TITLE PAGE

WEATHER CONTROL ON BUILDING IN WARM HUMID CLIMATIC REGION

A CASE STUDY OF OWERRI, IMO STATE CAPITAL

BY

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CERTIFICATION

I hereby certify that this work has been supervised, read and approved meeting part of the requirements for the award of Post Graduate Diploma (PG Federal University of Technology Minna, Niger State.

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In memory of my Dearest Mother late Mrs Sussanah Chinyere Ahumibe

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ABSTRACT

Building form part of man's environment. It has been under constand interaction with all the environmental components namely; physical, biological and social, physical component being the most active. The effect of climatic elements on building cannot be over emphasized. This project to a great extent highlighted the impact of these climatic elements on buildings.

The world is divided into different climatic zones, each with its own characteristics. Owerri, Imo State capital falls under the warm humid climatic zone, as such with its own peculiarity in terms of weather condition. It is quite unfortunate that most buildings in Owerri are not suitable for the climate of the area hence owners. Having carried out a research through survey on the general problem, this report try to analyze 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

Man's interaction which his environment has led to him modifying it to his comfort. Man's environment includes all the living and non-living element in his surrounding. It consists basically of three major components namely: Physical, biological and social. Physical environment refers to the non-living part of the environment e.g the air soil, water, minerals etc. climatic factors such as temperature and humidity have direct effect on man, his comfort and his physical performance. Man alters the natural characteristic of his physical environment sometimes on a small scale but more often on a very large scale,for instance he may clear a small patch of bush, build a hut and dig a small canal to irrigate his vegetable garden; or he may build large cities, drain swamps, irrigate arid zones, dam rivers and create large artificial lakes. Many such changes have proved beneficial to man but some aspect of these changes have created new hazards.

Biological environment refers to all living things in an area e.g. the plants, animals, micro-organisms and man. All these living things are interdependent on each other and they are ultimately dependent on their physical environment. For instance, the photosynthetic plants trap energy from the sun and circulate it among the living things in the area. Nitrogen-fixing organism convert atmospheric Nitrogen into the nitrates which are essential for plant life. Herbivorous mammal obtain its nourishment by feeding on plants. Carnivores feed on other animals while omnivores feed on both plant and other animals. Man deliberately manipulates the biological environment. He cultivate useful plants the provide food clothing and shelter, and he raises farm animals for their meat, milk, leather, wool and other useful products. He hunts and kills wild animals and other predators, and he destroys insect which transmit diseases or which compete with him for food.

Social environment represent the part of the environment which is entirely man-made. In essence, it represents the situation of man as a member of the society, his family group, his village or urban community, his culture including belief and attitude, the organization of society, politics and government, laws and the judicial system, the educational system, transport and communication.

Environmental influence includes in the broadest sense forces and restraints that arise from man's accumulated cultural resources contain in elaborately developed social, structures. The structure of society are industrial, political, religion or aesthetic in nature. Man cannot approach or solve any environmental problem without taking into account value judgements that are weighed against the consequences to our total culture.

Man's relationship with his environment is reciprocal influence on man, whilst at the same time, man extensively alters his environment to suit his needs and desires. Next to food in priority ranking for man's basic need for survival is shelter. This is an integral part of man's environment. Shelter is a spatial enclave where man lives or performs one activity or the other. Man's interaction with his environment has led to him modifying it to his comfort.

From time immemorial, there have been an evolutionary trend in shelter development. From shading and living under trees, man learnt to take refuge in caves. Man's expanding knowledge has led to his technological skills. Hence from geological (caves) settlement man metamorphosed into erecting miniature structures. This chronological trend in shelter development have reached to a stage now where building are considered highly technical as to be handled by only professionals. The art and science of buildings have become the centre point of various professionals in the construction field, such as Architects, Builders, Engineers etc. Hence buildings have become part of man's environment. Buildings apart from performing major function as shelter for man and his

activities, it is now under the direct influence of environmental components basically, physical biological and social.

Apart from making a functional and aesthetically balance design, an architect needs to go extra mile in considering and analyzing the design and construction implication with respect to prevailing weather condition (Climate) of the proposed building site. The major aim of adaptation is to enhance. Thus human comfort and convenience are considered when adapting one structural pattern or the other. This can be by way of self esteem and goal actualization or by cost effectiveness in terms of durability of the building component in question.

The influence of physical component of our environment on buildings cannot be over emphasized. By physical environment we refer to the non-living part of the environment e.g. the air, soil, water etc. Climatic factors have both active and direct influence on our building. Most of building components or elements deteriorate on reacting with weather. For instance, uncoated wooden material will deteriorate when in contact with rain. Some building components have the tendency of absorbing and retaining solar radiation only to emit it later on to the comfort or discomfort of the occupants. Most building are badly oriented, thus exposing them to the danger of wind pressure and solar radiation. All these problems will been considered and analyzed as much as possible in this report.

Each climatic region is associated with its perculiar problem. For the purpose of this thesis, emphasis is basically laid on warm humid climatic region which Owerri Imo State capital fall into. Various weather control techniques are high lighted for both future proposal and the current existing structures for maximum comfort of the people.

1.1.2 STATEMENT OF THE PROBLEM

A balance design is not just an assemblage of form and shapes, rather it is one that integrate each and every design principle with the general environment. One of the major objectives of buildings is to provide comfortable internal condition in an economic way. Hence human comfort should be the key factor and target of every good designer. Cost implication in terms of durability and maintenance cost is another determinant. These considerations are far from erection of mere enclosures as building. Architecture is contextual in nature. Some designs are suitable for a particular climatic region but unsuitable to other climatic region.

Owerri, Imo State capital is densely populated and has a lot of building structures. This ranges from commercial to residential and probably institutional buildings. A critical survey carried out by me proved that majority of these buildings is not weather friendly. While some are basically not suitable for the prevailing weather condition of Owerri, other are wrongly orientated or landscaped.

Owerri falls under the warm humid climatic region. A design meant for tropical dry sub-humid or semi-arid climatic zones can not fit in Owerri. After a critical survey and analysis, one can ascertain that most of the buildings in Owerri are basically for another climatic region which the designers adopted to create immediate impression neglecting the future implication. For instance, while parapet roof-type is suitable in the dry sub-humid and semi-arid tropical region of Nigeria (where rainfall is relatively low and wind pressure relatively high), it constitutes a problem to the humid tropical region of Nigeria (where rainfall is relatively high and wind pressure relatively low). Hence most of the parapet roofed buildings in Owerri leak and deteriorate faster than those with well-defined eave projection.

My survey also revealed that majority of the buildings in Owerri, especially the institutional buildings adopted the east-west orientation this exposing them to the early morning rising and late afternoon setting of solar radiation. Some of the buildings are poorly ventilated, this is not in terms of structural openings but as a result of poor orientation. In some buildings, the compounds are completely paved with little or no space for vegetal cover. This results in emission of heat to the interior part of the building.

ISBIC Mortgage bank, lake insurance company Ltd, and Hallmark bank Ltd buildings all in Owerri are good example of weather unfriendly building in Owerri. Yearly maintenance cost constitute huge economic burden to the owners. Many residential building are not left out in this ordeal. Some of the buildings in Owerri have been on constant effect of wind storm resulting in structural failure. Those problems could have been averted with proper planning and orientation.

Most of the buildings in Owerri lack proper landscape. Good landscaping helps to reduce the radient heat, filter air, prevent penetration of sun (as sun breakers). It also acts as wind breakers.

1.1.3 AIMS AND OBJECTIVES

Owerri, Imo State capital is the nerve centre of many activities and a large number of people are engaged in different activities for their daily earning. Basically almost all human activities require structures (Buildings) as a means of shelter. Buildings are supposed to provide the optimum external condition for human's comfort. Hence the major function of an architect should be to produce a balance design that will stand the test of time in terms of functionality, aesthetic value, circulation, ventilation and above all weather friendly in order to enhance comfortability and durability.

The major aim of this project is to:-

Establish to an extent weather control technique that will take care of vast number of existing buildings and future proposed buildings in Owerri for the maximum comfort of the occupants.

Therefore the objectives of this project are :-

- To assess the impact of climatic factors e.g. Solar radiation, precipitation, wind etc on buildings as a structure with reference to warm humid climatic region by mean of survey using Owerri, Imo State capital as case study.
- To highlight to a great extent, the various ways or techniques by which these climatic effects on buildings can be controlled to achieve optimum comfort for the inhabitants of Owerri.
- To highlight the design consideration and implications of different weather control techniques.
- To make recommendations on ways of achieving weather friendly designs.

1.1.4 JUSTIFICATION FOR THE STUDY

In order to specify the characteristics of the building and its services require to provide a range of environments, it is necessary to have a reasonably

accurate picture of the climatic and microclimatic characteristics of the areas in which the building is located. There is need 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 parttern and choice of building materials.

Owerri is not fully developed, infact it is at the verge of its growth. There have been a lot of building construction since after the civil war. This makes it possible to find a wide range of building types and patterns in Owerri. Most of these structures were erected without taking cognisance of the prevailing weather condition. Peoples ideas most at time, are limited to the aesthetic appearance of building without caring on 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 urgent need to achieve a balance in buildings where most of man's activities are carried out.

For instance, Abuja the Federal Capital Territory is a well planned city. Abuja falls under sub-humid tropical region. Designer's utilises the advantage of double plot allocation in Abuja to achieve a better orientation. Apart from building regulations which were strictly followed, There is a general landscaping in Abuja. This is characterized by tree planted along the streets to give natural shade and to cool down air. Most of the buildings in Owerri violated the building regulation of building about 33% and reserving about 67% for landscaping. There is no tree planting along Owerri Streets. One can only get a fairly balance buildings in Aladimma Housing Estate Owerri. There, government planned and developed the buildings according to the required standard and regulation. The houses were well landscaped. But this constitute only a little fraction of Owerri. There is urgent need to proffer a solution that will take care of the existing structures that housed the teeming population and for future developments.

1.1.5 STUDY AREA DESCRIPTION LOCATION

Owerri si located in Imo state one of the South-eastern states of Nigeria. What is now refer to as Owerri capital is the Owerri municipal since the old Owerri has been splited into three namely: Owerri municipal (Owerri north and Owerri West.

TOPOGRAPHY/GEOLOGY

Owerri and its hinter lands is situated in the northern part of the eastern coastal lowlands of tertiary rock. It belong to the warm humid climatic region of the tropics. Naturally, Owerri has a relative plain land with a gentle slope. The Soil composed of tertiary sand and clay. The Soil is stable with a bearing capacity of 285,87 KN/m^2. Owerri has a good natural drainage system. There is low danger of flood or erosion Ground water level is about 30m below sea level.

CLIMATE

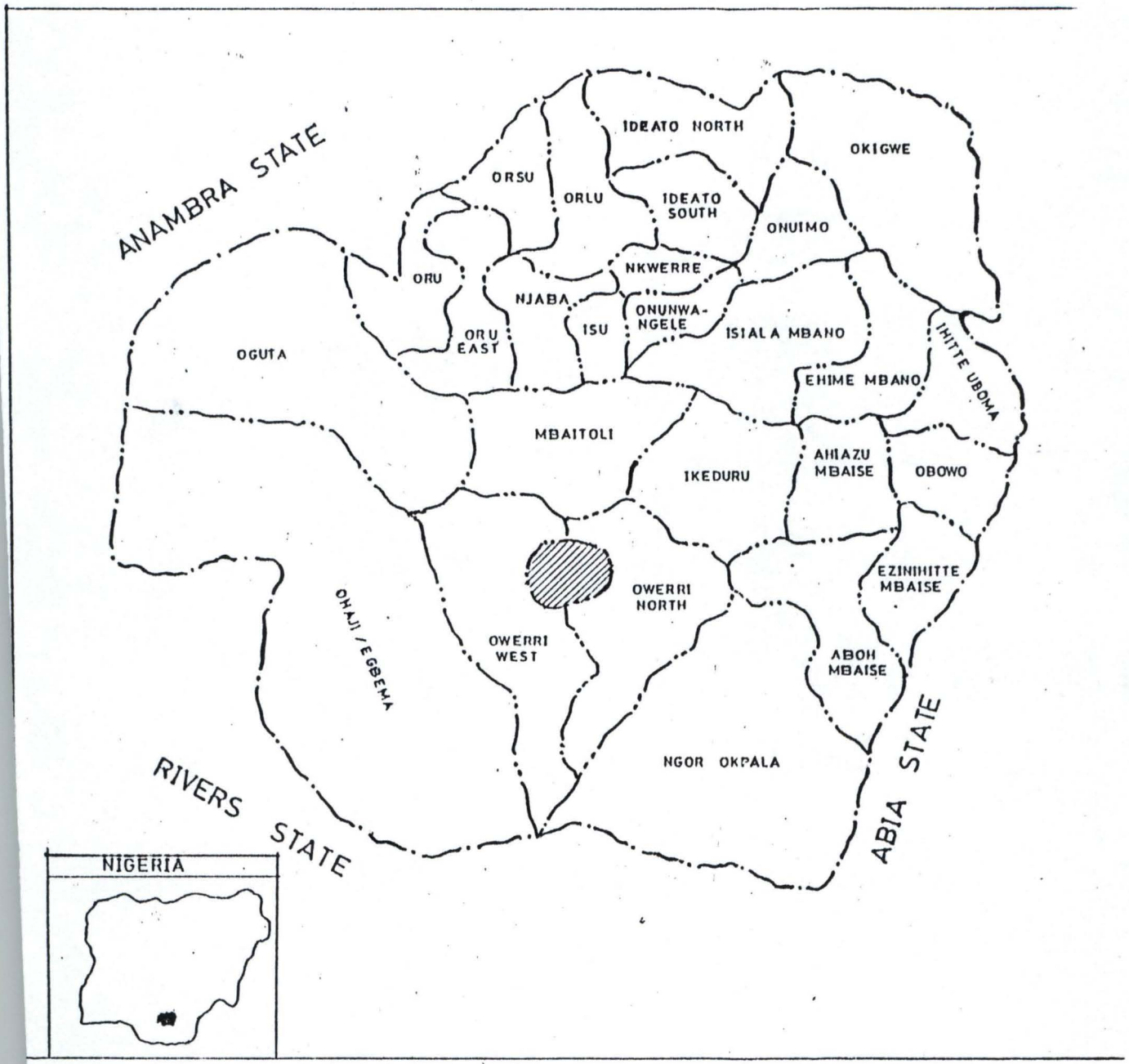
Seasons:-

(i) The long wet season starts in mid March and lasts till July. It is the season of heavy rainfall and high humidity.

(ii) The short dry season is the August break.

(iii) The short wet season follows the August break and lasts from September to October. The rainfall is usually not as intense as during the first wet season.

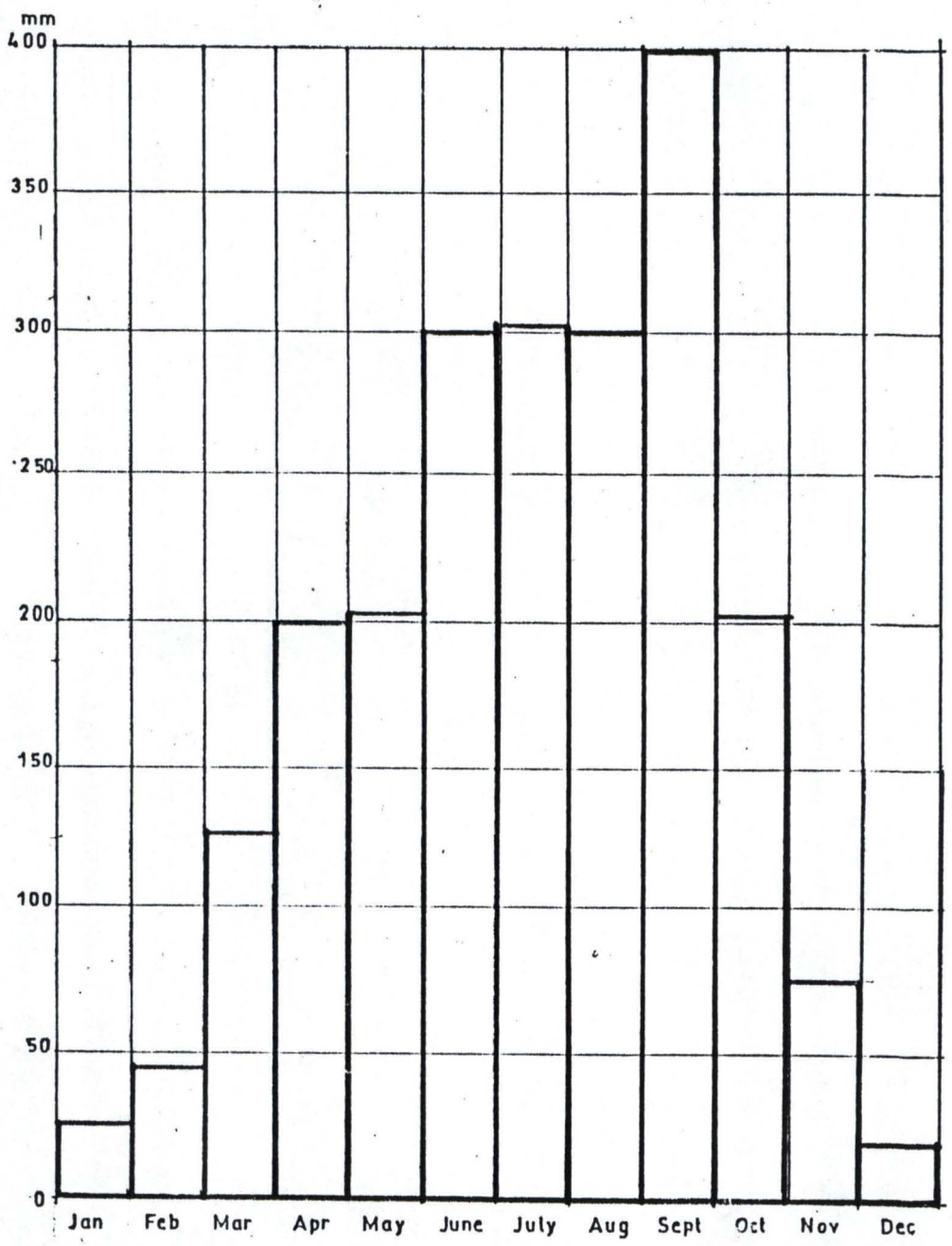
(iv) The long dry or harmattan season last from November to mid March. Hamattan mornings are cool and misty. Afternoons are full of haze because of the particles of the air brought down by winds.



SOURCE : MIN. OF LANDS, SURVEY AND URBAN PLANNING, (SURVEY DEPT) OWERRI.

fig 1.1 MAP OF IMO STATE SHOWING OWERRI CAPITAL AND OTHER L.G.A.

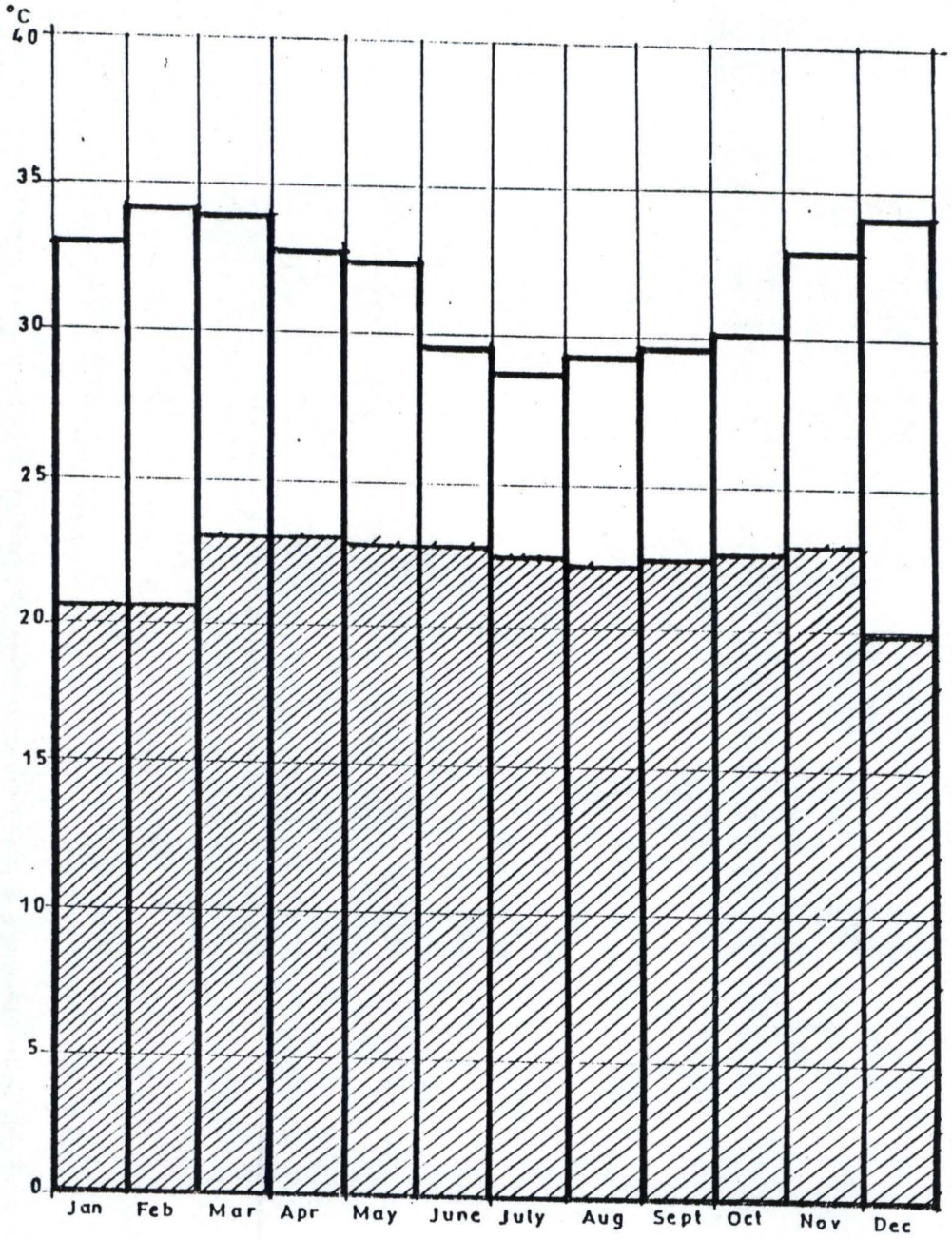
OWERRI MEAN MONTHLY RAINFALL



SOURCE : DEPT OF METEOROGICAL SERVICES OWERRI

fig 1.2

OWERRI MEAN MONTHLY MAX. AND MIN. TEMPERATURE



TOTAL/MEAN
max = 31.9
min = 22.5

KEY

Max tept.

Min tept

SOURCE : DEPT OF METEOROGICAL SERVICES OWERRI

fig 1.3

Rainfall

Owerri is characterized by relatively high rainfall of about 1850mm per year mostly received between March and October. The long dry season from November to mid March is general dry although some short and infrequent precipitation does occur.

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 a minimum between June and September. During the long dry season, night time temperature can be noticeably cooler.

Relative humidity

Relative humidity of Owerri is generally high throughout the year between 70% and 80%. Although as is to be expected, the highest figures are experienced during the wet season and is lowest during the dry season.

Wind

Owerri is under the influence of two winds namely:- The northeast trade wind south-west monsoon wind. The former is characterized by high velocity, dryness. 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 originates from the coast e.g seas and ocean, hence its wetness. It is predominantly at night and flows all year round.

VEGETATION

Generally, Owerri use in the forest vegetation, so it is expected to be covered by hick vegetation but human activities have reduced it to a mere farm land. The distant egetation in the horizon gives an idea of an unending green panorama. This leforestation calls for purposeful-landscaping alongside the building design to produce n environment that is refreshing interesting.

POPULATION

With the 1991 population figure, Owerri have a population of fifty one thousand wo hundred and twenty-three (51,223.00) people. With the current population growth ate, the figure has been exceeded.

ECONOMY

Owerri is dominated by Civil Servants and traders. Only a little fraction are armers. This is as a result of development which have dimished there farm land. The 'Eke Ukwu' Owerri market is a bee hive of commercial activities. This has attracted many financial institution to be sited in Owerri.

1.1.5 SCOPE AND LIMITATION OF RESEARCH

For the purpose of this project, emphasis is basically laid on warm humid climatic region where Owerri falls into. The characteristics of principal climatic elements as regards to human comfort and building design are considered. These are solar radiation, temperature, humidity, wind and precipitation. Although a full description of these elements, their distribution, measurements and interaction is beyond the scope of this report, a general description and brief introduction are highlighted for a better understanding of the subject matter.

The scope of this report is also limited to structural and natural consideration of weather control in buildings. Full and elaborate material schedules and specification are not given.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 ORIGIN OF BUILDING

The concept of building as a from of shelter arose as a result of permanency in man's settlement. From the broad point of view, settlement has to be a distinct and identifiable spatial enclave which accommodates human population and human activities. The need for a clear knowledge of the origin of human settlement cannot be over emphasized. The 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 human beings settling in one place or the other.

A number of factors led to the origin and growth of human settlement. Such factors include; social, economical, political and physical factors. As earlier mentioned, the early men were nomad i.e they were known to be moving from one place to another in search of food and shelter. Their main occupations that time were hunting and fishing. Although the early men were not stable at a particular place, there still arose this quest for family groups to come together at 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 expand, hunting and fishing because inadequate to meet the challenging population, cultivation of plant became the appropriate supplement. The initial temporary settlement than graduated to permanent settlement. The bronze age also led to the domestication of plants and animals. 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 inters. 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 its subsidence the savage creatures drew near, found 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 imitation of birds). Soon they set up forked stakes, connected with twigs and covered in mind, for the walls. The flat roofs were pitched and had eaves; reads and leaves were used as a cover. Virtuous finds confirmation of his theory in the survival of such huts in various parts of Europe. He notes the pit dwellings of the phrygians (dug into 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 builders 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 design of building and in the use and experience of buildings.

The need for shelter arises, of course, from the basic objectives which a building is designed to attain. Their 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 ie 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 Alberti's 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 others 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 storing 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 gross 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 ie 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 condition 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.

It is obvious that a building 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 microclimatic differences which should be recognised in the design and construction of buildings. As a result of various influences the air temperature in an urban area, for example, can be as much as 80C 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 climate information is not readily available and will have to be acquired through personal observation and local experience.

It is quite reasonable to hope that design based on a better climatic understanding will change and improve the quality of built forms. Many designers believe that the 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 costs something to build and maintain. In cold 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 than 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 authors 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 integrated. The gaps between architecture and the vernacular and between the architect's 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 these 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's 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 layout-to avoid the funneling of prevailing winds; the avoidance of south winds and 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 exposure, and roofed, in the north and of northerly exposure, and more open in the south. There follows a short discourse on how the pitch of human voice changes with latitude-the southerners have high and shrill voices, the northerners speaking in heavier tones. Bodies and minds correspond to these climatic effects too-the northerners being of vast height, fair and grey-eyed, unable to withstand heat or fever but brave; the southerners more stocky, robust in heat but timid.

Hence Vitruvius, considered human comfort as the major factor to be determined when designing.

In the book 'House Form and Cultures, prentice Hall, New Jersey; 1969, by Rapoport, A. numerous examples are quoted to show that climatically inappropriate form are often used where cultural, symbolic or social factors are the potent, crucial ones. The technical ones may act as mediating filters, or 'possibilistic' 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 Pueblo Indian group dwelling and the Navajo Hogan.

Never the less, 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.

2.4 THE CLIMATE OF CITIES

A relatively large spatial and temporal variation in conditions 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 wind 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 joins that flowing horizontally to create high velocities 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 reflectivity 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 suburbs and country outside.

Radiation and sunshine hours in cities are substantially less than outside them, due to the extra turbidity caused by smoke, dust and other pollutants. In cold climates in spite 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

As to of the primary function of any building it to counteract at least some of 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 users.

Although human comfort cannot be measured in terms of psychological factor only one of the primary requirements (and this 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 continuos exchange of heat between the body and its surrounding which may take place in four physically different ways-conduction, convection, radiation and evaporation. These physical processes depend on the climate and are influenced in particular by the four afore-mentioned 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 the 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 surfaces 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 25^0C, the clothed human body cannot get rid of enough heat by either convection or radiation and the loss of perspiration becomes the sole compensatory mechanism. Water consumes heat in order to evaporate, and as humans 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 move the air movement, the greater will be the evaporative potential. This is however lessened by clothing, which reduces the air movement, and increases the humidity over the skin.

2.5.1 COMFORT ZONE

The range of conditions in which thermal comfort is experienced is called the comfort zone-something which differs with individuals and is affected by the clothing worn, geographical location, age and sex. Although the 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 in terms 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 in terms of a single parameter or 'thermal index' which can be set out on a nomogram.

2.6 CLIMATE AND COMFORT

Victor Olgyay in 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, however, varied widely with different characteristics of building construction and 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 requirements 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 evaporative 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, however, 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 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 sketch plan stage.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY AND PROCEDURE

3.1 DESIGN OF THE STUDY

This study is designed to assess the impact of climatic elements on building as a structure with reference to warm humid climatic region using Owerri, Imo State capital as a study area. And also to analyze to a great extent, the various ways by which these climatic effect on building can be controlled.

In this project the survey research method were employed. This design was considered appropriate because it is a fact finding technique and facilitate the generation of information about current situation.

3.2 SOURCES OF DATA

To obtain data for this study, the researcher made use of two main sources namely; the primary and the secondary sources.

PRIMARY SOURCES

(i) Questionnaires:-

The researcher made use of a structured questionnaire as one of his primary sources of data. In the questionnaire a total of 27 questions were asked some with a set of answers from which respondent ticked the alternative which represent his/her opinion. A total of 100 questionnaires were distributed to landlords, workers and general inhabitants of Owerri at random.

The questionnaires were administered directly by the researcher himself to the inhabitants, the was able to collect reasonable number of questionnaires duty completed after some days.

(ii) On the Spot investigation

The researcher made use of spot investigation, which implies that, He took proper observation of each place he went to and not on hear-say of what is in existence at Owerri the stud area.

SECONDARY SOURCES

(i) Literature review:-

This method of data gathering entails an indepth study of the works done by some academicians, theorists, professional and authors alike. It involves gathering information from textbooks, newspapers, formal and other publication materials.

3.3 METHOD OF DATA ANALYSIS

The researcher used mathematical and statistical methods in data collection and analysis. These include: Tabulation, Percentages and diagrammatic illustration.

The above methods have been chosen by the researcher so as to ensure simplicity and easy understanding.

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 analyze various weather control techniques suitable for Owerri.

4.1 THE QUESTIONNAIRE

From about 11,500 households in Owerri municipal my study area, 80 households were chosen from 50 buildings as sample by means of random sampling. Out of the 80 households, 30 are landlords while 50 are tenants. Both section A and B of the questionnaire are to be answered by the landlords while the tenants are to answer only section B. 5 office blocks were also sampled. A total of 100 questionnaires were distributed. The table below shows that 88 questionnaires out of 100 were returned; representing 88% response.

TABLE 1

Questionnaire Distributed and Response Collected

Category of occupants	Number Distributed	Percentage	Number Returned	Percentage
Landlords	30	30	24	24
Tenants	50	50	46	46
Office Workers	20	20	18	18
Total	100	100	88	88

From the above table, 30 questionnaires representing 30% of the sampled population were issued to landlords and 24 were returned completed. Also 50

questionnaires representing 50% of the population were issued to various residential tenants and 46 were returned completed. 20 questionnaires representing 20% of the sampled population were issued to office workers from banks, and other establishments, 18 were returned completed.

SECTION A: FOR THE LANDLORDS/HOUSE OWNERS

TABLE 2

How old is your building?

Options	Responses	% Response
Below 5 Years	6	25%
5-20Years	14	58%
Above 20 Years	4	17%
TOTAL	24	100%

From the above table, 6 respondents representing 25% stated that their building are below the age of 5. 14 respondents representing 58% claimed that theirs are within the range of 5 to 20years. While 4 respondents representing 17% stated that their buildings had stood for more than 20years. This shows different age grades of buildings in Owerri.

TABLE 3

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

Options	Responses	% Response
Trend	6	25%
Architect	5	20.5%
Weather Condition	3	12.5%
Aesthetics	10	42%
TOTAL	24	100%

From the above table. 6 respondents representing 25% stated that building styles in vogue ie trend influenced their choice of building type. 5 respondents stated that they gave their designers free hand to give them a good design in terms of functionality and aesthetics. This represent 205%. Only 3 respondents representing 12.5% stated that prevalent weather condition in Owerri influenced their choice and orientation of building type. While 10 respondents representing 42% 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)?

Options	Responses	% response
Below 100,000	0	0%
100,000 to 500,000	6	25%
5000,000-1,000,000	8	33%
Above 1 Million	10	42%
TOTAL	24	100%

From the table above, none of the respondents agree that his building is below N100,000. 6 respondents representing 25% stated that their buildings are valued between N100,000 and N500,000. 8 respondents claimed that theirs are valued between N500,000 and N1 Million. This represent 33%. While 10 respondents representing 42% stated that their buildings have a current value of above N1 Million. This shows different category of buildings in Owerri.

TABLE 5

Options	Responses	% Response
Yes	8	33%
No	16	67%
TOTAL	24	100%

From the above table, 8 respondents stated that they are satisfied with the physical state of their building. This represent 33%. While 16 respondent representing 67% stated that they are not satisfied with the physical state of their building.

TABLE 6

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

Options	Responses	% Response
Yes	24	100%
No	0	0%
TOTAL	24	100%

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

TABLE 7

What type of Renovation do you Carry out?

Options	Responses	%Response
Painting	8	33%
Re-Roofing	3	13%
Both	2	4%
Others	12	50
TOTAL	24	100%

From the above table, 8 respondents representing 33% stated that painting is their major renovation work on their buildings. 3 respondents representing 13% stated that they have re-roofed their buildings. Only 1 respondents stated that he has carried out both re-roofing and painting of the building this represent 4%. While 12 respondents representing 50% claimed that they carry out various renovation works part from painting and re-roofing.

TABLE, 8

How often do you carry such renovation?

Options	Responses	% Responses
Every Year	2	8%
Every 2-6 Years	8	33%
Every 6-10Years	4	17%
Irregular Intervals	10	42%
TOTAL	24	100%

From the above table, 2 respondents representing about 8% stated that renovation on their buildings is a yearly affair. 8 respondents representing building every 2to 6 years. 4 respondents which represent about 17% claimed that they renovate their building every 6 to 10 years. Which 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)?

Options	Responses	% Response
Drive rain	12	50%
Solar radiation (sun)	6	25%
Lack of proper ventilation	6	25%
TOTAL	24	100%

From the table above 12 respondents representing 50% stated that drive rain is the common complaint form their tenants. 6 respondents 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?

Options	Responses	% Response
Financing it alone	5	21%
Financing jointly with the tenants	8	33%
Allowing the tenants to do it as part of their rentage	11	46%
TOTAL	24	100%

From the above table, 5 respondents representing 21% stated that will carry the burden alone not minding the tenants. 8 respondents representing 33% stated that the problems should be solved jointly with their tenants. While 11 respondents representing 46% stated that they will ask the tenants to do them and off set the bill through rentage.

TABLE 11

Suggest ways of improving the present state of your building?

Options	Responses	% Response
General renovation	10	42%
Only painting	6	25%
Landscaping	8	33%
TOTAL	24	100%

From the above table, 10 respondents representing 42% stated that their buildings need total renovation 6 respondents representing 25% claimed that painting alone can improve the present state of their buildings. While 8 respondents representing 33% stated that to improve the present state of their buildings they required to landscape them.

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%

From the above table, 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. While 34 respondents representing 39% spend more than 12 hours daily in their houses. This shows that greater number of sampled 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?

Options	Responses	% Response
10am-5pm	33	38%
8pm-2am	36	41%
All day round	10	11%
No discomfort	9	10%
TOTAL	88	100%

From the table above 33 respondents representing 38% stated that they experience major discomfort between 10am and 5pm. 36 respondents representing 41% stated that they experience their major discomfort between 8pm to 2am. 10 respondents representing 11% stated that they have discomfort

TABLE 15

Does rain entre your house whenever it rains heavily?

Options	Responses	% Response
Yes	58	66%
No	30	34%
TOTAL	88	100%

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

TABLE 16

If yes, through which channel?

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

From the above table, 48 respondents representing 55% stated that rain entre their houses through the windows. 10 respondents claimed that rain entre their rooms through the roof of the buildings. 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%

From the above table 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 sine some of the problem may be roof leakage.

TABLE 18

What is the nature of your compound's terrain?

Options	Responses	% Response
All paved	56	64%
Mainly covered with Vegetation	14	16%
Bare soil	18	20%
TOTAL	88	100%

From the above table, 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 compounds' terrain lack both paving and vegetation. This shows the level of landscaping in Owerri.

TABLE 19

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

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

The above table shows that 51 respondents representing 58% believed that terrain material can affect their comfort. While 37 respondent stated that terrain material has nothing to do with their comfort. This represents 42% of the 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%

From the above table, 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%

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 landscape.

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%

From the above table, 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

What is your view about the general planning of Owerri?

Options	Responses	% Response
Well planned	21	24%
Fairly planned	38	43%
Poorly planned	29	33%
TOTAL	88	100%

From the above table, 21 respondents representing 24% stated that Owerri is well planned. 38 respondents representing 43% stated that Owerri is fairly planned. While 29 respondents representing 33% stated that Owerri is poorly planned.

TABLE 24

State other defects you have observed in relation to your building's 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%

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

TABLE 25

How responsive is your land lord 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%

From the above table, 2 respondents representing only 2% stated that their landlords are highly concerned to their complaints. 32 respondents representing 36% stated that their landlords are lukewarm 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 26

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%

From the above table, 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.

4.2 WEATHER CONTROL TECHNIQUES

Having analyzed the various climatic problems that faced most buildings in Owerri and the discomfort associated with the inhabitants, it is very important to analyze different weather control techniques to know the one that will suit the existing structures and future proposed buildings. This has become necessary because the climatically unbalanced buildings can not be demolished in order to change their orientation. Rather many variable have to be put in place at least to reduce the discomfort to the barest minimum.

Many a times, various techniques are recommended in buildings to tackle the effects of climate without understanding the context and implication of such techniques. This had created more problems than solving them. For instance North-east and South-west orientation is a good orientation of air but poor solar radiation orientation in warm humid region, it can only be a good orientation in an area where heat conservation is necessary.

The following are the various weather control techniques to be employed in Owerri.

4.2.1 ORIENTATION

Orientation is one of the ways climatic effects on buildings can be controlled. It can be defined as the process of placing a building on the site to take best advantage of the surroundings. The orientation of wind and solar radiation as well as by the view, noise and privacy. The orientation of a building is affected by the quantities of solar radiation falling on different sides at different times. It has, however, been recognised that both radiation and temperature act together to produce the heat experienced by a body or surface. This is expressed

as the sol-air temperature, which includes three component temperatures : Firstly that of the out door air, secondly, the solar radiation absorbed by the body or surface and, lastly, the long-wave radiant heat exchange with the environment.

Building orientation affects the indoor climate in two respects, by its regulation of the influence of two district climatic factors.

(i) Solar radiation and its heating effect on walls and rooms facing Different directions.

(ii) Ventilation problems associated with the relation between the direction of the prevailing winds and the orientation of the building.

Considerations of these two factors may lead to contradictory Orientation requirements. This in a tropical country one orientation may provide the required lower temperatures, while another could result in higher indoor air velocities. The final choice in such a situation should be based on evaluation of the quantitative physiological advantage of each factor, which is also determined by the ambient air temperature and humidity levels.

In analysing the effects of orientation, however, it is more convenient to approach these factors separately and then to find the optimum solution for any particular situation. As will be seen later, it is possible to adjust the design of a building to modify the effects of orientation on both temperatures and ventilation conditions.

Effect of orientation on ventilation

Window orientation with respect to the prevailing wind direction is likely to have a considerable influence on the ventilation of the interior. The principal requirement for satisfactory ventilation is the provision of openings on both the windward and the leeward sides of a building, a necessity confirmed by laboratory and field studies. If there is only one opening, or if two openings are located on leeward sides of the building the average indoor air velocity is very

low, in the former case the velocity is almost independent of the wind direction, and is approximately 10 to 15% of the external wind speed. When the openings are place on both windward and leeward sides, it was observed that the average velocity is much greater; ranging from 30 to 50% of the external speed, depending on the inlet and outlet sizes and on the relation between the wind direction and the axis between inlet and outlet. When the wind is parallel to this axis, the air flows straight through the room, ventilating only a limited section, in which the air velocity is high. On the other hand, if the wind has a change direction within the room, a larger volume is affected by the air flow and the average velocities are higher.

Owerri experiences the influence of two major wind types namely :- The east trade wind and South-west monsoon wind. The north-east trade wind is characterized by its high velocity, dryness and it carries dust particles. It quite predominant between the month of December and February. The south-west monsoon wind on the other hand is characterized by its gentleness, humid nature, and its dust free. It originates from the coast e.g. Seas and ocean, hence its wetness. It is quite predominant at night and flows all year round.

Considering the fact that the sun rises in the east and sets in the west, the best orientation for buildings in Owerri. is north-south orientation. The north-east – south-west orientation recommended by most designers in Owerri is wrong.. The north-east –south-west orientation can at best only take care of the ventilation without taking care of the solar radiation effects.

This is illustrated in fig 4.1

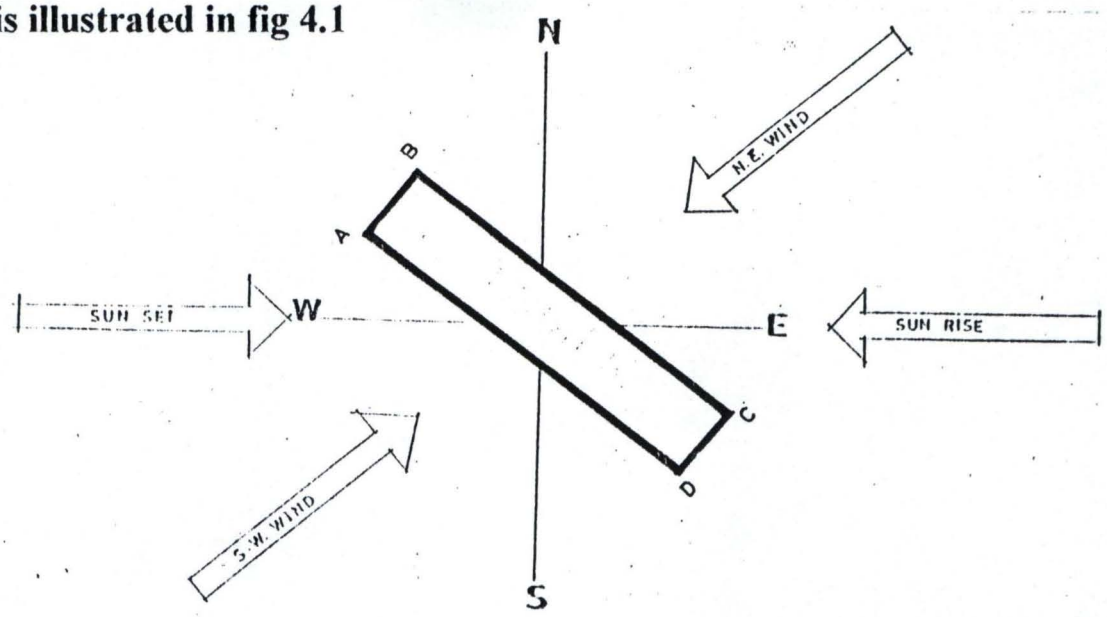


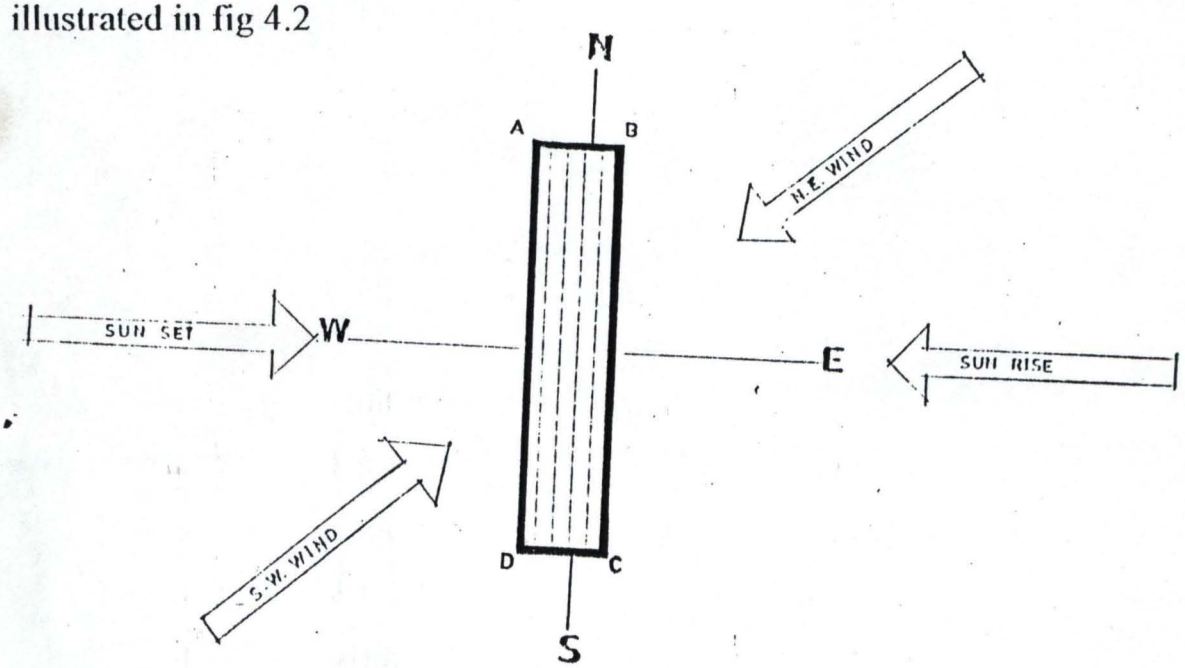
Fig 4.1

From the above Illustration

-The openings in sides AD and BC (the longer sides) will receive a good air flow

- The openings on sides AB and DC will receive no air flow
- Sides AD and DC will be under the direct the direct influence of lat afternoon solar radiation while sides BC and CD will be under the influenc of early morning solar radiation.
- The building also stated the risk of direct influence of the winds, which wil be acting perpendicular on the building.

East West orientation is also a bad orientation for solar radiation. Its effect i illustrated in fig 4.2



From the above Illustration

-The longer sides AD and BC will be under the influence of solar radiation and more heat will be absorbed by these sides.

As mentioned above, the best orientation for optimum comfort is North-South orientation as illustrated in Fig.4. 3

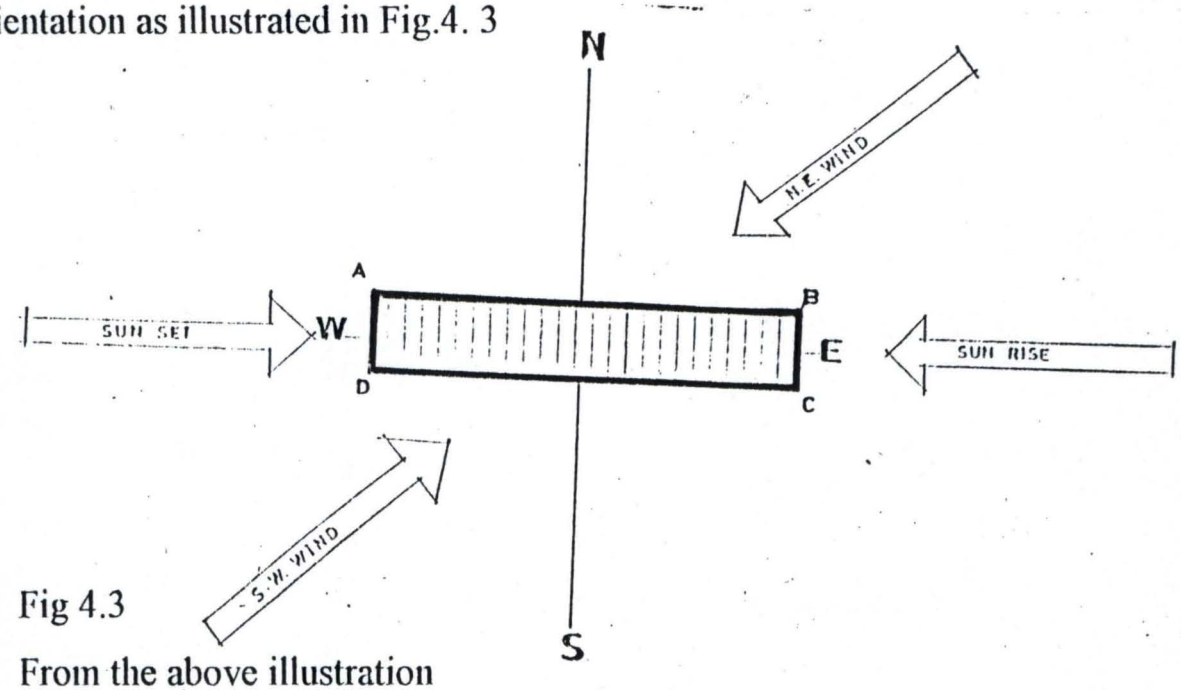


Fig 4.3

From the above illustration

-The longer sides AB and DC will be shut from the direct influence of solar radiation

-Sides AB and BC will have the influence of air flow from N.E trade wind at an angle of 45^{0}. This will increase the velocity of the wind. The same will occur at sides AD and DC which are under the influence of S.W monsoon wind.

-Wind effect from N.E trade wind can only have an angular effect on the building.

Having realized that North-South orientation is better than other options, opening should be minimize in the east and west (the shorter)sides of the building to reduce the direct effect of solar radiation. This will be quite functional in Owerri since the difference between the two temperature extreme is relatively small.

4.2.2 SHADING DEVICES

The impact of solar radiation on buildings in warm humid climate must be reduced not only by orientation and effective design of the structure, but also adequate shading. Although it is not always convenient or economical to shade roofs, walls lend themselves to this treatment in a number of ways which can be invaluable for eliminating or reducing one of the greatest sources of heat gain, the solar radiation entering through windows. Shading devices are also require to shade the walls and opening of driving rain which is another characteristic of warm humid climatic region.

Various methods are available for screening walls and windows, and when deciding on the shading requirement each façade must be separately considered to achieve the most effective solar control. Knowing exactly how the sun will strike a calculate the length of the overhang of a sum shade, depth of a fin, the angle of solar collector, the placement of a courtyard, the length of the shadows cost by nearly building, or even the way. Distant hills or other objects that rise above the local horizon will affect sunsets.

There are various types of shading devices they include;

Vegetation

Existing trees and shurbs provide the simplest way of protecting a low building (or part of it) from solar radiation.

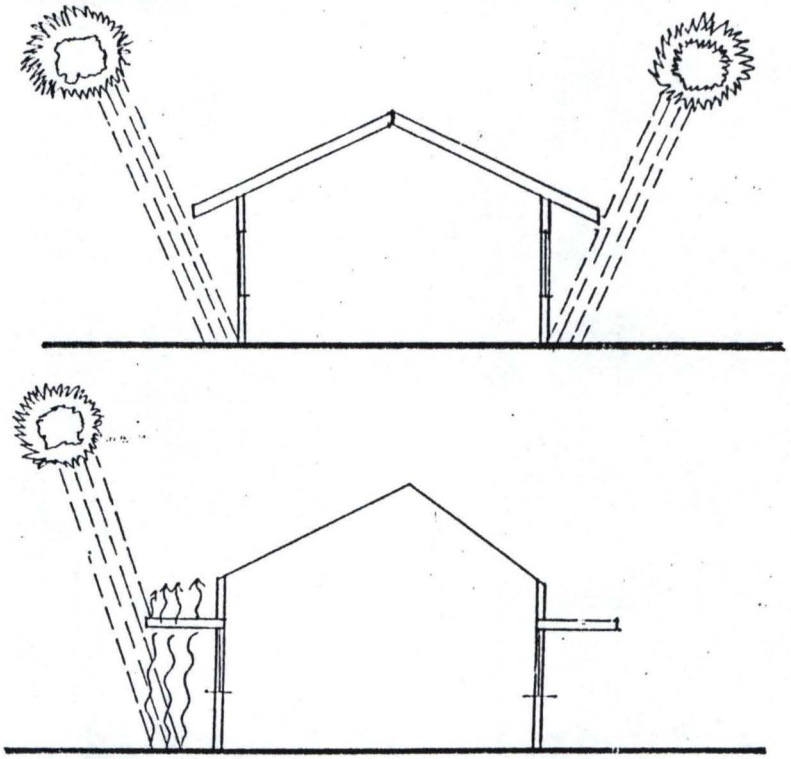
Horizontal Screens

Horizontal Screens are most effective against a high sun and are normally used on the north or south sides. The over hangs are generally sufficient to protect the interior of the dwelling from slanting sun and driving rain, as well as to provide shade over some portion of the surrounding area throughout the day.

Balconies and projecting floor slabs are also common from of horizontal screening.

In warm humid climate region, where heat conservation is not necessary, both the north and south walls must be considered.

Fig 4.4 is an illustration of the effect of solar radiation on building with over hangs.



Vertical Screens

This is in the form of closely spaced, columns vertical films or rotating houses. This type of shading device are useful; against the low sun on the east and west facades.

Vertical screen is illustrated in figure 4.5

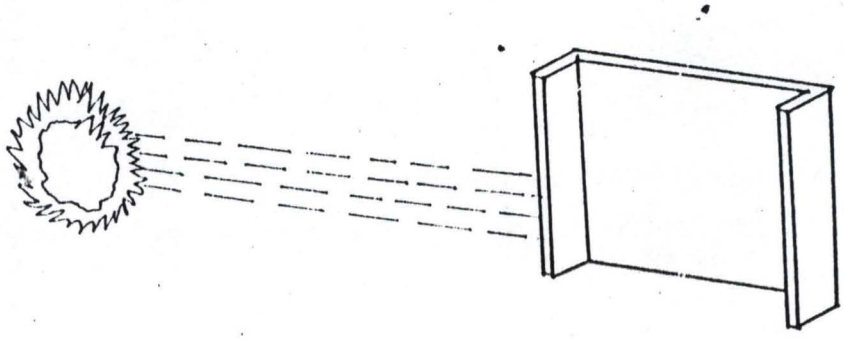


Fig. 4.5

Egg-Crate Screens

Egg-crates screens combined vertical and horizontal screening. The egg-crate grill, for example, can be effective for any orientation depending on its depth and the dimension of the openings. Atelier type of screening is used; it should be placed outside the lazing, be of low thermal capacity materials to ensure quick cooling after sunset, and should be designed to prevent not only reflection on to any part of the building but also hot air becoming trapped. This type of screen is illustrated in Fig. 4.6

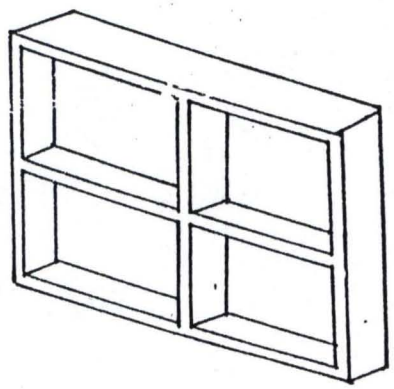


Fig. 4.6

Solar charts devised for several countries and a shadow angle protractor can be used to calculate shadow requirements and check the efficiency of the proposed screening for any orientation, for any time of the day, any day of the year. A shading ask can also be produced using a shadow angle protractor. Any solid object placed between the sun and the centre of the diagram (Point of observation) will cast a shadow on this point. The situation can also be reversed with the same effect; the light source can be placed at the point of observation and the shadow is then cast on to the sky vault. The areas of the sky, vault covered by the shadow are the portions oif the sky from which no light can reach the point of observation as long as the solid or opaque object is present.

If the sun itself moves through such on area of the sky, vault, clearly th point of observation will then b in shade and receive no direct light from the sun.

Shading devices are very useful weather control technique for bot existing and future proposed building such devices can be incorporated throug modification into existing building in Owerri. The construction method is simpl and relatively cheap.

4.2.3 STRUCTURAL TECHNIQUE

The structure of a building to a large extent controls some of the climat effect on it As mentioned earlier in chapter one, design should be contextual i nature. Although flat roofs are practical in areas where is seldom rains, the grea tradition for roofing in desert regions is the vault or done. This is because th rounded form of a hemispherical vault has a larger surface area than its base sola radiation is diluted facilitated.

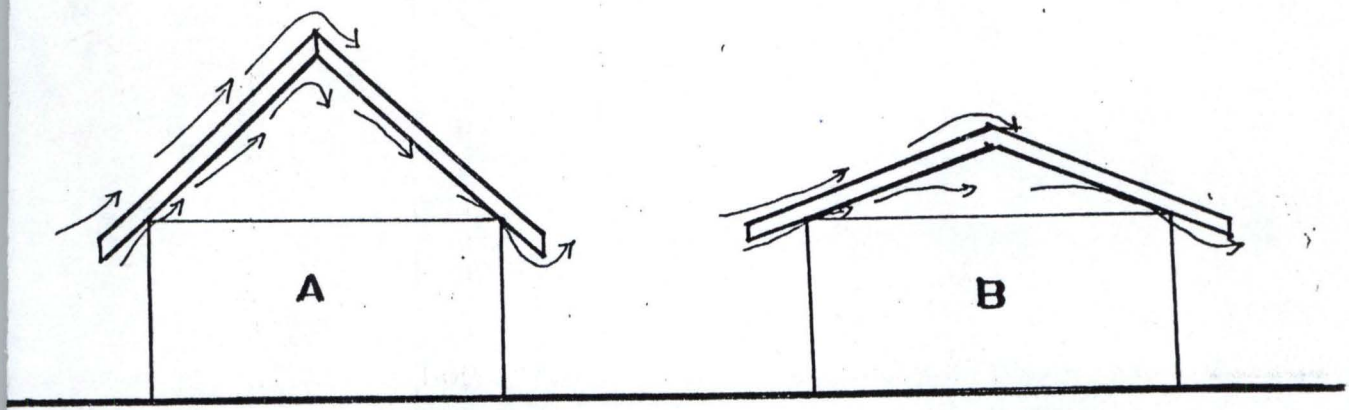
But in the warm humid region which is my study area, heavy rainfall an high humidity are combined with relatively moderate air temperature and hig solar radiation, so that shade and maximum ventilation are the critica components of comfort. Traditional shelters are most often very open in plan an construction, and one problem of the openness-necessary both day and night – i that with the small diurnal temperature range, little reduction in interna temperature is possible. The heat capacity of the structure must, therefore, be a low as possible to prevent accumulation of heat during the daytime , and mime re-radiation, which can cause discomfort at night when air movement is at it lowest.

To lessen the heat-retaining capacity of the structure and maximize the a flow across the interior, hollow sandcrete blocks should be used. The roo should be the dominant element in house in this region to act as a large umbrella

usually steeply sloped both insulated; the living space be low from the heat of the sum, and allows the torrential rain to be shaded quickly and almost silently. It also avoid condensation problems by being able to breathe;

High pitched roof is very suitable in Owerri. This will take care of wind pressure from removing the roof.

This is to give room for wind circulation inside the roof this is illustrated in **fig 4.7**



There will be more pressure in house B than in house A. This house B stand the risk of its roof being removed during powerful winds. The velocity of water run-off will also be low in house B during rain season, hence the roof components tend to deteriorate faster. Most of the colonial buildings in Owerri adopted this high patch roof-type e.g Holy Ghost college and Government College building.More than fifty year of construction, they still stand firm with little or no deterioration. While most of the post colonial buildings in Owerri adopted the flat roof system, thus been under serious threat of determination.

Parapet walls should not be used extensively in Owerri. This is because of the problems associate with it especially in warm humid region. Existing ones should be treated with aluminum flashing.

Cross ventilation is another important structural consideration in weather control. As wind blows against a structure, air piles up on the wind ward side, creating an area of high pressure. With the air flowing around the building, an area of reduced pressure is created directly down wind of the structure Thus a pressure difference exists between the wind ward and tea ward side in such a way that air will move through the structure-If adequate openings exist from the high pleasure side (or pressure zone) The larger the windows, the higher will be the windows air speeds, but this is true only when the inlet and outlet openings are increase simultaneously. When a room has unequal openings and the outlet is the larger, the much higher maximum velocities and slightly higher average speeds are obtained.

Although the aim should be to encourage air movement throughout the full depth of rooms-floor to ceiling and it is important to ensure that air flow into the space at a level, and in a pattern, which suits its function. For instance in bedrooms, particularly in warm-humid zones, the main air flow should be in that part of the room where beds are located and at a height a little above bed level.

4.2.4 LAND SCAPNG

Landscaping apart from increasing the aesthetic value of buildings, it also act as a natural coolant to buildings. Landscapes helps to filter air and many a times use as wind breaker. Most of the buildings surroundings in Owerri were extensively paved. Apart from serious discomfort cause to the occupants, it also result in flooding and erosion. This is because paving reduces infiltration capacity of the floor to zero.

Paving allows rain water to splash on the lower part of the walls resulting in peelings and general deterioration of the walls. Paving materials e.g concrete are good heat absorbents. They absorb heat from the solar radiation in the day time and emit it to the building during the night period.

The emitted rays can enter into the interior via the openings e.g windows, causing great discomfort to the occupants. This is mostly appreciative in warm humid region where heat conservation is not a desiring factor.

The portion of solar radiation which reaches the earth raises the temperature of the ground the amount depends on latitude, the season, the slope of the ground, the hour of the day and natural of the terrain is always found at the boundary between the ground and the air. The temperature, in other words increase considerably as one approaches the ground. At night, as a result of the loss of heat reverse is true and the temperature decreases as one approaches the ground. A peculiarity of micro climate therefore, is that the closer one approaches the ground the more extreme it becomes.

The natural cover of a terrain tend to moderate extreme temperature and stabilize conditions. Plant and grassy cover reduces temperatures and while they may be still further reduced by other vegetation, cities and man-made surfaces tend to elevate temperatures and reduce humidity.

The table 27 below shows the percent absorbtion of different material.

Material	Percentage Absorbtion
Paving	50
Bare Ground	30
Grass	5

Vegetation have little or no influence in the control of air movement around high structures, but their position and size can have a marked effect on the movement of air over and around how buildings. By day, in warm, humid areas where ventilation is so important, the air should entre the building through shade without passing over or through heated surfaces and vegetation can play an important role in this respect as long as it does not restrict the free flow of the breeze.

From the data collected about 73% of the sampled opinion proved that their compound were all paved and only about 12% claimed that grasses and hedges took much of their compound while 15% still remain unpaved and unplanted. This has been the major cause of their discomfort since not all the buildings were wrongly orientated.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

This study was centred on the weather control in buildings using Owerri as case study. The researcher carried out an in depth study into the impact of climate elements on buildings and occupants. Questionnaires were issued and various weather control techniques were 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 a key actor in the temperature change of the building's interior. For instance paved terrain absorb about 50% of the incidented rays from the sun and emit them to the immediate surroundings at night. This has to a large extent affected the comfort of people living in such environment even in buildings with good orientation. Research also revealed that Owerri people are less environmental conscious in their choice of building style. They follow trend and appreciate aesthetic values. Based on these findings recommendations are make.

5.2 CONCLUSION

In conclusion, 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 Owerri is centred 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. Therefore the various weather control techniques so far analyzed in this report can adequately take care of every variable in relation to warm humid climatic region.

5.3 RECOMMENDATIONS

Having researched into weather control on buildings through survey using Owerri as a case study and having analyzed various weather control techniques, I hereby make the following recommendations:-

1. With the exception of orientation as a weather control techniques, the other three methods ie shading devices, landscaping and structural techniques can be incorporated into the existing buildings with climatic defects in Owerri. This will help to achieve optimum condition in terms of comfort. The four techniques should be considered in all future development.
2. Planning authority in Owerri should ensure strict compliance of all building regulation as regard to landscaping and ventilation. Only stipulated 33% of each plot should be developed leaving the remaining 67% for extensive landscaping.
3. Parapet roof type should be avoided completely in Owerri as it has been proved to be a failure in the warm humid region
4. General landscaping especially tree planting along all streets in Owerri should be considered by the Owerri planning 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 in the Federal Capital territory Abuja and Minna. The general occupants should take the responsibility of landscaping the individual compound.

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

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INDEX 1

WEATHER CONTROL ON BUILDINGS –A CASE STUDY OF OWERRI
DESIGN OF QUESTIONNALRE

INTRODUCTION

I, 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 "Weather Control on Buildings and have used Owerri as my case study.

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.

SECTION A: FOR THE LANDLORD/ HOUS 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 ( )
   (c) 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 I million ( )

4. Are you satisfied with the 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 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 you been staying in this house ?
    .....

12 What is your occupation?.....

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

14. What time of the day or night do you experience major discomfort inside your house?
    (a) 10 am –5pm ( ) (b) 8 pm-2 am ( )
    (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 ( ) (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 ( ) No ( )

21. Do you feel that your compound is properly landscaped ?
    (a) Yes ( ) (b) 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 planing 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
    (d) 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 land lord to these complaints/ defects?
    (a) Highly concerned ( ) (b) Lukewarm in approach ( )
    (c) Less concern ( )

27. What are your suggestion on better land lord/ tenant relationship?
    (a) Periodic meeting ( )
    (b) Co-operation in areas of maintenance ( )
    (c) Establishing a code of conduct as guiding rule between the tow ( )