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THERMAL COMFORT (A MICRO CLIMATE OF SARKIN-PAWA AND LIMAWA-MINNA

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CERTIFICATION

I hereby certify that this project work has been supervised and approved meeting part of the requirements for the award of Post Graduate Diploma (PGD) in Environmental Management and Technology Federal University of Technology, Minna – Niger State.

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DECLARATION

I Labaran Garba the Director Works of Munya Local Government, HQ Sarkin-Pawa hereby declare that this project is an original work based on various research carried out.

SIGNATURE:.....
STUDENT(Labaran Garba)

DEDICATION

In memory of my Dearest Father Late Labaran Mohammad Lawal

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ABSTRACT

Building from part of mans environment. It has been under constant interaction with all the environmental components namely:- Physical, Biological and Social. Social Components being the most active. The effect of climatic elements on building cannot be over emphasized. This project to a greate extent highlighted the impact of these climatic elements on buildings.

Having carried out a research through survey on the general problem. this report try to analyse various weather control techniques on building to mitigate the problems associated with the existing buildings and creating standard for future developments.

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CHAPTER ONE

1.0. 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. Those 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 utilises 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), from harmful radiation from outer space. He founds comfort in the evolution of weather and climate made possible by the atmosphere. The atmosphere also enables transport 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) uses, water is, in addition, the basic building block of all living cells.

Plants and animals provide man with food, fibre, clothing, medicine, building materials, furniture, paper and other writing materials, and industrial raw materials. In addition to these, plants perform other important environmental roles viz: 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 nutrient cycle through the shedding of their parts, moderate micro-climate, provide places of abode for other life forms etc.

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 other's will change and the set-up or system will subsequently attain a new state of equilibrium or balance. For example, vegetal covers helps to enhance infiltration and promote the water cycle-a necessity for the continued supply of moisture to nourish , the vegetation. The process of water formation and availability, it should be noted, depends to a large extent on vapour transport and evolution mechanisms in the atmosphere and convective heating of the atmosphere from the land.

If any of these factors is removed or distorted a vital link necessary to complete the water cycle is missing and water availability becomes a problem.

Having established the nature of the environment in terms of its components and linkages and man's complete dependance on

them for survival, it is pertinent to remember that while every resource is ours to keep and use it, is our responsibility to ensure that some of it is left for future generation's use.

Its 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 worm humid climatic region of which Minna - Sarkin-Pawa fall into various weather control techniques using thermometer; wind anemometer & Dry-Wet thermometer are high lighted for both future proposal and the current existing structures for maximum comfort of the habitants.

1.1.2. **STATEMENT OF THE PROBLEM**

Sulphate attack on concrete is a known phenomenon and thermal conductivity of any building material is an important parameter especially in the tropics because of its imp heat ion on the total cooling load and hence energy conservation. In hot climates, the thickness of the walls sometimes must be increased to reduce the passage of heat.

A study of the thermal conductivity of the materials used for these walls is also essential in order to relate the strength qualities of these walls to the corresponding thermal comfort.

Its necessary to alleviate the quality of the environment for sustainable development. The waves of concern on environmental problems vis-a-vis on man and the environment. Many of these environmental problems varied in magnitude but, with serious consequences on both man and the environment.

Limawa area part of Minna the Niger State Headquarters is highly populated. It has alot of buildings ranging from residential to

institutional buildings including religious building (Mosques and Churches). While Sarkin-Pawa is a village/town with less number of habitant/population.

A critical survey carried out shows that majority of these buildings at Limawa are not whether friendly and majority are not basically suitable for the prevailing weather condition at Limawa. But the structures at Sarkin-Pawa are much more friendly compared to Limaw. This is because Limawa is over-populated and was wrongly oriented following the orientation or planning of the colonial masters in 50s.

Limawa falls under the warm humid climatic region. As such, all designs meant for tropical dry sub-humid or semi-arid-climatic zones can not fit in Limawa - Minna. After a critical survey and analysis, its 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 immediate beauty impressure neglecting the future implications i.e. parapet roots are suitable for dry sub-humid and semi 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 roofings leaks and deteriorate faster than those with well-defined pitched roof.

Proper landscaping and designs helps to reduce the radiant heat, filter air, and prevent penetration of sun (as sun breakers) it also acts as wind breakers.

1.13 **AIMS AND OBJECTIVE:**

Minna (Limawa) and Sarkin Pawa area part of Niger State. The two area's in question are involved in many activities. Large number of its their habitants are always engaged in many activities doing this or that to earn daily leaving.

The concept of climate and human comfort is an important parameters in measuring the productivity ratio of human activities under a prevailing climatic condition. The human thermal comfort has been the concern of various climatologist/meteorologist, this led to various work or researches carried out on this aspect of meteorology.

The major aim of this project is to:-

Establish to an extent weather control technique that will take care of a large number of existing buildings and proposed buildings in Limawa Minna and Sarkin-Pawa for the maximum comfort to the occupants.

To complement the foregoing statements/points raised above, the objective 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 inhabitants of Limawa and Sarkin-Pawa.

(3) To assess the impact of climatic factors e.g. solar radiation, precipitation, wind etc. on buildings as a structure with reference to worm humid climatic region by mean of survey using Limawa and Sarkin-Pawa as the case study.

(4) To make recommendations on ways of achieving weather friendly designs.

1.1.4. JUSTIFICATION FOR THE STUDY

It is necessary to have a reasonably accurate picture of the climatic and microclimatic characteristics of the areas in which building is to be located in order to effectively specify the characteristics of the building and its services require to provide a range of environments. In a broad language, its necessary to evaluate the performance of the overall design to the climate and internal environment. Building is an integral part of the environment. It is in constant influence of other environmental components. The most active among the components is climate. The climatic elements determine the building pattern and choice of building materials.

Sarkin-Pawa is not fully developed, it is at the verge of its growth. As such, there is the need as a matter of urgent and with seriousness of Munya Local Government Council to take into cognisance of the prevailing weather condition. While Limawa has already been fully/over developed without taking cognisance of the prevailing weather condition. Peoples ideas most at time, is limited to the aesthetic appearance of building without caring or minding about how environmental friendly the building may be. A careful survey have been made by the researcher to examine how human comfort are being regulated by the external climatic condition. There is the urgent need to achieve a balance in buildings where most of man's activities are carried out.

SCOPE AND LIMITATION

The researcher basically emphasis on worm humid climatic region where Limawa (Minna) and Sarkin-Pawa falls into. The

characteristics of principal climatic elements to human comfort and building design are considered which includes:- temperature, wind, humidity, solar radiation and precipitation. However, the detail 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 foregoing, the scope to this research is also limited to natural and structural consideration of weather control in buildings. (Meaning that the full and elaborate materials schedules and specification are not given.

CHAPTER TWO

2.0 LITERATURE REVIEW

2:1. STUDY AREA DESCRIPTION

Niger State was created by the Late General Murtala Mohammads regime. It was curved out of the former North Western State in 1976, the State is part of the middle-belts region of Nigeria. The area is relatively sperm and fragmented population groups.

GEOGRAPHY:- This research is confined to Minna town (Limawa area) which lies at latitude 9^0 37 North and Longitude 60 33' East on a geological base of undifferentiated basement complex of mainly gnesis and magmatite. To North-East of the town is a continuous steep out crop of granite which limit any urban development in that direction. While Sarkin-Pawa is latitude 8^0.34 North and Longitude 59-44 East.

CLIMATE:- Minna (Limawa) and Sarkin-Pawa experiences distinct dry and wet seasons, the wet season decreasing in length and amount of rainfall from south to north of the two towns in questions. The mean annual rainfall for Minna and Sarkin-Pawa varies. However, the main annual rainfall recorded 1334mm for Minna and 1346 for Sarkin Pawa. 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.

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 runoff from

the hills to the east. There are also large and isolated rock outcrops in this landscape and also some areas of scattered rocks.

RAINFALL:- Limawa (Minna) and Sarkin-Pawa both are characterized by relatively high rainfall of about 1850mm per year mostly received between April and October. The long dry season from November to March is generally dry. However some short and infrequent precipitation does occur. Reference Dr. Akinyeye (2001) lecture PGD Students.

TEMPERATURE:- Mean temperature is relatively constant throughout the year. It is around 250c with maximum temperature being experienced in the December to March period and a minimum between June and September. During the long dry season, night time temperature can be noticeably cooler.

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

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

1. The Northeast trade wind and
2. South-West mansoon wind.

The former is characterized by high velocity, dry was; And it carries dust particles. It is quite predominant in the day time and very powerful between the month of December and February. The later on the other hand is characterized by it low velocity (gentleness), humid nature and its dust free. It originate from the coast e.g. seas

and ocean, hence its witness. It is predominantly at night and flows all year round.

VEGETATION:- Sarkin-Pawa generally use 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 build up.

POPULATION:- Following the 1991 population figure Limawa (Minna) has a population of about 1 million and Sarkin-Pawa has about 1000. But with the current population growth rate, the figure has been exceeded.

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

2:2. 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 away to accommondate human population and human activities. The need for a clear knowledge of the origin of human settlement can not be over emphasised. 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 urbanisation.

A number of factors led to the origin and growth of human settlement, which includes:- Social, economical, political and physical factors. As earlier mentioned, early men were known to be moving from one place to another search of food and shelter. Their main occupation was hunting and fishing the earlier men were not

stable at a particular place. It was a problem for a family group to come together at a specific localities 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 expands, hunting and fishing became inadequate to meet the challenging population 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" 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 this interms. He describes the beginnings of the 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 company; developed language and soon, the first Houses. At first these were in caves, bent boughs and even rests (in initiations of births). Soon they set up forked stakes, connected with twigs and covered in mind for the walls. They flat roofs were pitched and had eares, reads and leaves were used as a cover. Virtuous 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 judgements, 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 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 content of a building continuously affects the physical more specifically the thermal environment, variation in which both in space and in time, may be needed not only for different activities, but also to provide stimulation and perhaps aesthetic experiences based on thermal sensations.

According to Albertis ten books on Architecture (1485) 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 other 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 wall 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 vapours which might chance to get into the house.

2:3. **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 interactions. 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 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 recognises in the design and construction of buildings. As a result various influences the air temperature in an urban area, for example can be as much as 80°c 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 my 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 personnel 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. All space something 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 the deprived are the sections of the community whose sparse resources allow them to achieve only less that 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 and architects, on the classical theories of the elements, on personal observation and to some extent, the living, vernacular tradition which the author's observed. Vernacular climatic building design, 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 intergrated. 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 generalizations. The brief examination of those attitudes at various times, which follows, may help in the understanding of the theoritical standpoint within which the design principles and aids can be placed.

In victorious book "The Ten Books", translated by F. Granger Vitruvius's work is 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 sorcth windsound 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 exposive, 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 sourtherner'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 vast height, fair and grey-eyed, unable to withstand heat or fever but brave; the sourtherner'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, apprentice Hall, New Jersey; 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 filter's or "possibilitic" 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 pueblc 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.

2:1. **THE CLIMATE OF CITIES**

A relatively large spatial and temporal variation in condition's takes place in and around the building surfaces and ground. 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 gives 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 mean wound speeds are experienced in the 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 windward side and upward flow on the leeward side. Streets often become wind funnels, collecting spillage from adjacent surfaces and creating high velocities near the ground. These condition will often create conditions of considerable discomfort, dust and in low temperature, wind-chill.

Another major urban effect is on the radiation and temperature budget. The buildings and surfaces between then 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 men city temperature may be as much as 40°c above that of the subuobs and country outside.

Radiation and sunshine hours in cities are substantially less than outside, due to the extra turbidity caused by smoke, dust and other pollutions. In cold climates inspite of decreased sun and radiation, city climate is likely to be more temperate than rural in degree day term, the difference is about 10 percent according to chandler.

2:5. **COMFORT**

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 in habitants or user's.

Human Comfort can not be measured in terms of psychological factor only one of the primary requirements (and this is particularly true in the hot climatic zones) is the maintenance of 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 of the subject are individual radiation characteristic, while other 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 of impede the dissipation of surplus.

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 in the main on the difference 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°c, the clothed human body cannot get rid of enough heat by either convection or radiation and the lose 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 and the more the air movement. The greater will be the evaporative potential, and increase the humidity over the skin.

2:6. **COMFORT ZONE**

The term comfort zone simply refer's to the range of conditions in which thermal comfort is experienced. Something that differ's 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 thermo-regulatory mechanisms of the body are in a State of minimal activity.

Comfort, which is also dependent 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 interms of any one of them as they affect 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 interms of a single parameter or "thermal index" which can be set out on a nomogram.

2:7 **CLIMATE AND COMFORT**

Victor Olgyay on his book {Design with 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 - one for summer and one 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 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. And as Givoni points out in his book man, climate and Architecture, the biodimatic 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 an 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 outset; 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 mohoney 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 sketch plan stage.

CHAPTER THREE

3:0. METHODOLOGY AND PROCEDURE

3:1. DESIGN OF THE STUDY

This study is carried out to assess the impact of climatic elements on building as a structure with reference to warm humid climatic region using Limawa (Minna) and Sarkin-Pawa as a study area.

The desogn was considered appropriate because it is a fact finding technique and facilitate the generation of information about current situation.

3:2. SOURCES OF DATA

Data were collected on two different locations (i.e. A and B). Location "A" was inside the room while location "B" was outside. The purpose is to obtain a comparative analysis of the micro-climate in these locations and to see how much influence the lagoon has on these locations. Data were recorded at selected intervals of time (30 minute interval) between the hours 9.00am to 6.00pm.

Data from our motion 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 temperature of the different locations were taken. The weather conditions were noted all through the study.

3:3. **INSTRUMENTS USED**

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

3:4. **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. Sweet loss is sometimes used as an index but it tend 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.

The most commonly used index is the effective temperature which was developed by Houghten and Yaglou (1923). Effective temperature, used in this research, is defined as the temperature of a skill, saturated atmosphere which has the same general effect upon comfort as the atmosphere under investigation. Thus, those particular conditions of temperature, humidity and wind velocity conditions that produce the same thermal sensation on an individual are said to have the same effective temperature (mather, 1974). To compute effective temperature the following equations is used

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

$$ET = 0.4 (Td + Tw) + 5^{0}F$$

Where Td2 dry or air temperature and Tw=Wer bulb temperature ET = effective temperature. The effective temperature will be used to compute the collected data in this write-up (research).

The second type of index to be used in computing, the thermal comfort of the study area is rather more sophisticated and was developed by lee and Henschel (1966). Thus index is known as the relative strain index. This index is given by the formular:-

$$R.S.I = \frac{10.7 + 0.74 (Ta - 35)}{44 - ea}$$

Where Ta = air temperature and ea = vapour pressure.

3.5 EFFECTIVE TEMPERATURE COMFORT CLASSIFICATION

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 Gaffiney 1973)

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 to the body. Below is the table showing the relative strain index comfort classification

Effective Temp (^{0}C)	Comfort Class
0.1-0.25	Comfortable
0.26-0.29	Transitional
0.3-0.4	Discomfort
0.4	Distress

Source: (After Gaffiney 1973)

The effective temperature was uesd because it is relatively easier to understand and it performs the same function with the relative strain index. Though it has its own shortcomings.

3.6 **DISCUSSION OF RESULT**

This write-up is concerned with the aspect of microclimates of two locations in the study area Sarkin-Pawa and Limawa-Minna.

The table below shows coverage for air temperature, wet temperature, relative humidity and wind speed.

TABLE1: **COLLECTED DATA 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
10.00	25.0	24.0	96	31.67	30.40	23.2	0.13	24.7
11.30	25.8	24.0	96	32.82	31.0	23.1	0.2	25.1
12.00	26.0	25.0	91	33.81	30.80	23.1	0.2	25.28
12.30	26.0	25.2	91	33.81	30.80	23.1	0.2	25.48
1.00	26.7	25.0	87	35.03	30.48	22.8	0.21	25.48
1.30	27.0	25.0	83	36.02	29.90	22.7	0.22	25.6
2.00	26.8	25.0	87	35.03	30.48	22.8	0.21	25.52
2.30	27.0	25.0	87	36.02	31.34	23.1	0.22	25.8
3.00	27.0	25.5	87	36.02	31.34	23.1	0.21	25.68
3.30	26.8	25.2	81	35.03	31.34	22.8	0.21	25.32
4.00	26.5	25.0	91	35.03	31.90	23.2	0.21	25.1
4.30	26.5	24.8	91	35.03	31.90	23.2	0.21	25.32
5.00	5.00	24.6	91	33.81	30.80	30.80	0.2	25.04

Source: Complied by the author. (2002)

The table releveals that the lowest temperature was recorded at 10.00a.m at Sarkin-Pawa. The highest temperature at station A (Sarkin-Pawa) was recorded in the afternoon at about 3.00-3.30p.m. At other periods of the day, temperature in station A range fron 25.0°C to 26.8°C as can be seen in table 1.

The wet temperature increasa slightly from 24.0oC at 10.00am to just 25.5oC at 3.00pm. The wet temperature did not exceed 25.5oC 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 speed of the wind in station A (Sarkin-Pawa) was low, it varies from 0 to 70 metres/hr. This low wind was a result of the presence of plants that serve as wind breaker in the metres/hrs. This low wind speed was a result of the presence of plants that serve as wind breaker in the environment.

The average relative humidity was high throughout the study period at Sarkin-Pawa (Station A). The highest relative humidity recorded was 96% and this occured between 9.30 to 11.00 am. The lowest relative humidity recorded was 83% at about 2.00pm. This indicate that the atmosphere during the study period was cloudy and mositure content very high. From the foregoing, it is evident that the planned nature of the environment, couple with the plant left to thrive 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.

The movement of wind from the surrounding were low such that at about 11.30am and 12.00p.m, windspeed were zero. There were increase in wind speed between 12.30pm and 5.00pm.

The velocity of the wind has contributed to the low temperature during the study period. This is because the wind moving in and out of the environment were cool and thus made the temperature to be relatively low.

Table 1 reveals the effective temperature (E.T) index and relative strain index for station A (Sarkin-Pawa Layout). There is no sharp variation in station A through out the day. The variation for effective temperature for station temperature for station "A" ranges from 24.3oC which was the lowest during the study period to 25.680oC as the highest. The effective temperature at 9.oo am was 24.8oC, this indicated a chilly condition. People interviewed during this period were not feeling very cold, just in between. The condition at this 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 25.1oC (Fig. 1). This condition was maintained throughout the study period and the slightest was 25.68oC at 3.30pm. The condition remains mild and farly comfortable. Also shown in table 1 is the relative strain index (R.S.I) for station 'A'. The distribution of relative strain index is shown in both fig 3 and table 1.

3.7. SITUATION IN PART OF NIGER STATE

Table 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 26.8oC while the wet temperature was 26oC.

The LImawa-Minna witnessed an increase in temperature at 10.00am when recorded temperature was 26.0oC. The air temperature steadily increase and by 2.00pm the temperature had risen to 28.5oC. At 4.00p.m air temperature began to increase though slightly (Table2).

The wet bulb temperature also follows the same pattern with slight variation in wet temperature reading. The wet bulb reading ranges from 24.4oC to 26.0oC as can be seen in table 2. The speed of the wind in station B continues throughout the day, the lowest being 8 metres in thirty minutes as shown in Table2. The low rate of the speed wind 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 cluster form such that solar rediation received could not immediately bend or reflect back to the atmosphere. 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 was varies from 83% to 96% (Table 2). These are lower than those of station A. The effective temperature at Sarkin-Pawa varies from 24.0 to 25.8oC. Table 2 reveals that between 9.00am and 11.30am most people were comfortable. Effective temperature between 12.30pm and 4.30pm ranges from 25.20C to 25.8oC which indicate a discomfort zone.

TABLE2: COLLECTED DATA 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	26.8	26.0	96	35.03	33.63	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	26.2
2.00	28.5	24.	73	38.46	28.10	22.1	0.3	26.1
2.30	27.5	25.4	83	37.36	31.00	23.0	0.24	25.96
3.00	27.2	24.8	83	36.02	29.90	22.7	0.22	25.5
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: Complied by the author. (2002)

TABLE 3: COMPARATIVE ANALYSIS OF THERMAL COMFORT BETWEEN SARKIN PAWA AND THE LIMAWA-MINNA

At the Sarkin-Pawa however, the station was slightly different.

	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	72.7	25.92
9.30	66.6	33.3	24.5	36.6	63.6	25.2
10.00	83.3	16.6	24.3	36.6	63.6	25.2
10.30	58.3	41.6	24.7	18.2	81.8	25.6
11.30	75.0	25.0	24.4	27.3	72.7	25.6
12.00	41.6	58.3	25.28	27.3	72.7	25.4
12.30	41.6	58.3	25.28	27.3	12.7	25.4
1.00	33.3	66.6	25.2	18.2	81.8	25.6
1.30	16.6	83.3	25.2	9.1	90.9	26.2
2.00	16.6	83.3	25.6	9.1	90.9	26.12
2.30	25.0	83.3	25.5	36.4	63.3	25.96
3.00	25.0	75.0	25.8	36.4	63.6	25.8
3.30	25.0	75.0	25.7	36.4	63.6	25.6
4.00	33.3	66.6	25.5	27.3	72.7	25.2
4.30	41.6	58.3	25.3	27.3	72.7	25.2
5.00	48.3	41.6	24.0	63.6	36.4	24.8

Source: Complied by the author. (2002)

The only comfort period was at 5.00pm when effective temperature was 24. 80C. The E.T. at 9.00am was 25.9°C. By 12.00pm the recorded E.T was 26.0°C. The E.T at the Limawa-Minna varies from 25.8°C to 26.2°C as shown in Table 2.

The table shows the comparative analysis of thermal comfort in both the Limawa-Minna (Station B) and Sarkin-Pawa (Station A). 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 9.00am and 12.30pm at Sarkin-Pawa were 58.3, 66.6, 83.3, 66.6, 75.0, 41.6 and 41.6 respectively. (Table 3) Where the percentage people comfortable respectively. This indicates that the atmospheric condition at station 'A' contributes to the freshness of the environment where as at station 'B', trees/plants were totally absent.

FINDINGS

The aim of the study is to determine the physioclimate of Sarkin-Pawa and Limawa-Minna in Minna town. From the above discussion, 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 period in station 'A' 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 help to maintain evaporative cooling close to the potential rate. Moreover, wind restores

comfort to an over heated body, it also removes heat from t a body thus inducing chill.

The people in the Limawa-Minna feel more distress. This is because of the effect of urban and building climate Rural undertone is cooler because of the structures in the urban areas; as tarred roads, corrugated iron sheet, crowding, urban slum and over population.

The human performance level in station "A" tends to be higher than that of station B.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION OF RESULT

Having carried out the necessary survey to acquire the requirement data and information for this study, it becomes necessary at this stage to present, analyze and interpret the data and information used for this study. This chapter will be divided into two parts; part one will consist the analysis of data/information from the questionnaire while the other part will be used to analyse various weather control techniques suitable for Sarkin Pawa and Limawa Minna.

4.1. THE QUESTIONNAIRE

From about 10,000 house holds at Limawa Minna and 3000 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 house holds were chosen from 30 buildings as sample by means of random sampling.

Table: 1

Questionnaire Distributed and Response Collected

Category of Occupants	Number Distributed	Percentage (%)	Number Returned	Percentage (%)
Landlords	30	30	20	20
Tenants	45	45	42	42
Office Workers	25	25	16	16
Total	100	100	78	78

Source: Complied by the author. (2002)

From the above table, 30 questionnaires representing 30% of the sampled population were issued to landlords and 24 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" FOR THE LANDLORDS/HOUSE OWNERS

Table 2

How old is your building?

Option	Responses	% Response
Below 5 years	7	25
5-20 years	13	58
Above 20 years	6	17
Total	26	100

Source: Complied by the author. (2002)

From the above table 7, respondents representing 25% stated that their building are below the age of 5. Thirteen (13) respondents representing 58% claimed that their buildings are within the range of 5 to 20 years. While 6 respondents representing 17% stated that their buildings had stood for more than 20years. This shows different age grades of buildings in Sarking Pawa and Limawa respectively.

Table 3,

What is the major factor that influenced your choice of building type and orientation?

Option	Responses	% Response
Trend	7	25
Architect	6	21
Weather Condition	4	12
Aesthetics	9	43
Total	26	100

Source: Complied by the author. (2002).

From the above table 7 respondents representing 24% stated that building styles in vogue is 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.

Table 4

What is the current value of your building in Naira (N)?

Option	Responses	% Response
Below	2	7.5
100,000 - 500,000	5	22
500,000 - 1,000,000	9	30.5
Above 1 million	10	40
Total	26	100

Source: Complied by the author. (2002)

From the table above, only two respondents representing 7.5% agreed that their buildings are below N100,000:00. 5 respondents representing 22% stated that their are valued between 500,000 and 100,000. This represents 30.5% while 10 respondents representing 40% stated that their buildings have a current value of above 1,000,000. This shows different category of buildings

Table 5

Option	Responses	% Response
Yes	9	35
No	17	65
Total	26	100

Source: Complied by the author. (2002)

From the above table 9 respondents stated that they are satisfied with the physical state of their buildings. This represent 35% while 17 respondents representing 65% stated that they are not satisfied with the physical state of their buildings.

Table 6

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

Option	Responses	% Response
Yes	26	100
No	0	0
Total	26	100

Source: Complied by the author. (2002)

From the table above all the landlord i.e 100% accepted that renovation works on their buildings is part of their responsibilities as landlords.

Table 7

What type of Renovation do you carry out?

Option	Responses	% Response
Painting	7	33
Re-Roofing	4	13
Both	2	4
Others	13	50
Total	26	100

Source: Complied by the author. (2002)

From the above table 7 respondents representing 33% stated that painting is their major renovation work on their buildings 4 respondents representing 13% stated that they have re-roofed their buildings. Only 2 respondents stated that they have carried out re-roofing and painting of the building which represent 4% while 13 respondents representing 50% claimed that they carry out various renovation works apart from painting and re-roofing.

Table 8

How often do you carry out such renovation?

Option	Responses	% Response
Every year	3	8
Every 2-6 Years	8	33
Every 6-10 years	5	17
Irregular intervals	10	42
Total	26	100

Source: Complied by the author. (2002)

From the above table 3 respondents representing 8% stated that renovation on their buildings is a yearly affairs. 8 respondents representing building every 2 - 6 years. 5 respondents that representing about 17% claimed they renovate their building every 6-10 years while 10 respondents representing 42% stated that their own renovation works are not regular.

Table 9

What are the common problem encountered by the tenants (related to the environment?

Option	Responses	% Response
Drive rain	13	50
Solar radiation (sun)	6.5	25
Lack of ventilation	6.5	25
Total	26	100

Source: Complied by the author. (2002)

From the table 9 above, 13 respondents representing 50% stated that drive rain is the common complaint from their tenants 6.5 responds each representing 25% each claimed that the common

environment related problem encountered by their tenants are solar radiation and lack of proper ventilation respectively.

Table 10

How do you go about solving these problems?

Option	Responses	% Response
Financing it alone	5	20
Financing it jointly with the tenants	8	30
Allowing the tenants to do it as part of their rentage	13	50
Total	26	100

Source: Complied by the author. (2002)

From the table above, 5 respondents representing 20% stated that they will carry the burden above not minding the tenants. 8 respondents representing 30% stated that the problems should be solved jointly with their tenants, while 13 respondents representing 50% stated that they will as the tenants to do then and offset the bill through rentage.

Table 11

Suggest ways of improving the present state of your building?

Options	Responses	% Response
General renovation	11	42
Only Painting	6.5	25
Landscaping	8.5	33
Total	26	100

Source: Complied by the author. (2002)

From the table above. 11 respondents representing 42% stated that their buildings need total renovation 6.5 respondents representing 25% claimed that painting above can improve the present state of their buildings. While 8.5 respondents representing 33% stated that, landscaping is the only way to improve the present state of their buildings.

SECTION "B": FOR OCCUPANTS

Table 12

How many hours do you spend in your house every day?

Options	Responses	% Response
Average of less than 8 hours daily	10	11
Between 8 and 12 hours daily	44	50
More than 12 hours daily	34	39
Total	88	100

Source: Complied by the author. (2002)

From the above table, 10 respondents representing 11% spend less than 8 hours in their houses daily. 44 Respondents representing 50% spend between 8 & 12 hours daily in their houses. This shows that greater number of sample population spend at least 8 hours in the houses.

Table 13

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

Option	Responses	% Responses
10 am - 5pm	33	38
8 pm - 2am	36	44
All day round	10	11
No discomfort	9	10
Total	88	100

Source: Complied by the author. (2002)

From the table above, 33 respondents representing 38% stated that they experience major discomfort between 10 am and 5 pm. 36 respondents representing 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 respondent claimed that they have no discomfort at all and this represent 10% of the sampled population.

Table 14

What do you feel is the main cause of the discomfort?

Options	Responses	% Response
Solar radiation (sun)	34	39
Lack of air entrance due to the direction and position of openings	31	35
Lack of proper ventilation in terms of openings	14	16
No comment	9	10
Total	88	100

Source: Complied by the author. (2002)

From the table above, out of the 79 respondents representing 90% of the sampled population that accepted discomfort at various time, 34 respondents stated that solar radiation is the main cause of their discomfort. This represent 39%. 31 respondents representing 35% stated that their rooms windows were not positioned in the direction of air flow 14 respondents representing 16% stated that their rooms lacks cross ventilation hence poor air circulation.

Table 15

Does rain enter your house whenever it rains heavily?

Options	Responses	% Response
Yes	58	66
No	38	34
Total	88	100

Source: Complied by the author. (2002)

From the table above, 58 respondents representing 66% stated that rain do enter their house in cause if heavy rain, while 30 respondents representing 34% stated that rain does not enter their houses no matter the rate of rainfall.

Table 16

If yes, through which channel?

Options	Responses	% Response
Window	48	55
Roof	10	11
No comment	30	34
Total	88	100

Source: Complied by the author. (2002)

From the table above, 48 respondent representing 55% stated that rain enter their houses through the windows. 10 respondents claimed that rain enter their rooms through the roof. This represent 11% while a total of 34% of the sampled population did not comment.

Table 17

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

Options	Responses	% Response
yes	58	66
No	30	34
Total	88	100

Source: Complied by the author. (2002)

From the table above, 58 respondents representing 66% believed that shading devices can solve the problem. While 30

respondents representing 34% stated that shading devices can not solve the problem since some of the problem may be roof leakage.

Table 18

What is the nature of your compound terrain?

Options	Responses	% Response
All paved	56	64
Manly Covered with vegetation	14	16
Bare soil	18	20
Total	88	100

Source: Complied by the author. (2002)

From the table above, 56 respondents representing 64% stated that their compounds are completely paved. 14 respondents representing 16% claimed that their compounds terrain are covered mainly with vegetation. While 18 respondents representing 20% stated that their compound terrain leak both paving and vegetation.

Table 19

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

Options	Responses	% Response
Yes	51	58
No	37	42
Total	88	100

Source: Complied by the author. (2002)

From the above table, 51 respondents representing 58% relieved that terrain material can affect their comfort. While 37 respondents stated that terrain material has nothing to do with their comfort. This represents 42% of sampled population.

Table 20

Do you feel that your compound is properly landscaped?

Options	Responses	% Response
Yes	28	32
No	60	68
Total	88	100

Source: Complied by the author. (2002)

From the table above, 28 respondents representing 32% stated that their compounds are properly landscaped. While 60 respondents admitted that their compounds lack proper landscape. This represents 68% of the sampled population.

Table 21

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

Options	Responses	% Response
Flowers and trees planting	54	61
Extensive paving	6	7
No response	28	32
Total	88	100

Source: Complied by the author. (2002)

From the above table, 54 respondents representing 61% stated that planting of trees and flowers can help to achieve good landscape 6 respondents representing 7% stated that paving their compound all through will help to improve the landscape quality. While 32% of the sampled population did not respond since they felt that their compounds are well landscaped.

Table 22

If the planning authority suggest the idea of trees and flowers planting within your compound, will you accept or support?

Options	Responses	% Response
Yes	88	100
No	-	-
Total	88	100

Source: Complied by the author. (2002)

From the table above, virtually all the respondents stated that they will accept or support the idea of trees and flowers planting if initiated by the planning authority.

Table 23

State other defects you have observed in relation to your buildings environment etc.?

Options	Responses	% Response
Erosion	8	9
Flood	-	-
Poor waste disposal	38	43
Lack of Conveniences	6	7
Non	36	41
Total	88	100

Source: Complied by the author. (2002)

From the above table 8 respondents representing 9% stated that other defect they observed in relation to their building environment is erosion. 38 respondents claimed that poor waste disposal is another 43%. 6 respondents stated that they lack

commences. This represents 7%. While 36 respondents representing 41% stated that they have no other defect no relation to their buildings environment.

Table 24

How responsive is your landlord to these complaints/defects?

Options	Responses	% Response
Highly concerned	2	2
Lukewarm in approach	32	36
Less concern	18	21
No response	36	41
Total	88	100

Source: Complied by the author. (2002)

From the table above, 2 respondents representing only 2% stated that their landlords are highly concerned to their complaints. 32 respondents representing 36% stated that their landlords are like warm in their approach. 18 respondents stated that their landlords are less concern about those defects. This represents 21% while 41% of the sampled population did not respond on this matter.

Table 25

What are your suggestion on better landlord/tenant relationship?

Options	Responses	% Response
Periodic meeting	28	32
Co-operation in area of maintenance	22	25
Establishing a code of conduct as guiding rule between the two	38	43
Total	88	100

Source: Complied by the author. (2002)

From the table above, 28 respondents representing 32% suggested periodic meeting of landlords and tenants relationship, 22 respondents representing 25% stated that landlords and tenants should co-operate in area of maintenance. While 38 respondents stated that there should be a code of conduct guiding both the action of landlords and tenants for a better relationship between the two. This represents 43% of the sampled populations.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

This study was centered on the weather control in building using Sarkin Pawa and Limawa as the case study. The researcher carried out the study on the impact of climate elements on building and 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 driving rain and roof leakage.

From the research also, terrain materials were found to be the key actor in the temperature change of the buildings 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.

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.

5.2 **CONCLUSION:**

The aim of the study is to determine the climate comfort of Sarkin-Pawa and Limawa. Since the impacts of climatic elements on buildings are multi dimensional, it requires both direct and indirect approach in profaning solutions. The various weather control techniques are contextual in application hence, required an in depth 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 problem experiences by occupants in both Sarkin-Pawa and Limawa (Minna) is centered on discomfort. For instance, poor ventilation, direct influence of solar radiation, driving 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 analysed in this variable in relation to warm humid climatic region.

5.3 **RECOMMENDATION**

Following the researched on weather control on buildings through survey using Sarkin-Pawa and Limawa (Minna) as a case study and having analysed various weather control techniques, I hereby make the underlisted recommendations:-

i 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.

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

iii Planning Niger State Urban Development Authority should ensure strict compliance of all building regulation in addition to landscaping and ventilation. Only stipulated 33% of each plot should be develop leaving behind the remaining 67% for extensive landscaping.

iv. General landscaping especially tree planting along all streets in limawa-Minna and Sarkin-Pawa should be considered by the NSUDA, 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 by Obasanjos administrative and Minna G.R.A. The general occupants should take the responsibility of landscaping the individual compound.

v. Building is an integral part of the environment hence should not be treated in isolation. Architect should design in relation to the environment.

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INDEX 1

THERMAL COMFORT:-
(A MICRO CLIMATE OF SARKIN-PAWA AND LIMAWA-MINNA)

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 Post Graduate Diploma, is writing a research project on "thermal Comfort and have used Sarkin-Pawa and Limawa-Minna as market studies.

Inview 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 confidentiallly.

SECTION A: FOR THE LANDLORD/HOUSE OWNERS

1. How old is your building?.....

2. What is the major factor 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 ( )

7. How often do you carry such renovation?

   a. Every Year ( ) b. Every 2-6 Years ( )
   c. Every 6-10 Years ( )

8. What are 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 problem?
   a. Financing it alone ( )
   b. Financing it jointly with the tenants ( )
   c. Allowing the tenants to do it as part of their rentage ( )

10. Suggest ways of improving the present state of your building
    a. General renovation ( ) b. Only painting ( )
    c. Land scaping ( )

SECTION B: FOR 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 feel 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 beavily?
    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 ( ) 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 ( ) 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 flowers within your compound will you accept or support?
    a. Yes ( ) No ( )

24. What is your view about the general planning of Owerri?
    a. Well planned b. Fairly Planned
    c. Poorly Planned

25. State other defects you have observed in relation to you 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. Lukewarm in approach( )
    c. Less concern ( )

27. What are your suggestion on better landlord/tenant relationship?
    a. Periodic meeting ( )
    b. Co-operation in areas of maintenance ( )