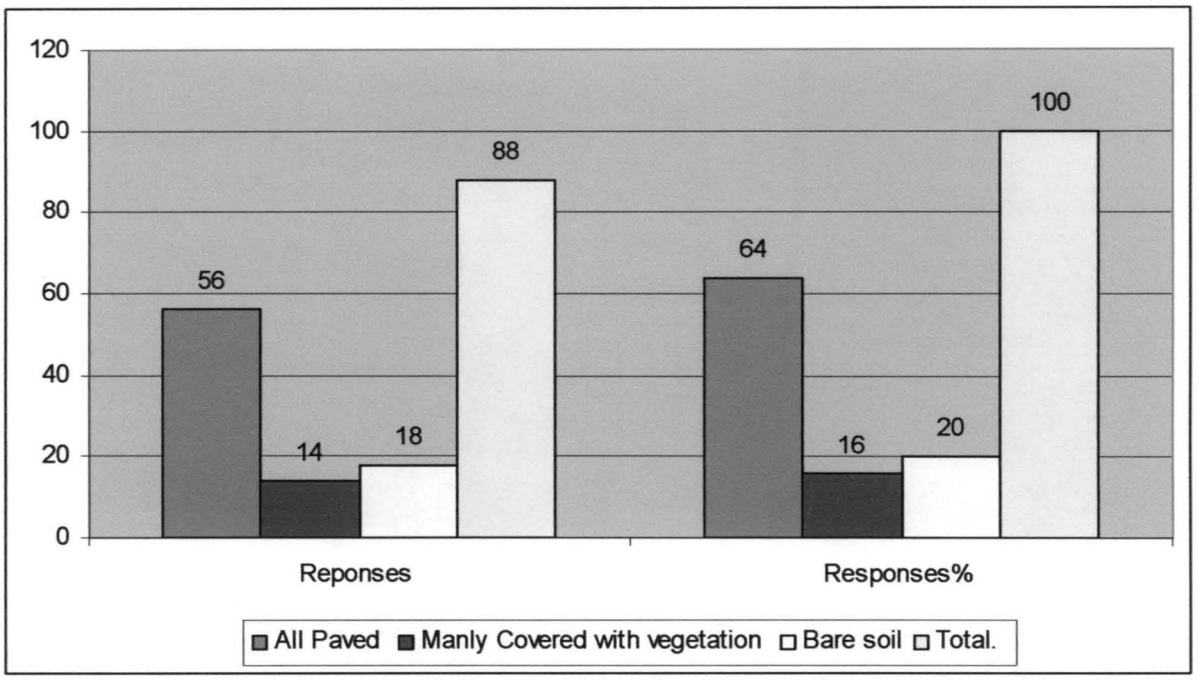
Figure 3.9: Introduction of Shading Devices Such as Window Hoods



Source: Field survey November 2007

From the figure above, 58 respondents representing 66% believed that shading devices can improve comfort ability of the inhabitants while 30 respondents representing 34% stated that shading devices can not improve comfort ability of the inhabitants because some of the problems may be due to roof leakages, lack of ceiling devices etc.

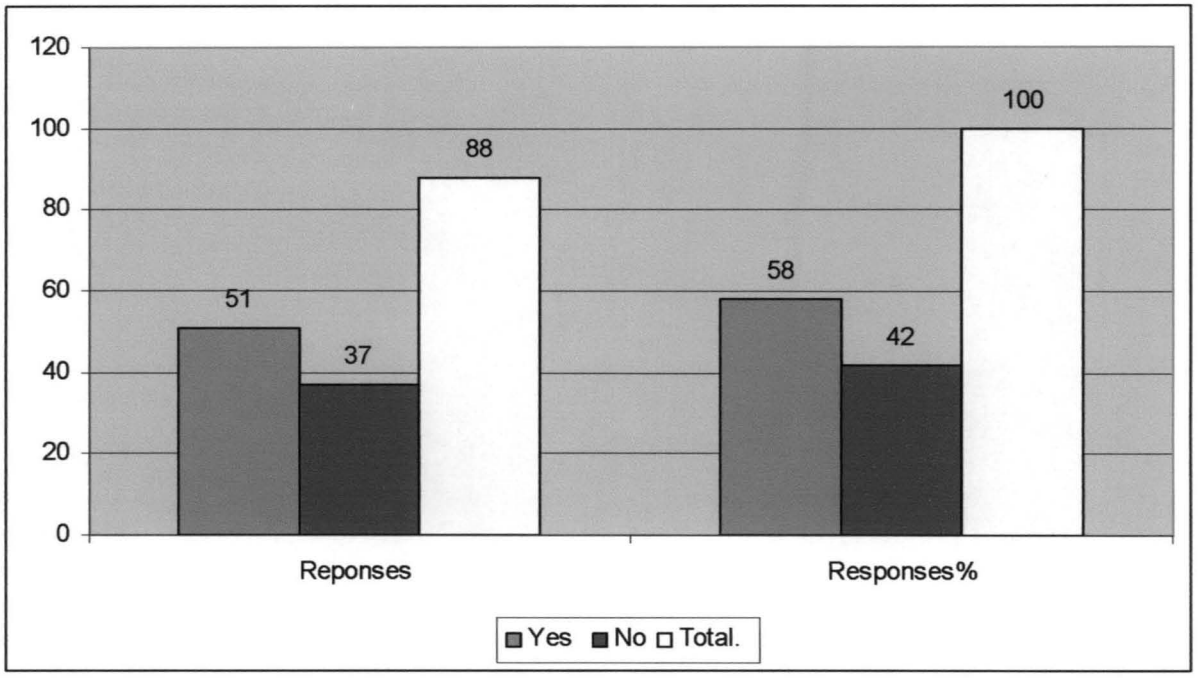
Figure 3.10: The Nature of Compound Terrain



Source: Field survey November 2007

From figure 3.10, 56 respondents representing 64% stated that their compounds are completely paved. 14 respondents representing 16% claimed that their compounds terrains are covered mainly with vegetation. While 18 respondents representing 20% stated that their compound terrain lacks both paving and vegetation.

Figure 3.11: Effect of Terrain Material on Human Comfort



Source: Field survey November 2007

From the above figure, 51 respondents representing 58 believed that terrain material can affect their comfort. While 37 respondents state that terrain material has nothing to do with their comfort, this represents 42% of sampled population.

CHAPTER FOUR

RESULTS

4.1 SITUATION IN SARKIN-PAWA (STATION A).

TABLE 4.1: DATA COLLECTED AT SARKIN-PAWA

Time	Air Temp	Wet.Temp	R.H	E.S	E.A.V.P. (Mb)	E.A.V.P	R.S.I	E.T
9.00	24.5	24.5	91	32.81	29.90	22.7	0.17	24.8
9.30	24.8	24.5	96	31.69	30.40	23.2	0.2	24.5
10.00	24.4	24.4	96	30.35	29.12	22.1	0.2	24.3
10.30	25.0	24.0	96	31.67	31.0	23.2	0.13	24.7
11.00	25.8	24.0	96	32.82	30.40	23.1	0.2	25.1
11.30	26.0	25.0	91	33.81	30.80	23.1	0.2	25.28
12.00	26.0	25.2	91	33.81	30.80	23.1	0.2	25.28
12.30	26.7	25.0	87	35.03	30.48	22.8	0.21	25.28
1.00	27.0	25.0	83	36.02	20.90	22.7	0.22	25.6
1.30	26.8	25.0	87	35.03	30.48	22.8	0.21	25.52
2.00	27.0	25.0	87	36.02	31.34	23.1	0.22	25.8
2.30	27.0	25.5	87	36.02	31.34	23.1	0.21	25.68
3.00	26.8	25.2	81	35.03	31.34	22.8	0.21	25.32
3.30	26.5	25.0	91	35.03	31.90	23.2	0.21	25.1
4.00	26.5	24.8	91	35.03	31.90	23.2	0.21	25.32
4.30	5.00	24.6	91	33.81	30.80	30.8	0.2	25.04

SOURCE: Field survey October/November 2007

Table 4.1 reveals that the lowest temperature was recorded at 10.00am at Sarkin-Pawa. The highest temperature at station A (Sarkin-Pawa) was recorded in the afternoon at about 2.00-2.30pm. At other periods of the day, temperature in station A ranges from 25^0C to 26.80^0C as can be seen in table 4.1. The wet temperature increased slightly from 24.0^0C at 10.00am to just 25.5^0C at 3.00pm. The Wet temperature did not exceed 25.5^0C throughout the period of study. The low depression recorded in this part of the study area indicates a high humidity during the study period. The average relative humidity was high throughout the study period at Sarkin-Pawa (Station A.) The highest relative humidity recorded was 96% and this occurred between 9.30 to 11.00 am. The lowest relative humidity recorded was 83% at about 1.30pm. This indicate that the atmosphere during the study period was cloudy and moisture content very high. From the foregoing, it is evident that the nature of the environment, coupled with the trees within contributes to the low temperature enjoyed in this part of the study area (Sarkin-Pawa). The effect of solar radiation during the study period could not have proper effect because most of the solar radiation could not gain direct influence on the surface of station A.

Table 4.1 reveals the effective temperature (E.T.) Index and relative strain index for station A. There is no sharp variation in station A through out the day.

The variation for effective temperature at station A ranges from 24.30^{0}C to 25.68^{0}C which was the lowest and the highest respectively during the study period. The effective temperature at 9.00 am was 24.80^{0}C, this indicated a chilly condition. People interviewed during this period were not feeling very cold, just in between. The condition at the time was enough for people to wear cardigan. The condition of the environment changed slightly at 12.00pm when effective temperature (E>T) increased to 25.10^{0}C. This condition was maintained throughout the study period and the slightest change was 25.68^{0}C at 3.30pm. The condition remains mild and moderately comfortable.

4.2 SITUATION IN LIMAWA

Table 4.2 shows the temperature readings (both the dry and wet), the wind speed, relative humidity, E.T., and relative strain index in the Limawa-Minna (Station B). The temperature reading of this station is much higher than station A this is because this part of the town is not planned. Most of houses are compacted and open spaces are totally absent. The air temperature at 9.00am was 26.80^{0}C while the wet temperature was 26.0^{0}C. Limawa settlement witnessed an increase in temperature at 10.30am when recorded temperature was 27.0^{0}C. The air temperatures steadily increase and by 2.00pm the temperature had risen to 28.50^{0}C. At 4.00pm air temperature began to decrease

though slightly (Table4.2). The wet bulb temperature also follows the same pattern with slight variation in wet temperature reading. The wet bulb reading ranges from 24.40^{0}C to 26.0^{0}C as can be seen in table 4.2. The speed of the wind in station B continues throughout the day, the lowest being 8 meters in thirty minutes as shown in Table 4.2. The low rate of the wind speed was due to the blockage of wind movement by clustered houses. The temperature reading of this station (station B) varies because of the pattern of built up area. The buildings are in closer form such that solar radiation received could not be circulated, rather then absorbed. These are scattered all over the lower part of the surface thus increasing the temperature of the environment. The relative humidity of station B (Limawa –Minna) was high throughout the day. It varies from 83% to 96% (Table 4.2). These are lower than those of station A. the effective temperature at Sarkin-Pawa varies from 24.0^{0}C to 25.80^{0}C. Table 4.2 reveals that between 9.00am and 11.30am most people were comfortable.

TABLE 4.2: DATA COLLECTED AT LIMAWA (STATION B)

Time	Air Temp	Wet Temp	R.H	E.S	E.A.V.P (MB)	E.A.V.P	R.S.I	E.T
9.00	26.8	26.0	96	35.03	35.63	24.50	0.2	25.92
9.30	26.8	25.0	87	35.03	30.48	22.8	0.2.	25.52
10.00	26.0	25.0	91	33.31	30.77	23.6	0.2	25.20
10.30	27.0	25.0	83	36.02	29.90	22.7	0.2	25.6
11.00	27.5	25.0	79	37.36	28.40	22.1	0.2	25.6
11.30	27.2	25.0	83	36.02	29.90	27.7	0.2	25.6
12.00	27.5	25.5	83	36.02	29.90	22.7	0.25.	25.6
12.30	26.8	24.8	83	35.03	29.10	22.1	0.2	25.4
1.00	28.5	24.5	79	37.36	29.50	22.4	0.24	25.68
1.30	28.8	25.0	77	38.46	29.46	22.5	0.3	50.0
2.00	28.5	24.0	73	38.46	28.10	22.1	0.3	26.2
2.30	27.5	25.4	83	37.36	31.00	23.0	0.24	26.1
3.00	27.2	24.8	83	36.02	29.90	22.7	0.22	25.96
3.30	27.5	25.0	81	35.03	31.34	22.8	0.21	25.32
4.00	26.8	24.6	83	35.03	29.10	22.1	0.2	25.4
4.30	26.5	24.4	83	35.03	29.10	22.1	0.21	25.2
5.00	26.0	24.2	87	38.81	29.40	22.30	0.2	24.9

SOURCE: *Field survey October/November 2007*

4.3 Comparative analysis of thermal comfort between Sarkin- Pawa and Limawa- Minna Settlement.

TABLE 4.3: Comparative data of Limawa and Sarkin-Pawa

Sarkin-Pawa				Limawa-Minna		
Time	% of man comfortable	% of man Distress	E.T.	% of man comfortable	% of man Distress	E.T.
9.00	58.3	41.6	24.8	24.3	27.7	25.92
9.30	66.6	33.3	24.5	36.6	63.6	25.2
10.00	83	16.6	24.3	36.6	63.6	25.2
10.30	3	41.6	24.7	18.2	81.8	25.6
11.00	58.3	25.0	24.4	27.3	72.7	25.6
11.30	75.0	58.3	25.28	27.3	72.7	25.4
12.00	41.6	58.3	25.28	27.3	12.7	25.4
12.30	41.6	66.6	25.2	18.2	81.8	25.6
1.00	33.3	83.3	25.2	9.1	90.9	26.2
1.30	16.6	83.3	25.6	9.1	90.9	26.12
2.00	16.6	83.3	25.6	36.4	63.3	25.96
2.30	25.0	83.3	25.5	36.4	63.6	25.8
3.00	25.0	75.0	25.8	36.4	63.6	25.6
3.30	25.0	75.0	25.7	27.3	72.7	25.2
4.00	33.3	66.6	25.5	27.3	72.7	25.2
4.30	41.6	58.3	25.3	63.6	36.4	24.8
5.00	48.3	41.6	24.0			

Source: *Field survey October/November 2007*

The table (4.3) shows the comparative analysis of thermal comfort in both the Limawa-Minna and Sarkin-Pawa. Generally speaking the people at Sarkin – Pawa tend to feel more comfortable at any point in time than their counterpart in the Limawa-Minna. For instance, the percentage of the people comfortable between 9.00.am and 12.pm at Sarkin-Pawa were 58.3, 66.6, 83.0, 3.0, 58.3, 75.0, 41.6 and 41.6 respectively. This indicates that the atmospheric condition at Sarkin-Pawa contributes to the freshness of the environment where as at Limawa-Minna trees/plants were totally absent.

CHAPTER FIVE

DISCUSSON, SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 DISCUSSION OF RESULTS

The aim of the study is to determine the physioclimate of Sarkin-Pawa and Limawa-Minna in Minna town. From the results, it was found that, the people in Sarkin-Pawa feel more comfortable, than the people in the Limawa Minna. For instance 66.6% of the people in Sarkin-Pawa were comfortable as against 6.6% in the Limawa-Minna. The reason accountable for this is that buildings and structures in Sarkin-Pawa are scattered, these enable free airflow, which is important because wind/air accelerates heat transfer by turbulence and by evaporative cooling. It also prevents the accumulation of high moisture content next to the skin and thus helps to maintain evaporative cooling close to the potential rate. Moreover, wind restores comfort to an overheated body; it also removes heat from the body thus inducing chill. The people in the Limawa-Minna feel more distressed. This is because of the impact of the effect of urbanization and climate change due to tarred roads, corrugated iron sheet, crowding, and urban slum and over population. The human performance level in Sarkin-Pawa tends to be higher than that of Limawa-Minna.

5.2 SUMMARY.

This study was centered on the weather control in buildings using Sarkin Pawa and Limawa as the case study. The researcher carried out the study on the impact of climatic elements on buildings and its occupants.

Questionnaires were divided and various weather control techniques were detailed or analyzed. Parapet buildings were found to be a failure in warm humid climatic region the maintenance cost is high and the occupant stand the risk of the effect of windy rain and roof leakages.

From the research also, terrain materials were found to be the key factor in the temperature change of the building interior. For instance paved terrain absorb about 50% of the incidental rays from the sun and emit them to the immediate surroundings at night this affected the comfort of people living in such environment, to a large extent, even in buildings with good orientation.

The research also revealed that Limawa people are less environmental conscious in their choice of building style. They follow trend and appreciate aesthetic values. Following the foregoing research, recommendations are made.

It has been analyzed that the architectural design tends to ignore the climate while pre-occupied with forms currently fashioned. The dwellings mainly rely on mechanical systems to separate conditions inside from those of outside. A wealthy occupant escapes the consequences of poor design through mechanical

air-conditioning. The others suffer from living conditions that permit neither efficient work nor rest or enjoyment.

5.3 CONCLUSION

The aim of the study is to determine the climate comfort of Sarkin-Pawa and Limawa. Man's comfort is the measure of the extent to which buildings have succeeded in satisfying the purpose for which they were designed. The natural environments in our buildings are rarely within acceptable comfort limits. Hence the provision of comfort for better living and performance remains constant struggle. Since the impacts of climatic elements on buildings are multi dimensional, it requires both direct and indirect approach to proffer solutions. The various weather control techniques are contextual in application hence, required indepth knowledge of the prevailing climatic condition and ways they relate with buildings.

From the survey carried out by the researcher through the questionnaires, the common problems experience by the occupants in both Sarkin-Pawa and Limawa (Minna) is centered on discomfort. For instances, poor ventilation, direct influence of solar radiation, windy rain etc. are examples of such problems that lead to discomfort. The buildings with good orientation also

suffer one deficiency or the other in terms of weather control. As such, the various weather control techniques so far detailed or analyzed in this research in relation to warm humid climatic region should be employed.

5.4 RECOMMENDATIONS

Following the research on weather control on buildings through survey using Sarkin-Pawa and Limawa (Minna) as a case study and having analyzed various weather control techniques, the major issue is how to solve this problem of human comfort within the study area. The first step to be considered for planning and architectural design purposes is having climatic data, to have a clear picture of the year-round, every moment of the day, performance of climate, its influence on building and the people who live in it (Bio climatic information). I hereby make the under listed recommendations:-

1. With the exception of orientation as a weather control techniques, the other three methods i.e. shading devices, landscaping and structural techniques can be incorporated into the existing buildings with climatic defects in Sarkin-Pawa and Limawa. This will help to achieve optimum conditions in terms of comfort. The four techniques should be considered in all future development.

2. Parapet roofing types should be avoided completely in Limawa Minna as it has been proved to be a failure in the warm humid region.

3. Niger State Urban Development Authority Planning department should ensure strict compliance of all building regulation in addition to landscaping and ventilation. Only stipulated 45% of each plot should be develop leaving behind the remaining 55% for extensive landscaping.

4. General landscaping especially tree planting along all streets in Limawa- Minna and Sarkin-Pawa should be considered by the Niger State Urban Development Authority, apart from the general beauty it portrays, it will help to modify and filter the air that circulate within the environment. A good example of this arrangement can be found at Rijau which is the best planned village in Niger State since its creation in 1976 and in Minna Govt. Reserve Area. The general occupants should take the responsibility of landscaping the individual plots.

5. Building is an integral part of the environment hence should not be treated in isolation. Architects, planners and engineers should design it in relation to the environment and in conformity with climatic elements in consideration.

6. Designers should also consider the followings:-

a. Spacing of building

b. Orientation of buildings

c. Space organization

d. Windows openings

e. Sun shading device

f. Material selection

g. Construction details

h. Color finishing and

i. Air and land pollution

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APPENDIX

AN ASSESSMENT OF HUMAN THERMAL COMFORT OF SARKIN-PAWA AND LIMAWA-MINNA, NIGER STATE, NIGERIA, USING THE EFFECTIVE TEMPERATURE INDEX

DESIGN OF QUESTIONNAIRE

INTRODUCTION

I, am an Environmental Management Student of Federal University of Technology Minna, as part of the requirements for the award of Master of Technology, am writing a research project on "human thermal Comfort" and have Sarkin-Pawa and Limawa-Minna as study area.

In view of this I have designed this questionnaire to help me source information as regards to your comfort for the successful completion of the project. I assure you that any information given to me would be used for the simple purpose of this project and your personal information shall be treated confidentially. Thank you.

SECTION A: FOR THE LANDLORD/HOUSE OWNERS

1. How old is your building/ _____

2. What is the major fact that influenced your choice of building type and orientation?

(a) Trend ( ) (b) Architect ( )

(b) Weather Condition ( ) (d) Aesthetics ( )

3. What is the current value of your building in naira (N)

a. Below 100,000 ( ) b. 100,001 – 500,000 ( )

c. 500,001-1, 00, 00 ( ) d. above 1 million ( )

4. Are you satisfied with physical state of your building? Yes ( )

No ( ).

5. Is renovation work on your building part of your duty as landlord?

Yes ( ) No ( )

6. What type of renovation do you carry out?

a. Painting ( ) Re –roofing ( )

b. Both ( )

c. Others Specify.

7. How often do you carry such renovation?

a. Every Year ( ) B. Every 2-6 years ( )

c. Every 6 – 10 Years ( )

8. What is the common problem encountered by the tenants (related to the environment)

a. Drive rain ( ) b. Solar radiation (sun) ( )

c. Lack of proper ventilation

9. How do you go about solving these problems?

a. Financing it alone ( )

b. Financing it jointly with the tenants ( )

c. Allowing the tenants to do it as part of their rent. ( )

10. Suggest ways of improving the present state of your building.

a. General Renovation ( ) b. Only painting ( )

c. Landscaping ( )

SECTION B: FOR THE OCCUPANTS

11. For how long have been staying in this house?

_____

12. What is your occupation? _____

13. How many hours do you spend in your house everyday?

_____

14. What time of the day or night do you experience major discomfort inside your house?

a. 10am – 5pm ( ) b. 8pm – 2am ( )

c. All day round ( ) d. No Discomfort ( )

15. What do you fell is the main cause of the discomfort

a. Solar radiation (sun) ( )

b. Lack of air entrance due to the direction and position of windows ( )

c. Lack of proper ventilation in terms of opening ( )

16. Does rain enter your house whenever it rains heavily?

a. Yes ( ) b. No ( )

17. If yes, through which channel?

a. Window ( ) b. Roof ( )

18. Do you think that introduction of shading devices e.g. window hood will solve the above problem.

a. Yes ( ) b. No ( )

19. What is the nature of your compound's terrain?

a. All paved

b. Mainly covered with vegetation.

c. Bare Soil.

20 Do you feel that the terrain material can have any effect on your comfort?

a. Yes ( ) b. No ( )

21. Do you feel that your compound is properly landscaped?

a. Yes ( ) No ( )

22. If no what do you suggest should be done to achieve a good landscape?

a. Flower and Tree Plaiting ( ) b. Extensive Paving ( )

23. If the planning authority suggest the idea of planting of trees and flower within your compound will you accept or support?

a. Yes ( ) b. No ( )

24. What is your view about the general planning of Limawa?

a. Well planned b. fairly planned

c. Poorly Planned

25. State other defects you have observed in relation to your building environment etc.

a. Erosion ( ) b. Flood ( )

c. Poor Waste disposal ( ) d. Lack of conveniences ( )

26. How responsive is your landlord to these complaints / defects?

a. Highly concerned ( ) b. Luke warm in approach ( )

c. Less concern ( )

27. What are your suggestions on better landlord/ tenant relationship?

a. Periodic Meeting ( )

b. Co-operation in areas of maintenance ( )

c. Establishing a code of conduct as guiding rule between landlord/ tenant