THE USE OF ARCHITECTURAL COMPONENTS IN MINIMISING MAINTENANCE FOR KADUNA STATE UNIVERSITY STUDENT CENTRE, KAFANCHAN.

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By

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DEPARTMENT OF ARCHITECTURE
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JULY, 2018

DECLARATION

I hereby declare that the work in this thesis entitled "**THE USE OF ARCHITECTURAL COMPONENTS IN MINIMISING MAINTENANCE FOR KADUNA STATE UNIVERSITY STUDENT CENTRE, KAFANCHAN**" has been performed by me in the Department of Architecture. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at this or any other institution.

Enock Kantiok _____ _____

Name of Student Signature Date

CERTIFICATION

This thesis entitled "**THE USE OF ARCHITECTURAL COMPONENTS IN MINIMISING MAINTENANCE FOR KADUNA STATE UNIVERSITY STUDENT CENTRE, KAFANCHAN**" By Enock, KANTIOK meets the regulations governing the award of the degree of Master in Architecture of the Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

To God almighty, my late dad, Mr James Kantiok, my beloved mum, Mrs Celina Kantiok and my brothers Caleb Kantiok, Stephen Kantiok, Sunom Kantiok and my dear sister Mrs Bariyat Benjamin. I am indebted to you.

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ABSTRACT

Due to the educational growth and technological advancement in the world, new ideas and innovations are developing in maintaining buildings most especially student centre. Which are difficult to maintain due to the nature of users and the population it accommodates. In Nigeria minimising maintenance problems in buildings demands the creation of spaces and specifying building materials which will minimise maintenance right from the design stage. Even in the developed countries, maintaining student centre buildings is a difficult task especially because the building designers could not proffer solutions to the maintainability of every building component, some of the major causes of building deterioration includes bad design, faulty construction, improper maintenance measures and most importantly the integration of maintenance design considerations and features in student centre, In order to determine the extent to which this was reflected in the design of Kaduna state University Student centre complex, Kafanchan, Nigeria, The methodology of the research employed distribution of questionnaire to the maintenance personnel and workers of some selected student centre in Kaduna, Jos and Ille - Ife as study cases, and at the same time a visual survey which vividly shows and evaluate the architects' consideration to maintenance. The research finally suggested the enforcement of maintenance integration in design requirements in student centres and planning authorities, it also proved that proper maintenance considerations during the design stage will save the building from been a failed design, It also shows the extent to which maintenance features can be integrated into student centre buildings.

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1.0 INTRODUCTION

1.1 Background to the Study

Maintenance as defined by the BS 3811is a combination of any actions carried out to retain an item in, or restore it to an acceptable condition. These actions can be carried out in anticipation of failure, 'retaining', and work carried out after failure 'restoring. Buildings generally, require proper and adequate maintenance to ensure comfort for the occupants for carrying out their day to day activities as well as to enhance the performance and life span of the buildings. According to Hoe (2008) and Suwaibatul (2011), the purpose of an effective maintenance is to achieve the following five key goals: preserve taxpayers' investments in public buildings, help buildings function as they were intended and operate at peak efficiency including minimizing energy consumption, prevent failures of building systems that would interrupt occupants' activities and the delivery of public services, sustain a safe and healthy environment by keeping buildings and their components in good repair and structurally sound and also provide maintenance services in ways that are cost-effective. Maina and Haruna (2014) also noted that closer attention to specification and design related matters which are crucial should be adhered by design professionals such as the architect.

An excellent practice of maintenance is greatly needed to increase the life cycle of a property and to minimize unexpected breakdowns or deterioration effects. Thus, all buildings require maintenance to function and move smoothly towards its dilapidation, decay and failure by age which would be considerably decayed because of proper maintenance. Due to the vastness of the works, it involves the interaction between several determinants that govern the use of buildings Faremi *et al.,* (2011). The determinants involves planning, directing, controlling and organizing maintenance services for the

sustenance of the value of a building, therefore, it must be considered as a strategic process if the value of a building is to be sustained Olufemi (2009).

Education growth and technological advancement in some countries in the Nineteenth century has led to the growing demand for student's creativity and interpersonal skills which are factors that led to development of skills and inovations in many parts of the world. Student centres thus, are some of the building types specifically characterised with various recreational activities. As education growth and technological advancement becomes worldwide, the development is spreading throughout the world, even in developing countries. It is unfortunate but, glaring fact, that student centres in Nigeria are in very poor and deplorable conditions of structural and decorative disrepairs as stated by Yakubu (2009). These poor maintenance practices in student centres have led to neglect, and vandalism towards public properties, gradual decline in patronage and loss of its beauty.

Ansari (2014) also noted that buildings depending on their nature of activities require a maintenance plan, which when followed strictly, will ensure the postponement of building deterioration. Public buildings with all kind of activities, users of different age and background are difficult to control and they also pose an enormous threat to the maintenance of these public buildings. It is because of this; student centres usually need the services of other professionals, from architects, landscape architects, engineers and technical persons, security personnel, and others as facility managers, to help them run their facility, from its maintenance to operation. The difficulty and dangers of maintaining these public buildings especially student centres makes the architects to have a lot to offer in ensuring the feasibility of maintaining public buildings especially at the design stage when they can foresee how most if not all, the maintenance possibility of these buildings.

This study seeks is to develop a maintenance strategy model for student centres, which will ensure to reduce and ease maintenance problems right from design stage and how this strategy can be used by the maintenance departments of the building.

1.2 Problem Statement

Technology and new building materials coupled with new architectural styles are making buildings more sophisticated; as educational growth and technological advancement in the world is increasing every day, new ideas and innovations are developing in buildings most especially public buildings. Student centres are one of the public buildings often interesting and inspiring structures for it is the crossroad for students to exhibit their interpersonal skills in the collegiate atmosphere, these centres will only be this way for as long as the building is properly maintained. There are many specific maintenance tasks on public buildings that need to be regularly maintained including window cleaning, inspection of component of the building such as walls, floors, roofs and even structural repair. When building accommodates large number of people of different lifestyles it becomes difficult to maintain because of façade of buildings with large openings and glass pane, at times irregular shapes with poor access to roofs and the various elevations. Maintaining these kinds of building pose threats to the lives of the maintenance workers to access certain parts of the building for cleaning and replacing. According to Moses (2011), every component of a building should have access for maintenance considering how it can be cleaned and replaced to prevent early failures.

However, access, replacement, maintenance equipment, poor detailing, material selection in relation to the climate study are some of the design problems of the building that leads to poor maintainability. Alexander (2003) also noted that most public buildings these days suffer maintenance problems due to some of these design issues and poor maintenance culture.

Student centres usually require frequent maintenance due to the population it accommodates, its nature of activities, inaccessible roofs and elevations. Mostly maintenance like cleaning and replacing is a common problem in such buildings. In Nigeria, most buildings especially students centre suffers maintenance problems which can be attributed to the designers inability to integrate into the design right from the design stage.

Integrating of these maintenance features from the design stage will explain why the maintenance plan and culture is not adhered to, and how can the architects make their buildings easily maintainable right from the design stage by providing the necessary features needed to ease maintenance.

1.3 Aim and Objectives

The aim of this study is to develop a maintenance strategy model for student centres, which will reduce and ease maintenance problems right from design stage.

The objectives of the study are:

(a) To identify parts of student centres that frequently needs maintenance.

(b) To develop a design framework that would ensure the integration of maintenance features in student centres.

(c) To demonstrate the outcome of the study in the design of a proposed Student Centre Complex.

1.4 Research Questions

This research intends to answer the following questions;

(a) How have maintenance design features shaped student centre buildings?

(b) What are the maintenance design features that can be integrated into the design to enhance the maintenance of student centres?

1.5 Scope of Study

This research will be focused on architectural design elements, mainly on spatial organization, aesthetics, building form, building elements, site planning and landscaping, structural and construction system as well as to come up with a good design which incorporates maintenance factors. The survey research will focus on Student Centre Complex using questionnaire, interview schedule and case studies of existing Students Centre Complexes locally. The study will attempt to incorporate other facilities in the proposed Student Centre Complex which would enhance attraction, utilisation and as well meet the spatial, and functional requirements of its users.

1.6 Justification of Study

The driving force behind this student centre is to encourage the students to utilise their intellects and express their talents in the collegiate atmosphere which is the crossroad of developing civic engagement, social, interpersonal development, leadership skills and friendship.

To the government it would help in the reduction of maintenance cost, since building cost is one of the crucial areas draining the national economy. And also to become a useful reference for architects and design engineers to incorporate crucial maintenance factors during design phase to ensure a successful implementation of design for less maintenance, particularly for future projects in Nigeria.

Furthermore the study will assist managers of student centres buildings to become aware of the current state of their building infrastructure and its effect on the safety and health of personnel and also to put in place adequate innovative measures to prevent

deterioration in new buildings which ultimately lead to increased cost in restoring these buildings to their original state.

2.0 LITERATURE REVIEW

2.1 Introduction

This review analyse the current literatures that relates to building maintenance and student centre buildings. The purpose is to highlight the issues useful to the successful completion of this study. However, it must be stated that this review is eclectic due to the fact that there are limited works in the area of maintenance design considerations in student centres. Thus, the review is divided into four major sections namely maintenance in buildings; public buildings and student centres evolving due to technological advancement and the architectural design features for maintenance considered during the design of such buildings; architectural input to maintenance of public buildings. The first is about maintenance of buildings generally, the need for maintenance, types of maintenance, building defects, maintainability of buildings and other maintenance issues. The second looks into how architecture is changing due to development in technology and how economic development and space need is sophisticating buildings. The third examined the need for proactive architectural considerations in designing public buildings and student centres to be maintenance conscious, and how certain design features can be used to make student centres easily maintainable which will in turn pose a lesser risk in maintaining and to also reduce the maintenance cost of the building.

2.2 Building Maintenance

Building maintenance as defined by Ajibola (2009) is the work undertaken in order to keep, restore or improve every part of the building, the services and surroundings to an accurately accepted standard and to sustain the utility and value of the facility to the user, tenant and owner. According to Tuleun (2014) maintenance can be seen as the effort in connection with different technical and administrative action to keep a physical asset,

or restore it to a condition where it can perform a required function. British Standard (BS 3811), also stated the meaning of building maintenance as the combination of all technical and associated administrative actions intended to retain an item in, or restore it to, a state in which it can perform its required function. Chanter and Swallow (2007) establishes that from this definition two key components can be identified:

1. Financing, initiating and organizing of maintenance works is also considered part of maintenance, instead of only actions that relate to the physical execution of maintenance work.

2. The notion of an acceptable condition of required function, which implies an understanding of the requirements for the effective usage of the building and its parts, which in turn bring closer, the considerations of building performance.

Maintenance can also be referred to as work undertaken in order to keep, restore or improve every facility, that is, every part of the building, its services and surrounds, to a currently accepted standard and to sustain the utility and value of the facility Yiu (2007). Al- Hammad (2011) on the other hand defined maintenance as to hold, keep, sustain or preserve the building or structure to an acceptable standard. Amobi (2006) also defined maintenance in engineering terminology as the continuous upkeep, in good condition of a system to achieve operational reliability with maximum designed output result, endurance and stability. The definition adapted here for building maintenance is the work undertaken to keep or restore every facility, that is, every part of a site, building and contents to an acceptable standard. Thus, maintenance aims at retaining components, equipment as well as the entire structure at specified level of acceptable performance. The acceptable standard here must be no less than the statutory requirements and one which sustains the utility and value of the facility. It will also include some degree of continuous improvement over the life of the building as acceptable amenity standards rise.

Akin (1998) noted that the principal objective of building and infrastructural maintenance is the upkeep of the building for continuous and reliable use. The wear and tear arising from use or misuse, weathering and other agencies must be anticipated and appropriate measures put in place to adequately take care of them. The concept of maintenance involves taking appropriate steps and precautions to ensure that a given piece of property attains its possible life span.

2.2.1 Types of Maintenance

There are several terms associated with the types of maintenance in buildings. The most commonly used classification is the one by British standard (BS3811) which broadly classifies maintenance into two categories namely:

1. Schedule Maintenance (Planned maintenance)

2. Corrective maintenance (Unplanned maintenance):

The classification of maintenance as planned or unplanned is shown in Figure 2.1

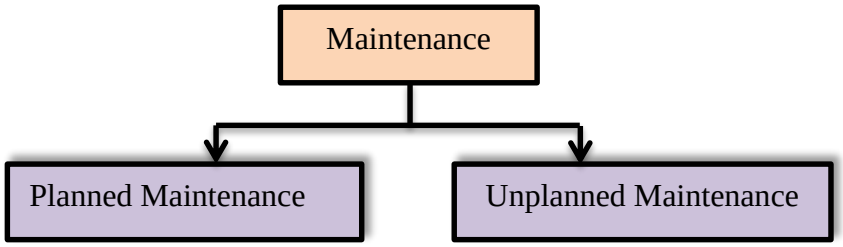


Figure 2.1: Maintenance Classification
Source: (BS 3811, 1984)

1. Planned Maintenance

Planned maintenance is a maintenance organised and carried out with fore thought, control and the use of records to pre-determined plan. BS3811 defined this type of maintenance as the work undertaken in accordance with standby based system of

priorities, each operation properly planned and organized in advance with necessary labour, plant and materials assembled ready for use when required. When properly applied, this maintenance type will lead to a greater margin of safety and reduce the risk of having to resort to emergency work.

Planned maintenance reduces the possibility of an item not meeting an acceptable standard and also to prevent breakdown facility or service. It generally involves regular inspection and identification of signs anticipated breakdown and consequently carrying out of repairs on the building and its facilities. It is carried out at pre-determined intervals intended to reduce the probability of failure. Ivor H. Seeley also stated that this is work directed to the prevention of failure of a facility, carried out within the expected life of the facility to ensure continued operation. The maintenance official knows what to aim at and thus, plans how to arrive at it. Other qualities of preventive maintenance include;

i. It provides essential management records.

ii. The program is flexible and subject to review.

iii. The work is organized and controlled.

iv. It is cost effective.

2. Unplanned Maintenance

BS 3811 defines unplanned maintenance as work performed to restore a facility to operation or to an acceptable standard. It involves replacement or rectification of damage or deteriorated facilities or parts. This type of maintenance is carried after a failure has occurred and intended to restore an item to a state in which it can perform its designed and required function. It involves those tasks to be performed as a result of failure to restore the component to its original state of performance. It may involve outright

replacement or to remedy established defects. It is work needed to restore the integrity of a damaged or deteriorated structure and it includes the repair or replacement of defective parts or components. BS 3811 explained it as the maintenance work resulting from unforeseen breakdown of facilities requiring urgent attention. It is work resulting from unforeseen breakdown or damage due to external causes such as acts of nature, settlement in buildings and shrinkage of building components. Basically, the first step of correcting such problems is to handle the cause of the problems. Because, most natural defects in buildings become critical only slowly and usually are evidenced by visible signs whose development can be monitored over a considerable period of time. This is to enable the observer to correctly identify their origin because; uninvestigated treatment of defects may not bring lasting solutions rather it may lead the maintenance personnel treating just the symptoms instead of the causes. The maintenance personnel must be able to ensure that the structure remain suitable for their intended use.

It is of utmost important to note that however thorough investigation and diagnosis of defects is the most reliable solution. Also, it is not very possible to foresee the extent of remedial work involved until the defect is opened up and exposed to an in-depth examination.

Corrective maintenance is also categorized by Ivor H. Seeley into;

a) Avoidable maintenance

b) Predictable maintenance

a) Avoidable maintenance: this was defined as the works required rectifying failures caused by the use of incorrect or faulty materials, incorrect design and incorrect installation. The features of this include;

i. Essential estate management records are obtained.

ii. Work is organized and therefore controlled.

iii. Statutory, legal and professional responsibilities are met.

iv. Direct or correct labour can be used to execute the job.

b) Predictable maintenance: Other researchers referred to predictable maintenance as schedule maintenance. Amobi (2006) also defines it as regular periodic work that may be necessary to retain the performance characteristics of a facility as well as that required to replace or repair the product after achieving a reasonable life span.

This schedule maintenance is undertaken for the following objectives:

4. Safety of the building itself and occupants.

5. Long term building preservation (enhanced life cycle).

6. Enhanced asset value.

7. Minimizing the disruption to all internal activities especially business activities.

2.2.2 Stages in Maintenance

Maintenance can be done in different stages. Each stage will have different characteristics. Probst – Wallace (2010) defined those stages as follows:

a. Planning and Design Stage

From the design stage a lot of money can be saved with the proper plan and design. For this reason, the building manager and maintenance personnel should be consulted during the early stages of the building design. The planning and designing of the facility should be based on the identified function and be as maintenance free as possible.

b. Construction Stage

According to Probst – Wallace (2010) In order to achieve minimum level of maintenance during the building life, work performed during the construction phase must be done with the highest quality in term of workmanship. As a result, expert contractor should be selected to perform the project.

c. Maintenance Stage

In this stage, maintenance is performed after the building has been constructed and occupied.

2.2.3 Functions of Maintenance

According to Amobi (2006) maintenance functions comprise these separate components namely; servicing and cleaning, rectification, repair and replace and renovation.

a. Servicing and Cleaning

Stephen (2002) explained servicing which is essentially a cleaning operation is undertaken at regular intervals of varying frequency and is sometimes referred to as day to day maintenance.

As more sophisticated equipment are introduced, so more complicated service schedule becomes necessary. The frequency of cleaning varies but could be considered for instance as floors swept daily and polished weekly, windows washed monthly, flues swept every six months, painting for decoration and protection every five years.

b. Rectification

Adejimi (2005) noted that rectification work usually occurs fairly early in the life of the building and arises from short comings in design, inherent faults, and unsuitability of components, damage goods in transit or installation and incorrect assembly. Rectification

is avoidable as all that is necessary is to ensure that the component and materials are suitable for their purposes and are correctly installed.

c. Repair and Replace

Repairs are carried out to restore components and parts of a building to functions as designed. Replacement is inevitable because service conditions cause materials to deteriorate at different rates. Stephen (2002) much replacement works are carried out not because of physical breakdown of the materials or elements but from deterioration of appearance.

d. Renovation

According to Adejimi (2005) Maintenance can also come in form of renovation which consists of work done to restore a structure, service and equipment by a major change to the original design and specification, or to improve on the original design. Renovation may include rehabilitation or modernization or adaptation.

The functions as outlined above, covers almost all the aspects of maintenance needs. It is therefore, a pre requisite for all buildings that are to be upgraded to one or more of the listed functions to undergo maintenance.

2.2.4 Causes of Maintenance Problems

According to Stephen (2002) Building services rarely perform as well as they are desired to. The causes emanate from deficiencies in design, construction, commissioning, tenancy work and maintenance. Many researchers have also observed that the causes of maintenance problems could be looked at under three main divisions:

1. Causes initiated during the design stage.

2. Causes initiated during the construction stage.

3. Causes initiated during the usage stage or the users' carefree attitudes otherwise known as bad maintenance culture. Alkhatam (2003) opined that all these could be planned for

during the design stage. Unfortunately, by the provision of the normal contract system, designers of buildings rarely have a long span interest in the buildings they produced; hence, they become divorced from the maintenance problems that follow from their bad designs. The crucial point emphasised by Adejimi (2005) is the cause initiated during the design stage and how planning at this stage can be employed to incapacitate other causes during the other stages. Maintenance problems though do manifest during the use of the building, their causes mostly are born during the design stage.

2.2.5 Building Defects

Al-Hammad (2011) defined building defect as an imperfection deficiency or fault in a building element or component which adversely affects its functional performance or appearance. Some defects are the natural consequence resulting from ageing and normal use but many premature failings can be traced to a lack of proper skill and care. A Building Research Establishment (BRE) study concluded that over 90 percent of building defects could be explained partly or wholly as the result of readily identifiable faults in design or construction which could have been foreseen and hence prevented. Broadly, the causes may be attributed to the following as noted by Mohan *et at.,* (2011):

a. Inadequate Brief: It is often argued that defects start on the drawing board but in some cases they can originate at an even earlier stage. Al-Hammad (2011). For example, the design brief may lay down totally unrealistic cost limits or fail to give vital information on the functional requirements of the building, which will further restrict the designer during the design stage.

b. Faulty design decisions: According to Alexander (2003) the most common faults may be grouped as follows:

i. Failure to follow well established design criteria in the choice of structural system and selection of materials.

ii. Ignorance of the basic physical properties of materials: for instance failing to make allowance for the differing thermal and moisture movements of materials used in combination.

iii. Use of new materials or innovative forms of construction which have not been properly tested in use: This is often the result of uncritical reliance on manufacturers' literature quoting simulated laboratory tests.

iv. Misjudgment of user and climatic conditions under which the material will have to perform.

v. Complex details which have a low probability of successful execution on an open building site.

vi. Poor communications between different members of the design and construction teams.

The fault may be traceable to component manufacturers, specialist sub-contractors and consultants as well as the main designer. A less obvious design fault is the failure to consider the case with which components can be maintained and eventually replaced. For instance, little or no thought is given to the standardization of components in order to reduce the need to carry a large variety of spare parts or to ensuring that access can be easily gained for servicing and cleaning Hoe (2008).

2.2.6 Design Defects Affecting Maintenance

Many of these maintenance problems arise where the design is satisfactory in principle but has low probability of achievement in practice. These are not to be regarded as defects in workmanship but as rather as too high an expectation in the design. Hoe (2008) gives the following as a list of design defects affecting maintenance:

a. Inadequate provisions for thermal movement

According to Cobbinah (2010) there exists movement related to the thermal condition of some components within a building. Whenever the designer ignores the spacing for contraction and expansion movement, building defect from design angle arises. Such movement causes cracking of the structure which will result in corrosion of the structural items or cracking of the wall or will affect the look of the building. Materials exposed to varying thermal conditions will undergo dimensional change as a result of the vibration and movement of their atoms and molecules. The extent of this movement is related to the strength and character of the bonding between these atoms or molecules, and to the increase or decrease in temperature. Unless restraint, most materials will contract in response to a decrease in temperature. Chanter and Swallow (2007) also noted that in a case where materials are exposed to cycles of high and low temperatures repeatedly, as experienced during the course of the day, between day and night, the materials will experience corresponding cycles of expansion and contraction. Within a homogenous material, such cyclical movement between the surface and the body of the material can lead to sheer failure and the detachment of the surface layer, and when such component is cemented to a particular section of the building, there is the likelihood that it will come off from its initial designed point, which will continuously lead to failure.

b. Ignoring aggressive environment and weather condition effects

According to Ansari (2014) in building design, the designer should always select and specify the right material to tolerate the existing weather which will result in less

maintenance. The possible environmental influences on materials should be considered at the design stage. All materials commence decaying when incorporated in a structure and it is the designer' function to endeavor to control this. Stephen (2002) noted that buildings situated near road, rail and airport facilities often receive heavy concentrations of polluted air and water and special attention requires to be given both as to the choice of materials and detail, together with maintenance cyclic time intervals. Problems result when the designer is used to certain weather conditions and then moves to another place where the weather different without giving consideration to the weather changes. This problem causes the material to deteriorate in a shorter time and leads to defects in other parts of the building for instance the internal paint, when the external paint does not protect the water from seeping through.

c. Ignoring biological effects

Stephen *et al.,* (2007) stated that the designer should always have an idea about the building location and the type of plants and insects existing in that area and if any special treatment is needed against these biological factors to be specified in the design drawings. Ignoring biological factors could lead to continuous maintenance which can be avoided during the design stage.

d. Inadequate structural design

The inadequate structural design by the designer as cited by Yakubu (2009) will cause the building to settle or the building's structural elements to crack and further help initiation of steel bar corrosion or cracking of the walls or walls finishing.

e. Ignoring variation in soil conditions

There are cases where the soil structures vary in one area. Therefore, the designer should always make sure that the soil conditions are similar to the land built next to it. Such a

problem will cause settling which will cause cracking of structural elements or exterior and interior walls of the building. Chanter and Swallow (2007)

f. Ignoring the load impact on structural stability

When a building is subjected to physical or mechanical action such as the elevators, the vibration of central air-conditioning units or wend load in high rise buildings. Such problem will result in continuous surface cracking and cannot be solved until the impact of movement is isolated. Haris (2013).

g. Exceeding allowable deflection

This happens when the designer exceeds the allowable structural span length or does not evaluate the dead and live load effect correctly. Wordsworth (2001).

h. Inadequate concrete cover

Yakubu (2009) noted that corrosions reach the concrete reinforcement faster if the concrete cover on the steel bars is insufficient, which will result in corrosion of the steel bars and cracking of the concrete element.

i. Improperly locating conduits and pipe openings at critical structural locations

This happen when the structural engineer does not review the layout of the mechanical or electrical design, where the electrical and mechanical designer installs the conduits in a very critical structural elements or damage to the mechanical system of the building, for instance breakage of water pipes or sewer leakage. Freiberger (2007)

j. Not relating exterior material selection to climatic condition

The designer should always select the color and type of a building's exterior finishing material to suit the weather and environmental conditions of the building, for instance to avoid painting external façade of buildings with dark colors in a dusty area where they require a lot of cleaning, or using paints which cannot resist heat and humidity in a very humid area. Hoe (2008)

k. Inadequate joints between finished faces

Designers should specify the location of joints in floor slabs, walls, and others, insufficient joints will cause cracking of the surface or overlapping of tiles or wall cracking due to thermal expansion.

l. Not considering maintenance access

It should be realized by building designers that items of plant have to be renewed or have extensive works executed to them to maintain their efficiency, during the life of the fabric. Therefore facilities for access should be provided to permit the components to be exchanged or serviced without wasteful consequential works. Buildings are designed so that the maintenance workers with their equipment can reach any place in the building to perform maintenance work. Ignoring such a factor will increase maintenance cost and effects and obstruct preventive maintenance.

Ansari (2014) also noted that Designer should always design the building according to the available maintenance equipment in the market. The designer should be aware of the equipment available in the market so that he can consider it in his design. Such a problem of not considering this arises during the cleaning of a building's exterior surface or windows or changing lamps in a very high area. Unavailability of the required equipment will increase the maintenance cost and obstruct preventive maintenance.

n. Poor detailing

Tuleun (2014) noted that the defects in buildings may arise from poor detailing. An explanation of this is that sometimes the designer leaves the details of the design to be worked out by draughtsman who are either inexperienced or unqualified to take this responsibility. Also in some cases, the designer leaves out some details to be decided on the site during the construction. Al Khatami (2003) on the other hand added that, design complexity contribute to the maintenance problems of a building. Complexity in the design is the inclusion of inaccessible spaces both on floors (plan complexity) and

elevations (form complexity). Buildings should be designed in such a way that it will be easy to maintain and will pose no additional threat to the maintenance personnel. Design complexity will prevent maintenance work to be carried out easily, quickly and economically. Major replacement can often be avoided if regular cleaning and minor repair can be carried out without difficulty. For example, maintenance requires some tools to be used in performing particular tasks, if the designer does not allow enough clearance to get the tools in and out, this minor problem will get bigger and become major problem. Adejimi (2005) concluded in his research, that the listed factors were found to be significant in affecting the maintenance strength of buildings. The relationship was proved to be positively correlated as higher maintainability depends on proportionate higher significant effects of the components. The conclusion of the research was that high maintenance strength can be given to a building as design inputs when each of the components is exhaustively resolved as design questions.

2.2.7 Architectural Design and Building Maintenance

According to Sivannathan *et al.*, (2009), architectural design is an important stage in the construction of a building which involves the selection or the organization of materials and forms in a specific way to satisfy a defined purpose. For this purpose to be achieved, Son and Yau (2009) believe that designers must possess a good knowledge on the relationship between architectural design and building maintenance which includes the following;

2.2.7.1 Accessibility

The poor accessibility for maintenance as cited by Moore (2009) can hinder its maintenance if the designer does not consider the requirements for an access and the provision for one. The study further noted some peculiar instances such as when theatres

do not have catwalks that usually ease the maintenance on high interior spaces and also the exterior facades or rather where roofing materials after construction are not accessible at all; ultimately, these will be abandoned when the roof fail. All this as a result leads to difficulties in maintenance and also high cost of maintenance. Ansari (2014) summarised it all stating that building defects will continue to occur if access for easy maintenance aren't provided.

2.2.7.2 Building Form

The form of a building as cited by Okoroh *et al.*, (2003) affects its maintenance which is usually based on the Architects designing building with complex and apparently expensive forms and shapes. The continual interest of architect in complexity and the desire to design buildings that make visual noise is gradually on the increase as observed by Olufemi (2009). The complexity of most of these designs as stated by Al-Khatam (2003) prevents maintenance work to be carried out easily, quickly and economically. Brochener (2003) have also backed the above stating that one of the problems of design is the provision of a structure in a complicated form. These as stated by Iyagba (2005) for some main reasons can be briefed in two points:

i. Some architects believe that building will be a dull and an unimaginative if they follow the simple forms.

ii. Some clients like the direction of more complex and even inefficient forms of building; perhaps for reasons of prestige or display.

2.2.7.3 Detailing

Alarcon and Mahjoub (2009) stated that when poor detailing such as incomplete and inexplicit drawings which require a great amount of specification are ignored, it affects the maintenance of buildings. The often inconsistencies in design, error and omissions or

simply lack of clarity and knowledge, wrong assumption as highlighted by Mir *et al.*, (2007). Kingfell (2011) in design drawings has a great effect on the output of those carrying out the work resulting in various building defects as shown in Figure 2.2.

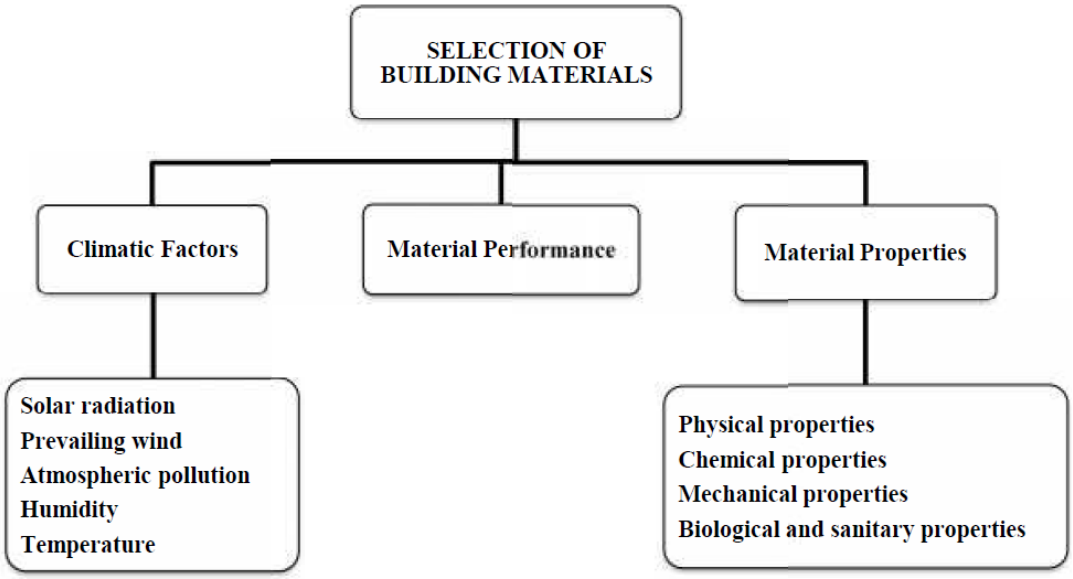


Figure 2.2: The development of building defects due to incomplete drawing and specifications
Source: Reeves (1999)

For example the absence of proper architectural detailing of rainwater discharge from the roof, building face and poor ventilation as cited by Crompton *et al.*, (2004) can cause deterioration of the building facade, fungi growth, dampness and rainwater penetration into the building or stagnation within or on the construction as shown on Figure 2.3.

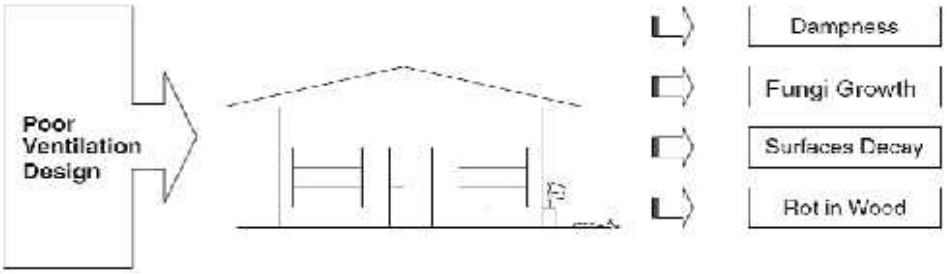


Figure 2.3: The Poor drainage of water resulting in ponding.
Source: Vidler (2008)

2.2.7.4 Spatial Organisation

The various spaces in a building according to Caruso (2014) when ill designed can lead to maintenance problems in the future of the building. Some of these can be listed as narrow stairs, passages and doors. Also studies done by Al-Khatam (2003), has shown that the non-utilisation of spaces after its completion results to maintenance negligence by building owner. Therefore the design of dead zones or spaces should be avoided. Also spaces should be properly designed to reduce the incidence of vandalism as observed by Haris (2013).

2.2.7.5 Materials Specification

A study done by Iyagba (2005) has shown that materials are mostly blamed for defects when the fault lies in the choice of materials unsuitable for the conditions to which they will be subjected. For example the use of paints or wood that cannot survive in the climate and humidity to which the building is subjected. Mir and Paul (2006) also noted that designers often select different elements for a building in order to create interest, visual depth and contrast. But a range of these materials will need careful design and selection if the junctions are not to cause a need for early remedial work as discussed below.

a. Selection of Building Material In Relation To Environmental Factors

The durability of a building generally can be influenced by several environmental factors which may include the following;

i. Intense solar radiation

ii. Moisture/ Water

iii. Temperature

iv. Prevailing wind

v. Atmospheric pollution

i. Intense Solar Radiation:

The continual heating of building fabric by visible light and infra-red radiation, combined with the most damaging effects of the ultra-violet (UV) light rays, as stated by Ziebik and Hoinka (2013) deteriorate and break down the structure of the furnishings, and other materials, eventually leading to the discolouration that is associated with fading.

ii. Moisture/water:

Water as stated by Kincaid (1994) is the most prevalent chemical agent and the agent with the greatest impact on the properties of materials. Its presence in form of moisture as noted by Iyagba (2005) is often detrimental, enabling physical, chemical or biological reactions to take place such as corrosion of metals, decay, dimensional change, rotting of wood products, displacement, leaching and so on. The above factor as stated by Patanapiradej (2006) can occur due to intrusion of moisture around windows or rooflines which are as a result of improper roof design and/or construction, complicated design and inappropriate detailing

iii. Temperature:

The gradual change in temperature as noted by Cobbinah (2010), if not given room for in the form of movement control joints or by other means, during the design stage will create an avenue for several problems such as cracks, thereby affecting the durability of the several components.

iv. Prevailing Winds:

Prevailing wind direction as observed by Wordsworth (2001), is known to be another factor that affects the design of a building which has a high proportion of damage to roofs. This may occur because both design and construction almost certainly made insufficient allowance for its effect. Therefore an increasing knowledge of the effects of the wind can led to better design.

v. Atmospheric pollutions:

Studies done by Brochener (2003) have shown that atmospheric pollutants such as sulphur dioxide and sulphates, nitrogen oxides, chlorides, carbon dioxide and ozone affects buildings and likewise its material manifesting damages such as degradation, discoloration and embrittlement.

b. Selection of Building materials in relation to its properties

Saghatfarush *et al.,* (2012) stated that Architects or rather designers are subjected to a great deal of lobbying to use one product rather than another, and are bombarded with an overabundance of publicity material without great consideration of its properties. This as a result can have two severe consequences:

i. It may influence the designer to use a new component (material, system, etc.), which has not been sufficiently proved in practice, with a consequential failure to meet requirements.

ii. Conversely, there may be the opposite reaction, resulting in the designer using a component or material with which he is familiar, whether or not it is the right choice in the circumstances.

The characteristic properties of the various types of finishes/ materials if not carefully considered according to Reeves (1999) can result to high rate of maintenance. They include the following; physical properties, chemical properties, mechanical properties, biological properties. The negligence of these properties could however result to deformation, breakdown, mold growth, corrosion, among others.

c. Selection of Building Materials In Relation To Its Performance/ Usage

Akin (1998) noted that the materials used in public buildings such as internal finishes, doors, windows, fittings and equipments are prone to damages. Therefore as observed by

Al-Khatam (2003), selection of materials should be in compliance with the performance specification requirements in order to minimize future maintenance problems. Akin (1998) further backed the above stating that materials need to be robust to counter abuse, easy to clean, offer minimum maintenance, and be suitable for various functions within the building.

2.2.7.6 Ventilation Design

Ventilation components in buildings such as windows, exhausts and ventilation ducts and air passages according to Reeves (1999) serve as the respiratory organs and passages for buildings. When certain areas in a building are not provided with adequate fenestrations as stated by Yau (2009), it could lead to many problems such as moisture condensation, and staining, room for thick moulds and fungal growth.

2.2.7.7 Construction System

The use of construction methods which have not been properly tested in use and also the lack of constructability of such methods as studied by Freiberger (2007) are one of the major problems detected during construction and can in the long run create maintenance problems.

2.2.7.8 Roof Design

According to Hyeong (2013) the more complex a roof is designed, the greater the likelihood of valley gutters to drain abutting roof slopes and the more prone it will be for leakages. The study further showed that when roof covering are laid at too low a pitch, rain may penetrate the roof covering, especially if the roof is in an exposed situation. Therefore sloped roofs which have the advantage of shedding water as noted by Hammad

(1997) reduces the potential of roof leaks and require less maintenance than flat roofing systems.

The idea of enhancing the looks of modern buildings as observed by Olufemi (2009) comes into play in most designs when the application of parapet wall is often used thereby proposing a flat roof which is generally considered to be an unsophisticated and simple approach to providing a building with a roof. Unfortunately such choices of roof as noted by Suwaibatul *et al.*, (2011) are more prone to leakage and water-related problems/ failure than pitched roofs. This is frequently as a result of poor design, because the designer has failed to recognise that the simplicity of form does not mean that efficient performance is simple to achieve in technical terms, e.g. a pitched roof sheds water quickly, a flat roof does not; the designer has to consider how to avoid water ponding on its surface.

2.2.7.9 Site planning and landscaping

The primary objective of landscaping is to preserve and enhance existing resources, improve the environmental quality of the facility, minimize the life cycle maintenance and improve visual quality. Richard (2005) stated that even if there is no such thing as a maintenance free landscape certain tips or factors such as simplicity in design and selection of low maintenance materials and paving systems can minimise the cost for landscape maintenance.

2.3 Relationship between Building Maintenance and Architecture

Many designers as stated by Reeves (1999) aim to achieve a distinctive design that may act as a trendsetter in the design world. Tay and Ooi (2001) further observed that architects are more conscious of aesthetic values: for example in selecting a facing brick the colour will be considered first and then the texture before the porosity is considered. Given the same choice, the Engineer examines the porosity and the density of the

materials before considering the final shape of the brick after firing. The quantity surveyor ought to consider the initial, running and maintenance costs of the material. In the course of such activities, as noted by Speeding and Holmes (1999) many professionals have not yet concentrated on good planning of maintainability for all building elements. Although considered important by many, the aspect of maintenance is seldom fully taken into account during the building process.

Based on the above different concepts and scholars, a conceptual model of the various building factors and elements from the design stage as shown in Figure 2.4 can be applied to possibly minimize the maintenance problems at the post occupancy stage of a building.

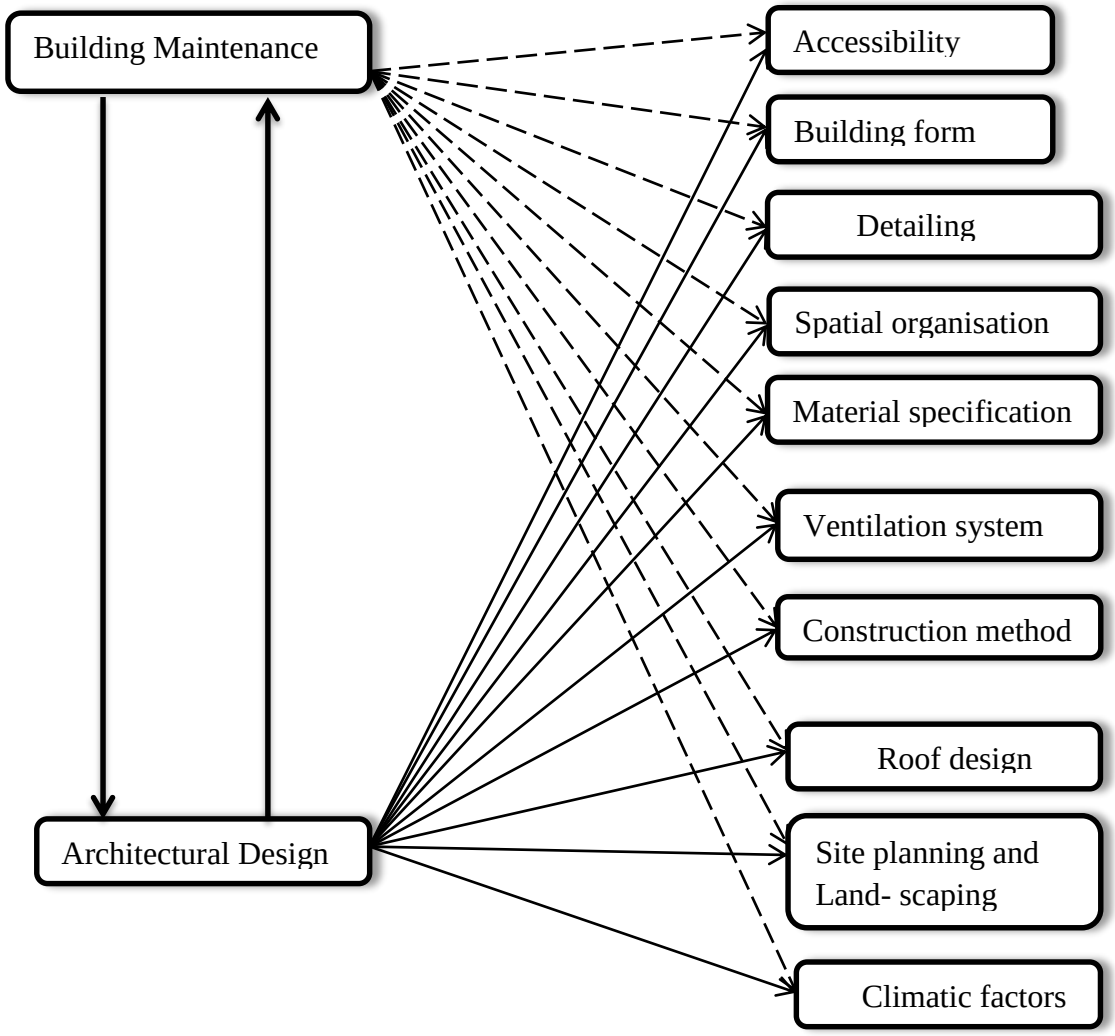


Figure 2.4: Conceptual frameworks of architectural Design and Maintenance.
Source: Researcher 2016

2.4. Origin of Student Centres

Student centre as noted by Fletcher (1987) started as a coming together of students as a union for fortifications in Italian university Degli Studi Di Bologna, one of the oldest and famous universities in Europe, founded in the Italian city of Bologna in the 11th century, it became in the 12th century and 13th centuries the principal centre for studies in civil and canon law attracted students all over Europe, since it had no fixed site or student housing and scholars. At this period there was no structure or organised form of students union.

According to Williams (2008) Student union began in Scotland; here one participant describes part of the immediate circumstances behind the creation of student representative council (SRC) at Edinburgh, not so much to agitate for students rights. Freiberger (2007) contributed that the honour of invention of student centres was jointly given to Oxford and Cambridge universities in England. These two universities discovered that the campus environment contains stimuli that motivates students physically, emotional, biological and socially.

In Nigeria, student centres as noted by Yakubu (2009) have been in existence even before the 1992 Federal Government donation to provide social centres for various universities. The first union building was that of university of Ibadan which was built in 1968. Although there was no defined outline for the student centres here in Nigeria when it started, they were radical in procedures. This centre and other existing one was an avenue for student social and recreational need. According to Williams (2008) student centres are found in the first and second generation universities while the third and later generations do not have enough facilities or structures to house student's social, political and recreational activities.

According to Moses (2011) the constant changing trend in student centre varies from pplace to place, time to time and as a result of development or administrative policies,

therefore it is necessary to design such structures that will respond to the dynamic nature of the student's organization, thereby preserving the architectural identity and integrity of student centres. Further noted that the existing student centres in Nigeria do not have the ability to expand or adapt to various uses.

2.4.1 Student Centres Design

Moses (2011) defines student centre as a physical building complex in a university campus which serves the socio – cultural, educational, political and recreational among other needs of the students and the university community at large. It is intended to provide a place for debating, relaxation and leisure within the academic environment to act as safe, healthy and recreational avenue for stress relief for the university users.

Student centre as defined by Moore (2009) a home for renewal, participation and performance; a forum for dialogue, diversity and civic engagement; a laboratory for learning, living and demonstrating a sustainable future. Yakubu (2009) Student centre is a place or building in a college or university campus dedicated to social and organizational activities of the student body. A place where people come together for communal benefits such as cultural, recreational/ sports, commercial, entertainment and educational activities. Student unions are traditionally the most vocal advocates of student rights.

2.4.2 Trends in Students Organisations

According to Fletcher (1987) Students organisations grow and change with time. Reeves (1999), noted that apart from constant increase in number of the student's union functions, the sizes of the spaces keeps on increasing due to either increase in demand or students population. The trends in Student centre complexes in universities in the world is summarized in Table 2.1

Table 2.1: Trends in student organization. Source: Reeves (1999),

STAGES	EXAMPLES OF UNIVERSITIES	AIM	SPACE REQUIREMEN	ARMS OF THE UNION
1st	Bologna and Paris	To secure protection	Meeting rooms	Executive members and the congress
2nd	Cambridge and Oxford	Not so much to agitate for students rights as to preserve their image.	Debate chamber, coffee bar and dining room.	Students representative councils,executive members and congress
3rd	Queens university and Toronto	To protect students right and create a place for relaxation	Common rooms, coffee room, dining areas, debate chambers.	Students representative councils,executive members and congress
4th	Most American universities	To protect students right, to create a place for relaxation.	Common rooms, coffee room, dining areas, debate chambers, meeting room, offices, news room, and restaurant.	Students representative councils,executive members and congress
5th	Nigerian universities	To protect students right and a place for training, relaxation, entrepreneurs hip and skill acquisition	Common rooms, coffee room,dining areas,debate chambers, meeting room, offices, news room, and restaurant, outdoor recreation activities, performing halls, commercial areas.	Students representative councils,executive members and congress, judicial council.

2.4.3 Kaduna State University

Kaduna state university was established in 2002, with the main campus at Abubakar Tafawa Balewa road Kaduna. The University building was initially a teaching hospital

which was converted to the Kaduna State University. The university started with the Arts and social sciences courses until 2009 when the Kafanchan campus was open to cater for Engineering, Environmental design and Agriculture courses.

2.5 Summary of Key Literature Findings

According to Iyagba (2005) all buildings are prone to deterioration (i.e., wear and tear) and no structure can reasonably be expected to last forever. Although acthe longevity of the building can be prolonged by the designers at the design stage as stated by Faremi *et al.,* (2011). Therefore every decision made during the building design stage of a design has its own impact on a building. Architects at the design stage of a project must visualize the building in use, and materials and finishes chosen, its capability of withstanding everyday wear and tear. The designer according to Caruso (2014) must have a better understanding of the various factors that can affect the maintenance of the building which have been explained in details such as choose of material, quality design, accessibility to various building components, adequate detailing, among others that meets the functional needs and budget constraints laid down and can be maintained in good working order for a reasonable time at a reasonable cost.

Designs as well as drawings as noted by Haris (2013) should therefore be easy to read and understand with sufficient cross sections, properly cross-referenced. Working drawings should be properly done because they serve as links between two core activities (designing & making of the buildings) during the construction process .If the links are weak, then the product would not be worth the standards. The drawings therefore must be carefully thought off and thoroughly dimensioned. Architects should endeavour to produce structures with proper detailing which are compatible with the overall requirement of building; which in turn reduces defect and maintenance problems.

3.0 METHODOLOGY

3.1. Introduction

This study develops a maintenance strategy model for student centres, which will ensure to reduce and ease maintenance problems right from design stage. This chapter outlines the research design, the population of the study, sample and sampling procedure, instruments of data collection and data analysis used for the study.

3.2. Research Design

The research design of this project should enable one to collect data from only a part of the population to represent the entire population, case study and questionnaire method is chosen. A survey method is further used to collect data and analyse the case studied. This approach is preferred to because it relied more on raw field data or primary data collection techniques.

3.3. Population of the Study

The population of the study consists of nine first and second generation universities within Nigerian with student centres.

3.4. Sampling and Sampling Technique

Purposive sampling technique is used. This involves the selection of samples on purpose from the population. Student centres were selected based on related peculiarities to the topic in consideration. These three student centres will be selected based on their potential to supply the necessary information under certain dependent variables which will be outlined in the course of the study. The following student centres were chosen:-

- The Aliyu Mustapha social centre ABU Zaria.
- Obafemi Awolowo University students centre, Ille – Ife.

- University of Jos Students Centre.

3.5. Variables of Study

The following variables are going to be used in undertaking the research. Suitable instruments of data collection are to be employed in determining the inculcation of the variables in the cases to be studied. Hoe (2008) and Al Shiha (1993) explained in their research the defects affecting maintenance generally from the inception of the design. The variables to be used include Building form, shape and complexity, building materials, maintenance access, spatial organisation, and site planning and landscape and construction system. The variables are discussed below:

I. Building form, shape and complexity; use of simple and related spaces, cubical form to deviate from arriving at complex elevations.

II. Building materials; use of qualitative materials that are easily replaceable and which do not easily deplete.

III. Maintenance access; providing access to roofs and at various strategic elevations especially where will be prone to maintenance.

IV. Spatial organization: use of coordinated and related spaces with emphasis on cubical spaces rather than circular spaces.

V. Site planning and landscape: providing access for both vehicular and pedestrian with vast areas of greenish lawns and trees sparsely planted away from the building that provides a serene environment for outdoor activities

VI. Construction system: adopting a simple and cubical building form that will aid ventilation and lighting.

3.6. Instrument of Data Collection

The instruments of data collection used in this research are: questionnaire survey, and visual survey checklist.

I. **Questionnaire:** The questionnaire is structured, which means it is standardized and the same questions will be presented to various respondents, in the same order and the choice of alternative responses is restricted to a predetermined list. The questionnaire is meant for the facility managers and maintenance staffs of the selected buildings.

II. **Visual Survey Checklist:** Visual survey of the buildings is another instrument. The checklist of the visual survey includes; accessibility to high level windows, reaching and cleaning all nooks of the building, replacing components and parts, ceilings heights, considerations in re-painting and replacing, so also the cleaning of the building fabric and other related maintenance issues. Photographs are taken for careful survey.

3.7. Validity of Instrument

The instrument of data collections are presented to the research supervisor to check. The supervisor made contributions and amendment to make the instrument valid.

3.8. Administration of Research Instrument

Introductory letters are made to introduce the researcher to the facility managers of the buildings and the head/manager of the building seeking for their corporation to make the research a success.

3.9. Chapter Summary

In this Chapter the methods that were adopted for the research were highlighted. Sources of data were both primary and secondary with emphasis on primary data. Secondary data basically were sourced from the buildings and the users.

For the primary data, attention was focused on the organizations being housed by the building, users of the facility, facility managers and or the maintenance staff. Questionnaires and Visual survey of the buildings were carried out in order to gather a considerable volume of data in relation to qualitative and quantitative attributes of the student centres.

The sampling technique was basically purposive sampling of the student centres available, which are first and second generation universities which has related peculiarities to the topic in consideration.

4.0 DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter presents in detail how the collected data were analysed. The analysis was done in line with the research questions and it was conducted in three-stage process. First, the data from the surveys were documented and analysed. In the second part, the data from each of the studies were summarised and tabulated and finally, a comparative analysis of the various cases was done in a tabular form to summarise the entire result obtained.

4.2 Data Assessment

In evaluating maintenance problems in the design of Student centre complex the integration of maintenance design features of a building, Seeley (1976) gave out the following factors to be considered during the design of every component and part of a building. The factors in this study are to be dealt with accordingly with the parts of the building being studied. They are:

1) Serviceability: How can every part by cleaned?

2) Accessibility: How can every part of the building be accessed?

3) Life span: How long will the component and its materials last?

4) Replacement: How can every part of it be replaced?

The list below give the variables used in evaluating the architects design considerations for maintenance in the studied buildings:

4.2.1. Building Form

The shape of the building and its height is a factor which differentiates the maintenance of various buildings. Buildings with complex shapes, irregular forms, and high elevations that have no direct access are more difficult to maintain. Architects, that considered these factors in their designs, make the maintenance of their buildings easier to perform, by putting into cognisance how the shape, form and height complexities can be of use and accessed for various maintenance services. Therefore, shape, form and complexity, coupled with height have a lot to do with maintenance.

4.2.2. Materials Used

The maintenance of buildings depends on the type of materials used in the building. It is the architect's decision to select the appropriate materials with the required life span and economic value to withstand all other internal and external factors affecting the building.

4.2.3. Maintenance Access

Architects and designers should realised that components of the building needs to be maintained or replaced to maintain their efficiency. Therefore facilities for access should be provided to permit the components to be exchanged or serviced without wasteful consequential works. Buildings are designed so that the maintenance workers with their equipment can reach any place in the building to perform maintenance work. Ignoring such a factor will increase maintenance cost and effects and obstruct preventive maintenance.

4.2.4. Integrated Maintenance Technology Equipment

All buildings generally require maintenance, but public buildings on the other hand are riskier to maintain than normal buildings. This is usually, due to their nature of activities and the population it accommodates. The maintenance equipment at times needs some of its component installed and integrated into the building for stability and easy operation. It is mostly in the forms of staircase. The architect's ability to foresee and know the type of equipment that will be required to maintain the building will save a lot for the building and make it easily maintainable. The equipment usually includes brooms, rake, window cleaning equipment and others.

4.2.5. Considering Environment and Weather Conditions

In building design, the designer should always select and specify the right material to tolerate the existing weather which will result in less maintenance. The possible environmental influences on materials should be considered at the design stage. All materials commence decaying when incorporated in a structure and it is up to the designer to know how to tackle the issue. Buildings situated near road, rail and airport facilities often receive heavy concentrations of polluted air and water and special attention requires to be given both as to the choice of materials and detail, together with maintenance cyclic time intervals. Problems result when the designer is used to certain weather conditions and then moves to another place where the weather is different without giving consideration to the weather changes. This problem causes the material to deteriorate in a shorter time and leads to defects in other parts of the building.

4.2.6. Relating Exterior Material Selection to Climatic Condition

The designer should always select the color and type of a building's external materials to suit the climate of the region, for instance, not painting buildings with dark colors in a dusty area where they require a lot of cleaning, or using paints which cannot resist heat and humidity. And again, like using perforated walls in a dusty and rainy climate.

4.3. Case Study Data

The following as mentioned earlier are the studied cases. Each of them is a student centre in Nigeria. They include ABU student centre, OAU student centre and Unijos student centre Building. The result of the evaluated data are as follows:

4.3.1. Case Study One: Aliyu Mustapha student centre (Ahmadu Bello University, Zaria)

Background: The building is located opposite the Amina girls' hostel, adjacent the Nuhu Ribadu girls hostel, basketball court and kontagora convocation square. It was the old students dining hall that was redesigned and constructed into the student centre complex. The student centre consist of offices shops, restaurant, Amphi - theatre cinema and sit outs. Plate I shows the entrance view of the student centre and Figure 4.1 shows the floor plan layout of the student centre.



Plate I: Approach view to Aliyu Mustapha student centre
Source: Researcher's Field work

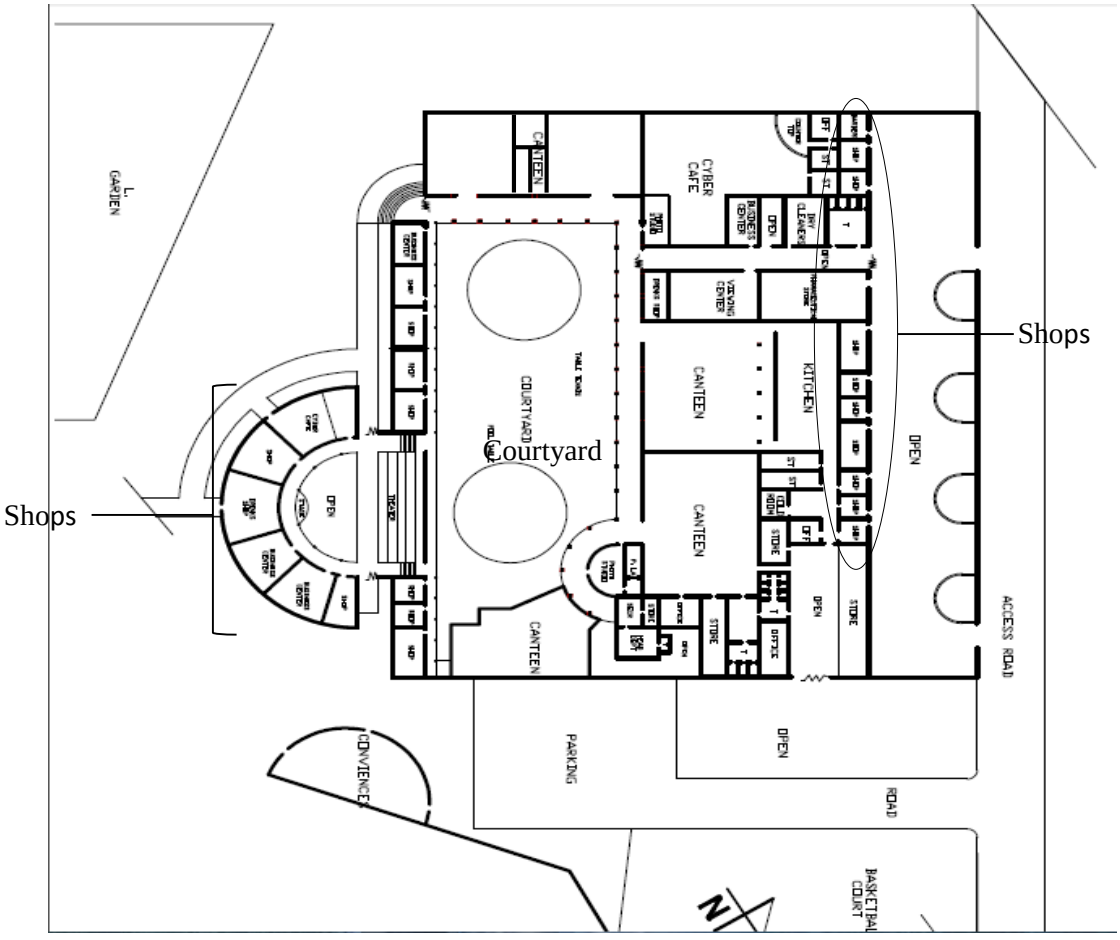
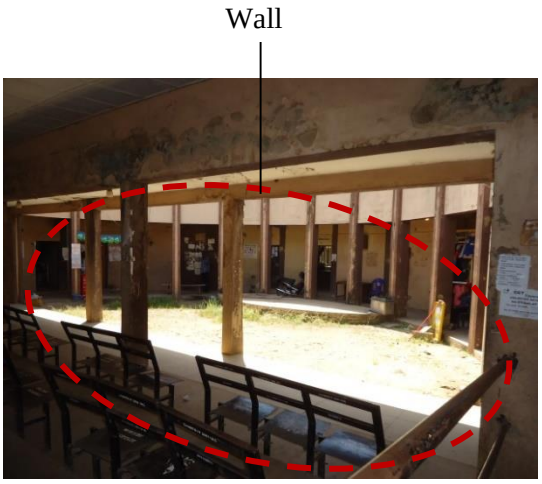


Figure 4.1: Floor plan of Aliyu Mustapha student centre
Source: Researcher's Field work

1. Building Form, Shape and Complexity

a. Poor Detailing:

The construction of the courtyard of Amphi – theatre is poor because there was no provision to channel rain water from the courtyard as shown in Plate II (a). The poor construction of roof deck at the entrance of the amphi theatre has resulted to high rate of leakages and deterioration on the walls as shown on Plate II (b)

a. 

b. 

Plate II: Defect due to poor detailing at Aliyu Mustapha student centre
Source: Researcher's Field work

b. Drainage Layout Based On the Form

Due to the shape of the building and nature of roof, drainage pipes were introduced in areas where concrete decking was used. Plate III shows the effect of rainwater on the parapet of the building.



Plate III: Drainage layout of Aliyu Mustapha student centre
Source: Researcher's Field work

2. Materials Used considering environmental and climatic condition:

a. Finishes:

Sustainable building material was used for the skirting of the building which had high resistance to environmental factors such as rainfall, moist, solar radiation. Such materials. However Plate IV and V shows the extend of deterioration on the wall due to poor building material finish, emulsion paint was used on the walls which gradually peeled off due to rainfall and solar radiation.



Plate IV: Wall Finish of Aliyu Mustapha student centre
Source: Researcher's Field work



Plate V: Wall finish of Aliyu Mustapha student centre
Source: Researcher's Field work

b. Roofing Material

The roofing material used is aluminum and some parts decked, the roof was not properly pitched thereby causing leakages in some parts of the roof. Plate VI shows the level of deterioration on the parapet wall. However in an attempt to reduce the level of maintenance problems arising from the exposures of the roofing material and the leakages, some part of the roof were replaced with aluminum roofing sheet.



Plate VI: Roofing material of Aliyu Mustapha student centre
Source: Researcher's Field work

c. Ceilings:

Most parts of the ceiling materials as seen on Plate VII shows the poor construction of the roof resulting to high level of leakages. This however has led to high cost for maintenance.



Plate VII: Ceiling of Aliyu Mustapha student centre
Source: Researcher's Field work

3. Site planning and Landscaping

a. Use of low maintenance landscape elements

The use of concrete pavements and interlocking tiles as hard landscape elements was used extensively except for some areas in the court yard as shown on Plate VIII were no hard or soft landscape material was used thereby leading to stagnation of rainwater in the courtyard.

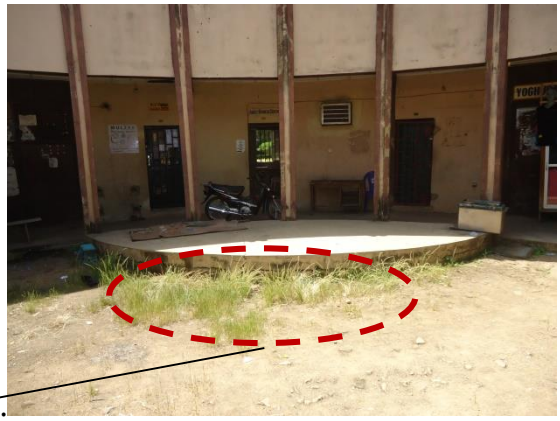


Unpaved area

Plate VIII: Landscape element of Aliyu Mustapha student centre
Source: Researcher's Field work

b. Drainage layout

No considerations was made for proper drainage of water. There is no drainage pipe or channels provided to drain out rain water from the court yard thereby causing growth of grasses and stagnation of water as shown in Plate IX a.b.

a.  b. 

Plant growing in the court yard

Plate IX: Drainage layout of Aliyu Mustapha student centre
Source: Researcher's Field work

4. Construction Method:

a. Maintenance Access: No maintenance access was incorporated in the design of the student centre to access the roof and high level windows of the building. However a temporary wooden ladder which is not a component of the building is used to access some parts of the roof as shown in Plate X.



Plate X: Maintenance access of Aliyu Mustapha student centre
Source: Researcher's Field work

5. Considering Environment and Weather Conditions: The architect considered the environment in relation to the orientation such that the building's longest side is almost aligned to north-south direction, deviating a little from the glaring sun at east-west. The building is directly adjacent to a road, which due to vibration and pollution. The external wall is affected. Internally, sign of defect due to the inability of the external materials to overcome the weather and environmental conditions outside.

a. Relating Exterior Material Selection to Climatic Condition: Kafanchan as a tropical town experiences extreme sunshine, with high temperature, being in a guinea savannah region the humidity is relatively high, all of which have adverse effect on building

materials. Relating external material to climate, basically, both, tiling and glazing have an acceptable performance in the sun more than normal painting. Darker paints and materials calls for frequent maintenance, so does the dark-blue glazing on the building.

b. Integrating Maintenance Technology in the building:

The designers did not integrate any part or component of the available maintenance equipment to aid in maintaining the building.

4.3.1.1 Summary of the Study

The summary presents the researcher's assessment of maintenance design considerations and the results obtained during the researcher's field survey at Aliyu Mustapha student centre building Zaria.

Table 4.1 Evaluating design and maintenance considerations for ABU student centre

S/N	VARIABLES	FEATURES	SCAL FACTOR 1	2	3	4	5	REMARKS
1	Building form	Adequate detailing Simple and rectilinear plan.					✓	Acceptable
		Drainage layout based on the form.			✓			Acceptable
2	Materials used Considering environmental and climatic condition	Qualitative materials that is easily available and replaceable.			✓			Acceptable
		Materials suitability to the climate of the region.			✓			Acceptable
3	Site planning and landscaping	Use of low maintenance landscape element.			✓			Acceptable
		Adequate drainage Layout.	✓					No provision for drainage of rain water.
4	Construction system Considering environmental and climatic condition	Suitability to climate and Environment.					✓	Acceptable
		Flexibility of Construction method.			✓			Acceptable
5	Maintenance Access	Access to roofs and various strategic elevations especially where will be prone to maintenance.		✓				Poor maintenance access
6	Integrating Maintenance Technology in the building	Incorporating parts of maintenance equipment in the building.			✓			Acceptable

SCALE FACTOR: Excellent= 5, Very Good= 4, Good= 3, Fair= 2, Poor= 1

4.3.2 Case Study Two: Naraguta student centre (University of Jos)

Background: The building is Located in the permanent site of the University campus adjacent the Abuja hostel with tenancy for offices, shops and other commercial activities. The Naraguta student centre has octagonal building forms with a court yard at the centre. Plate XI shows the entrance to the building and Figure 4.2 shows the sketches of the floor plan re- produced by the researcher showing locations of spaces and the nature of the activities at the centrre.



Plate XI: Entrance to the Naraguta student centre
Source: Researcher's Field work

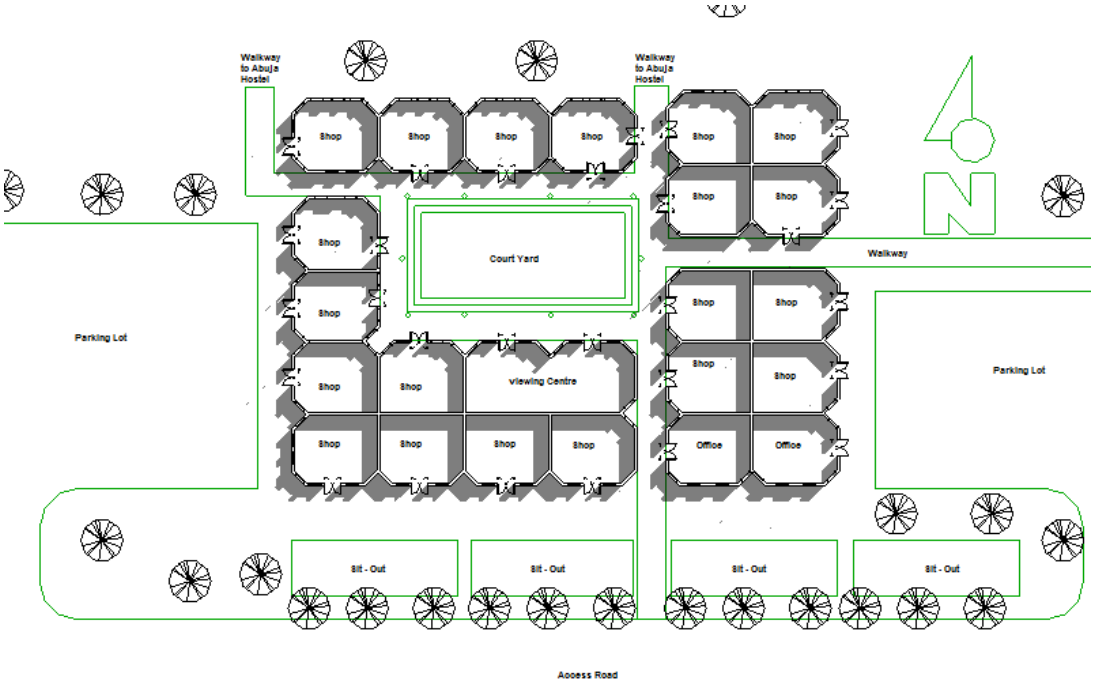


Figure 4.2: Floor Plan of Naraguta student centre
Source: Researcher's Field work

1. Building Form, Shape and Complexity

a. Poor Detailing:

Parts of the roof is decked with concrete which was not properly designed which resulted to leakages, peeling of paints and patches on the slab and walls of the building as shown on Plate XII



Plate XII: Defect as a result of poor detailing at Naraguta student centre
Source: Researcher's Field work

b. Drainage Layout Based On the Form

The drainage layout of the building consist of asbestos drainage outlet pipe that partially drained water out from the building and some pipe drained water into the courtyard as shown in Plate XIII (b). Roof decks were introduced in parts of the building to channel this water without using pipes at various points around the building as shown on Plate XIII (a) thereby causing peeling of paints and leakage on the roof slab.

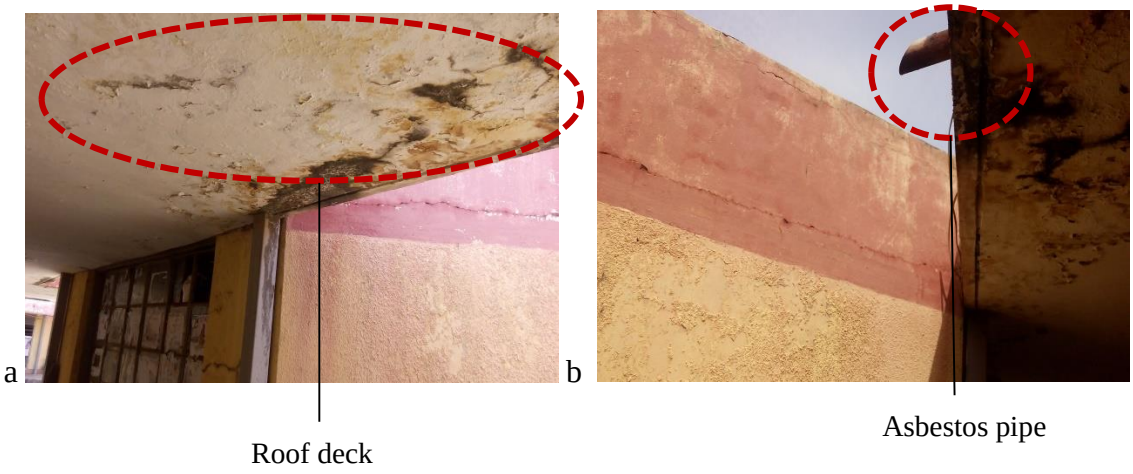


Plate XIII: Drainage layout of Naraguta student centre
Source: Researcher's Field work

2. Materials Used considering environmental and climatic condition:

a. Finishes:

The building material finish used on the walls was emulsion paint which has low resistance to environmental factors such as rainfall, moist, solar radiation. Concrete was used as the roofing material painted with emulsion paint which in time peeled off due to rainfall as shown in Plate XIV



Plate XIV: Finishes of Naraguta student centre
Source: Researcher's Field work

b. Roofing Material

The roofing material used is concrete. The excessive exposure of roof has led to the leakages of roof and peeling of paints as shown on Plate XV (a). However in an attempt to reduce the level of maintenance problems arising from the exposures of the roofing material and the leakages, some part of the roof were replaced with aluminum roofing sheet as seen on Plate XV (b).

a. b.

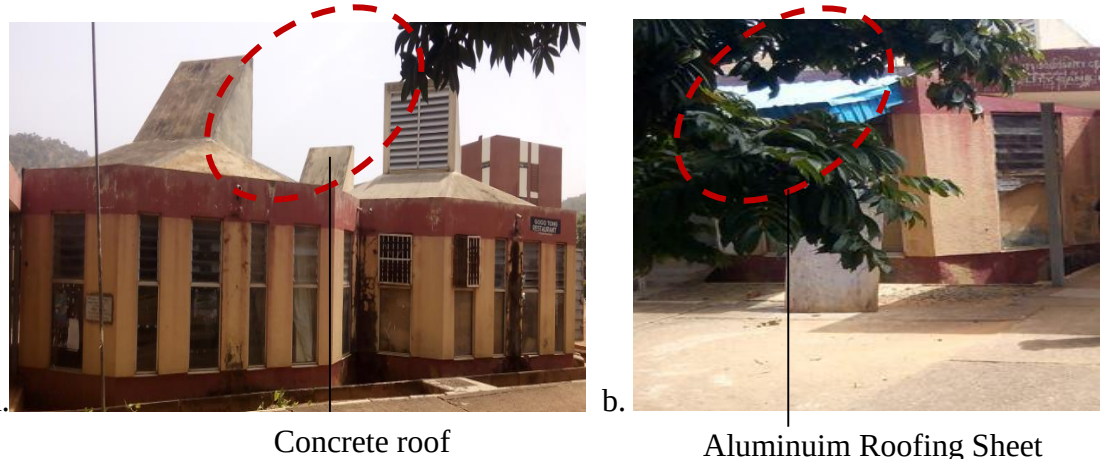


Plate XV: Roofing material of Naraguta student centre
Source: Researcher's Field work

c. Ceilings:

Most parts of the ceiling materials as seen on Plate XVI are presently in a bad state due to the high level of leakages from the roof and slabs. This however has led to high cost for maintenance.



Plate XVI:Ceiling of Naraguta student centre
Source: Researcher's Field work

3. Site planning and Landscaping

a. Use of low maintenance landscape elements

The use of concrete pavements and interlocking tiles as hard landscape elements which has high resistance to human traffic, and environmental factors was used at the entrance façade of the building as shown on Plate XVII.



Plate XVII: Landscape of Naraguta student centre
Source: Researcher's Field work

b. Drainage layout

There is a drainage pipe provided at each decked roof which drains water into the courtyard and another drainage pipe in the court yard to drain rainwater out from the courtyard which is blocked with polythene bags as shown in Plate XVIII.

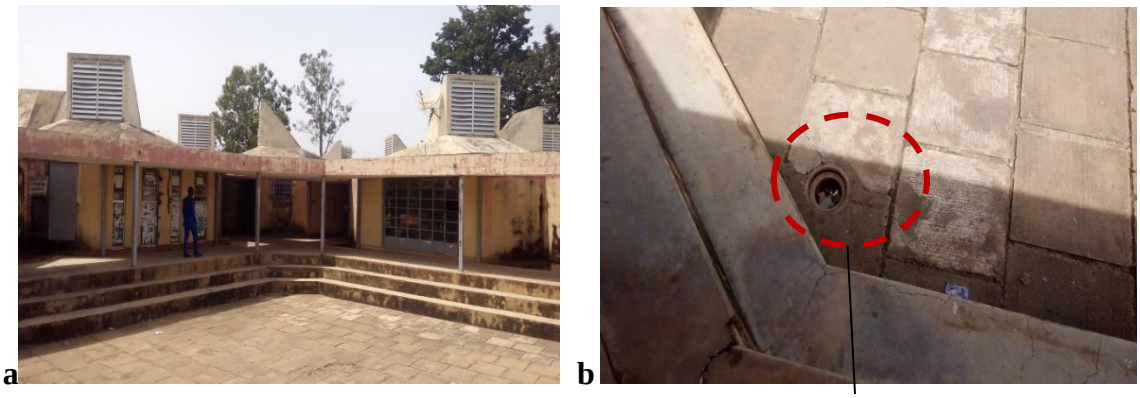


Plate XVIII: Drainage layout of Naraguta student centre
Source: Researcher's Field work

4. Construction Method:

The use of octagonal forms and concrete roof without using a protective material on the roof poses great problems in the building. Absence of maintenance access to the roofs has created leakages and peeling of wall paint.

a. Maintenance Access: There is no access to the roof and exterior elevations of the building.

5. Considering Environment and Weather Conditions: The architect considered the environment in relation to the orientation such that the building's longest side is almost aligned to north-south direction, deviating a little from the glaring sun at east-west. The building is directly adjacent to a road, which due to vibration and pollution. The external wall is affected. Internally, sign of defect due to the inability of the external materials to overcome the weather and environmental conditions outside.

a. Relating Exterior Material Selection to Climatic Condition: Jos as a temperate town experiences extreme cold during the harmattan, with low temperature, being in a guinea savannah region the humidity is relatively low, all of which have adverse effect on building materials. Relating external material to climate, basically, both, tiling and glazing have an acceptable performance in the sun more than normal painting. Darker paints and materials calls for frequent maintenance, so does the dark-blue glazing on the building.

b. Integrating Maintenance Technology in the building: The designers did not integrate any part or component of the available maintenance equipment such as platform for accessing high elevation and maintenance access such as staircase or ladder to aid in the maintenance of the building.

4.3.2.1 Summary of the Study

The summary presents the researcher's assessment of maintenance design considerations and the results obtained during the researcher's field survey at Naraguta student centre building Jos.

Table 4.2 Evaluating design and maintenance considerations for Naraguta student centre.

S/N	VARIABLES	FEATURES	SCALE FACTOR 1	2	3	4	5	REMARKS
1	Building form	Adequate detailing Simple and rectilinear plan.			✓			Complex form which poses maintenance challenges
		Drainage layout based on the form.				✓		Acceptable
2	Materials used Considering environmental and climatic condition	Qualitative materials that is easily available and replaceable.				✓		Acceptable
		Materials suitability to the climate of the region.				✓		Acceptable
3	Site planning and landscaping	Use of low maintenance landscape element.				✓		Acceptable
		Adequate drainage Layout.		✓				No provision for drainage of rain water.
4	Construction system Considering environmental and climatic condition	Suitability to climate and Environment.					✓	Acceptable
		Flexibility of construction method.				✓		Acceptable
5	Maintenance Access	Access to roofs and various strategic elevations especially where will be prone to maintenance.		✓				Poor maintenance access
6	Integrating Maintenance Technology in the building	Incorporating parts of maintenance equipment in the building.		✓				No consideration was made for maintenance equipment.

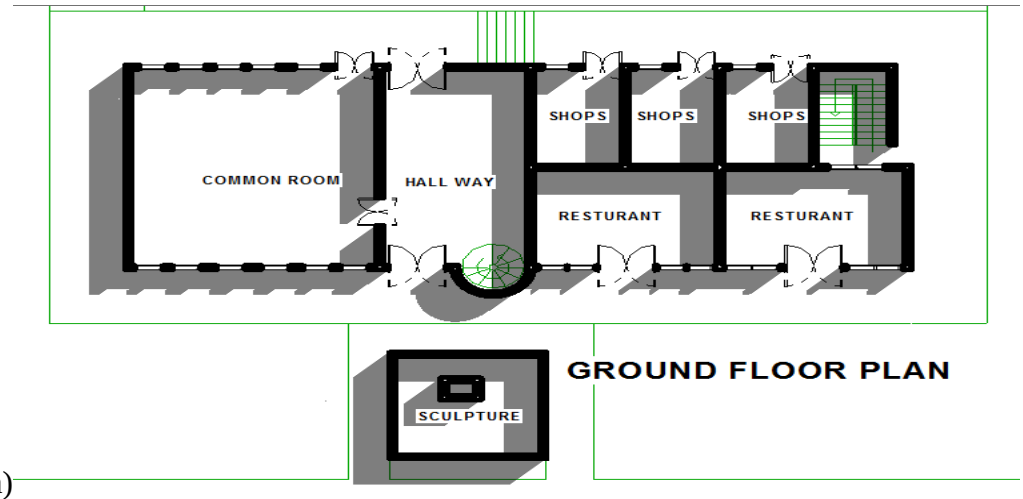
SCALE FACTOR: Excellent= 5, Very Good= 4, Good= 3, Fair= 2, Poor= 1

4.3.3 Case Study Three: OAU Student Centre, Ille - Ife

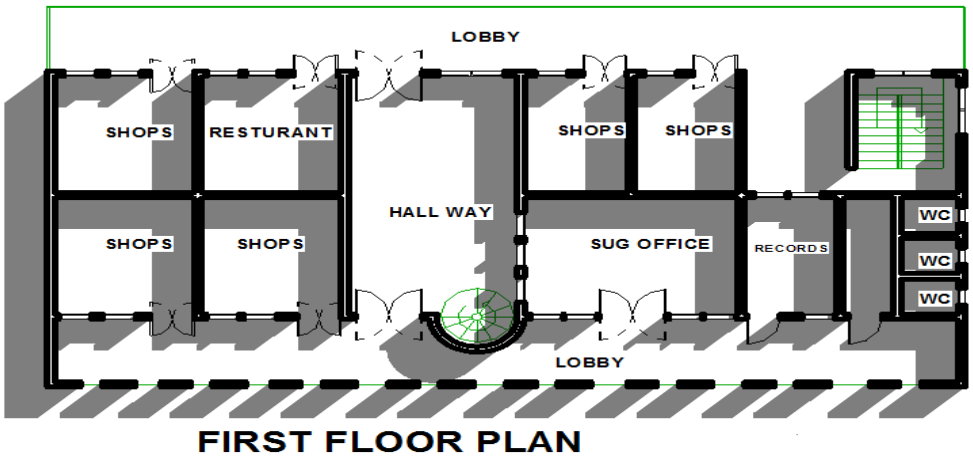
Background: The building is located adjacent the senate building. It was designed constructed as a sport complex before it was redesigned into a student centre complex. It comprises of offices, shops, sporting, leisure and other commercial activities. The OAU student centre building consist of activities such as commercial services on the ground floor, offices on the upper floor sporting and leisure activities at the rear side of the building. Plate XIX shows the approach view of the building. Figure 4.3 shows the sketches of the floor plan made by the researcher. The OAU student centre building is approximately 9m high and the nature of the activities includes commercial, leisure, academics and socio – cultural. Thus, this range of activities further complicates the maintenance challenges in the building.



Plate XIX: Approach view of Obafemi Awolowo University student centre
Source: Researcher's Field work



(a)



(b)

Figure 4.3: Floor plans of Obafemi Awolowo University student centre
Source: Researcher's Field work

1. Building Form, Shape and Complexity

a. Poor Detailing:

The poor plumbing in the toilet, accompanied with poor detailing has resulted to high rate of leakages and deterioration of building material as shown on Plate XVI (a) and (b)

a  b 

Water Leakage

Plate XX: Defects as a result of poor detailing of Obafemi Awolowo student centre
Source: Researcher's Field work

b. Drainage Layout Based On the Form

The roof of the building is concrete decked connected with poly vinyl chloride (PVC) drainage pipes which are constructed at various columns in the building.

2. Materials Used considering environmental and climatic condition:

a. Finishes:

The materials used on some parts of the building was constructed with stone which has high resistance to environmental factors such as rainfall, moist, solar radiation as shown in Plate XXII. However finishes used on the walls was emulsion paint which was exposed excessively to environmental factors such as rainfall which gradually fades out with the need for repainting at short intervals as shown in Plate XXI.



Plate XXI: Wall finish of Obafemi Awolowo University student centre
Source: Researcher's Field work



Plate XXII: Wall finish of Obafemi Awolowo University student centre
Source: Researcher's Field work

b. Roofing Material

Concrete was used as the roofing material, coated with asphalt and painted with a silver paint, which helps to prevent leakages and dampness.

c. Ceilings:

Most parts of the ceiling materials as seen on Plate XXIII are presently in a good state due to the proper construction of the roof. This however has minimized maintenance and replacement.



Plate XXIII: Ceiling of Obafemi Awolowo University student centre
Source: Researcher's Field work

3. Site planning and Landscaping

a. Use of low maintenance landscape elements

They use of concrete pavements and interlocking tiles as hard landscape elements which has high resistance to human traffic, and environmental factors as shown on Plate XXIV and the planting of low maintenance flowers and trees.

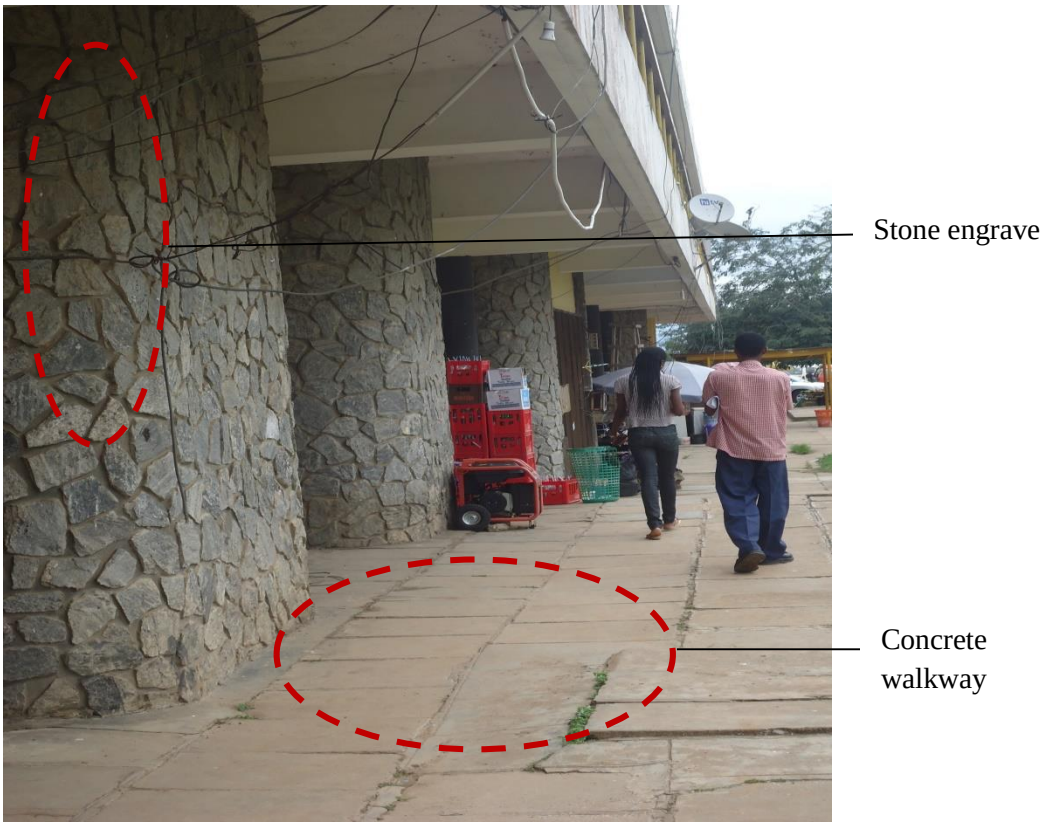


Plate XXIV: Landscape of Obafemi Awolowo University student centre
Source: Researcher's Field work

B. Drainage layout

A consideration was made for proper drainage of rainwater through drainage pipes provided.

3. Construction Method:

The use of concrete roof and properly placed drainage pipes was used for the roof, sustainable building material such as stone was used at some parts of the building.

a. Maintenance Access: The access to the roof is by use of an iron Scaffold the roof which is not a component of the building.

5. Considering Environment and Weather Conditions: The architect considered the environment in relation to the orientation such that the building's longest side is almost aligned to north-south direction, deviating a little from the glaring sun at east-west. The building is directly adjacent to a road, which due to vibration and pollution. The external

wall is affected. Internally, sign of defect due to the inability of the external materials to overcome the weather and environmental conditions outside.

a. Relating Exterior Material Selection to Climatic Condition: Ile - Ife as a Tropical town experiences extreme sunshine and rainfall during the rainy season, with high temperature, being in a tropical rain forest region the humidity is relatively high, all of which have adverse effect on building materials. Relating external material to climate, basically, both, tiling and glazing have an acceptable performance in the sun more than normal painting. Darker paints and materials calls for frequent maintenance, so does the dark-blue glazing on the building.

b. Integrating Maintenance Technology in the building: The designers did not integrate any part or component of the available maintenance equipment to aid in maintaining the building.

4.3.3.1Summary of the Study

The summary presents the researcher's assessment of maintenance design considerations and the results obtained during the researcher's field survey at OAU student centre building Ille - Ife.

Table 4.3 Evaluating design and maintenance considerations for OAU student centre.

S/N	VARIABLES	FEATURES	SCALE FACTOR 1	2	3	4	5	REMARKS
1	Building form	Adequate detailing						Acceptable
		Simple and rectilinear plan.					✓	
		Drainage layout based on the form.						Acceptable
					✓			
2	Materials used Considering environmental and climatic condition	Qualitative materials that is easily available and replaceable.				✓		Acceptable
		Materials suitability to the climate of the region.				✓		Acceptable
3	Site planning and landscaping	Use of low maintenance landscape element.			✓			Acceptable
		Adequate drainage Layout.				✓		Acceptable
4	Construction system Considering environmental and climatic condition	Suitability to climate and Environment.				✓		Acceptable
		Flexibility of construction method.			✓			Acceptable
5	Maintenance Access	Access to roofs and various strategic elevations especially where will be prone to maintenance.		✓				Poor maintenance access
6	Integrating Maintenance Technology in the building	Incorporating parts of maintenance equipment in the building.		✓				No consideration was made for maintenance equipment.

SCALE FACTOR: Excellent= 5, Very Good= 4, Good= 3, Fair= 2, Poor= 1

4 .4 Results from Questionnaire

A questionnaire survey was conducted and respondents were required to fill in information as apply to the state of deterioration of these buildings. Furthermore questionnaires survey was to successfully achieve objective 1 and 2 (see item 1.4) which are as follows:

(a) To identify parts of student centres that frequently needs maintenance.

(b) To develop a design framework that would ensure the integration of maintenance features in student centres.

The questionnaires were administered to Facility managers and workers of the facility of the various students centre:

(i) The Aliyu Mustapha Student centre ABU Zaria.

(ii) Obafemi Awolowo University students centre, Ille – Ife. (OAU)

(iii) University of Jos Students Centre.

The questionnaires were distributed across three case based on the number of respondents in the student centre. Table 4.4 shows the number and percentages of questionnaire distributed per student centre. Figure 4.4 shows the questionnaire distribution of questionnaires distributed in Aliyu Mustafa student centre, Obafemi Awolowo University students centre, Ille – Ife. (OAU) and University of Jos Students Centre in a pie chart.

Table 4.4 Distribution of questionnaire
Source: Researcher's Field work

	ABU	**OAU**	**UNIJOS**
Number distributed	50	47	48
Number retrieved	40	45	42
Number invalid	10	2	6
Percentage (%)	32	35	33

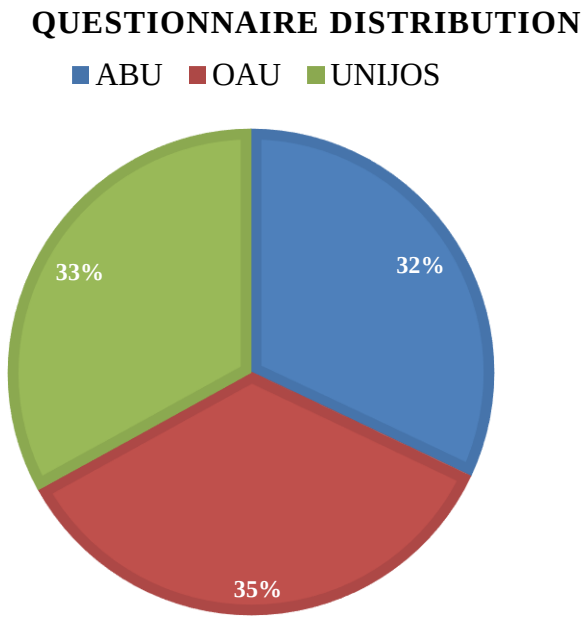


Figure 4.4: Questionnaire Distribution
Source: Researcher's Field work

4.4.1 User Demographic Data

This section deals with user's demographic information / Bio data. These are itemized below:

- Gender
- Age
- Marital Status
- Educational Status
- Position / Rank
- Income Level

4.5. The Aliyu Mustapha social centre ABU Zaria. Results

Table 4.5, Figure 4.5 and 4.6 shows the result derived from the demographic data of facility workers and managers of the student centre. 75.0% male and 25.0% female,12.5%

of the staffs are within the age of 22 – 5, 25% within the ages of 26 – 30, 50.0% within the ages of 31 - 39 years and 12.5% above 40years. However 40.0% were single while 60.0% where married. There were 3 facility managers and 37 maintenance workers with 7.5% and 92.5% respectively. An average maintenance worker is educated with SSCE was 92.7%, 5% of facility managers had HND and 2.5% of the facility manager had National diploma.

Table 4.5a Users bio data information
Source: Researcher's Field work

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
	Male	30	75.0
Sex	Female	10	25.0
	18 – 21	Nil	Nil
	22 – 25	5	12.5
Age	26 - 30	10	25.0
	31 – 39	20	50.0
	Above 40	5	12.5
Marital Status	Single	16	40.0
	Married	24	60.0
	Facilty	3	7.5
Position / Rank	Manager		
	Facility worker	37	92.5
	0 – 1 Year	Nil	Nil
	1 – 3 Years	10	25.0
Working	4 - 5 Years	15	37.5
Experience	6 – 10 Years	10	25.0

Table 4.5b Users bio data information

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
	SSCE	37	92.5
Educational Status	B.sc / HND	2	5.0
	Above B.sc	Nil	Nil
	Others	1	2.5

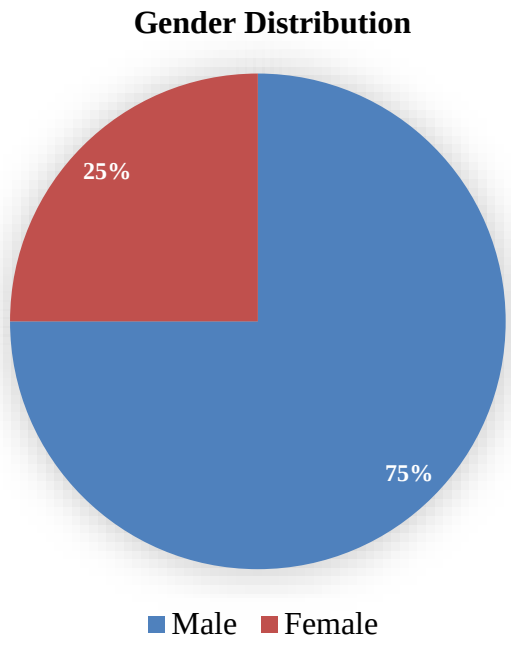


Figure 4.5: Gender Distribution
Source: Researcher's Field work

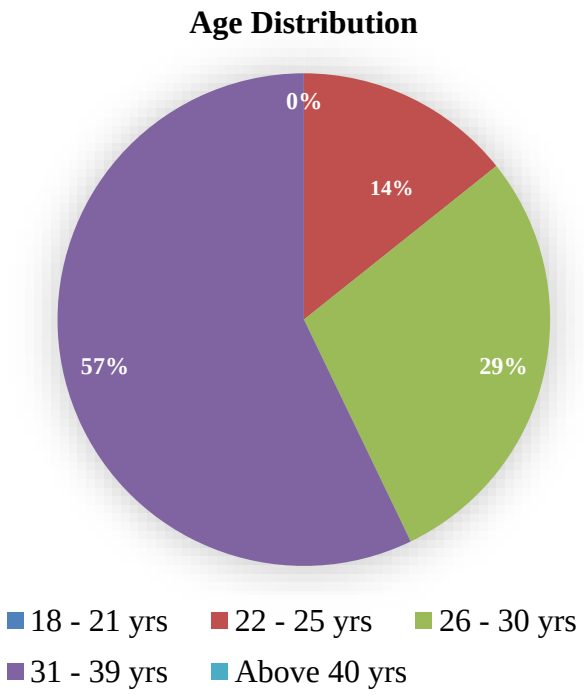


Figure 4.6: Age Distribution
Source: Researcher's Field work

4.5.1 Maintenance policy in Student Ccentre

This section deals with workers and facility manager's perception on the effectiveness of the maintenance policy in student centres. Table 4.6 shows where 50.0% stated that daily maintenance was carried out in the building, 12.5% stated that periodic maintenance was adopted and 37.5% says both daily and periodic maintenance was carried out, 50.0% of the staffs agree that the roof is the part of the building that requires frequent maintenance due to rainfall and heavy wind, 25.0% agrees to the floor as the major building component that requires frequent maintenance, 15.0% prefers the ceiling to be maintained more and 10.0% agree that the wall of the building requires more maintenance. 77.5% acknowledged the fact the maintenance equipment's and access stand alone, 10.0% stated that these equipment's are component of the building and 12.5% agrees that the

maintenance equipment's and access both stand alone and are integrated in the building.

Figure 4.7 shows that the roof is the most part of the building that is requires maintenance.

Table 4.6 Maintenance policy of the student centre
Source: Researcher's Field work

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
Type of Maintenance	Daily	20	50.0
	Periodic	5	12.5
	Both	15	37.5
Building Part that requires more Maintenance	Floor	10	25.0
	Wall	4	10.0
	Ceiling	6	15.0
	Roof	20	20.0
Integration of Maintenance Equipment	Stand alone	31	77.5
	Component of the building	4	10.0
	Both	5	12.5

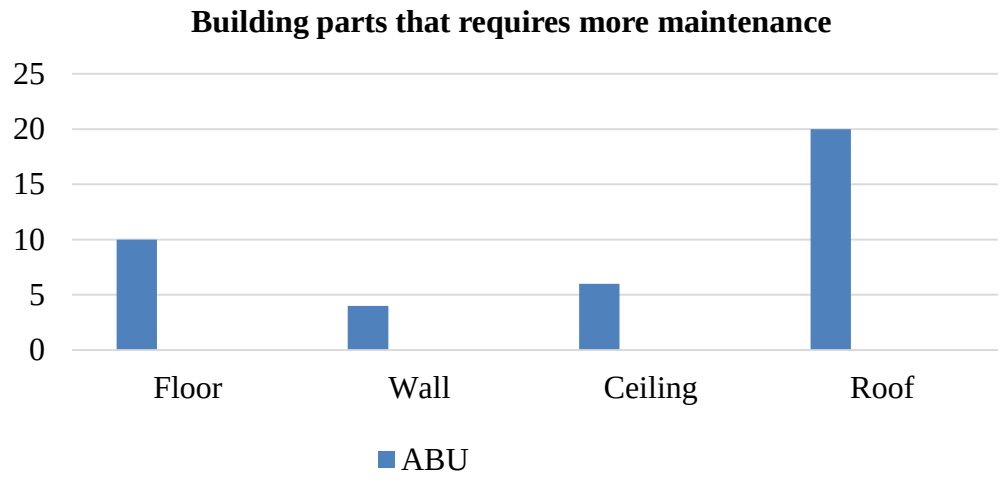


Figure 4.7: Building Parts that require more Maintenance
Source: Researcher's Field work

4.5.2 Maintenance challenges in Student Centres

This section deals with workers and facility manager's perception on the maintenance problem in student centres. Table 4.7 shows that 62.5% stated that the toilet is the major space in the building with maintenance, 20.0% agrees that the garden and recreational area are spaces that requires frequent maintenance, 12.5% stated that the shops are spaces with the most maintenance challenges because of its nature of activities, 5.0% agrees that the theatre requires more maintenance because of the lack of proper drainage pattern. 60.0% stated that the major cause of defects in the building is caused by poor design and construction method adopted, 25.0% agrees that weather is the major cause of defects in building and 15.0% stated that the activity of the users causes defect in the building, 90.0% very unsatisfied with the maintenance access of the building which attributes to the negligence in maintaining various part of the building, 10.0% were unsatisfied with the access as many buildings has no maintenance access. Figure 4.8 shows that the causes of defect in building is due to poor construction.

Table 4.7a Maintenance challenges in the student centre
Source: Researcher's Field work

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
Spaces That Requires More Maintenance	Toilet	25	62.5
	Shop	5	12.5
	Theatre	2	5.0
	Recreation / garden	8	20.0

Table 4.7b Maintenance challenges in the student centre

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
Causes of defects	Weather	10	25.0
	Users activities	6	15.0
	Very Unsatisfied	28	70.0
Maintenance	Unsatisfied	12	30.0
Access to Building	Neutral	Nil	Nil
Component	Satisfied	Nil	Nil
	Very Satisfied	Nil	Nil

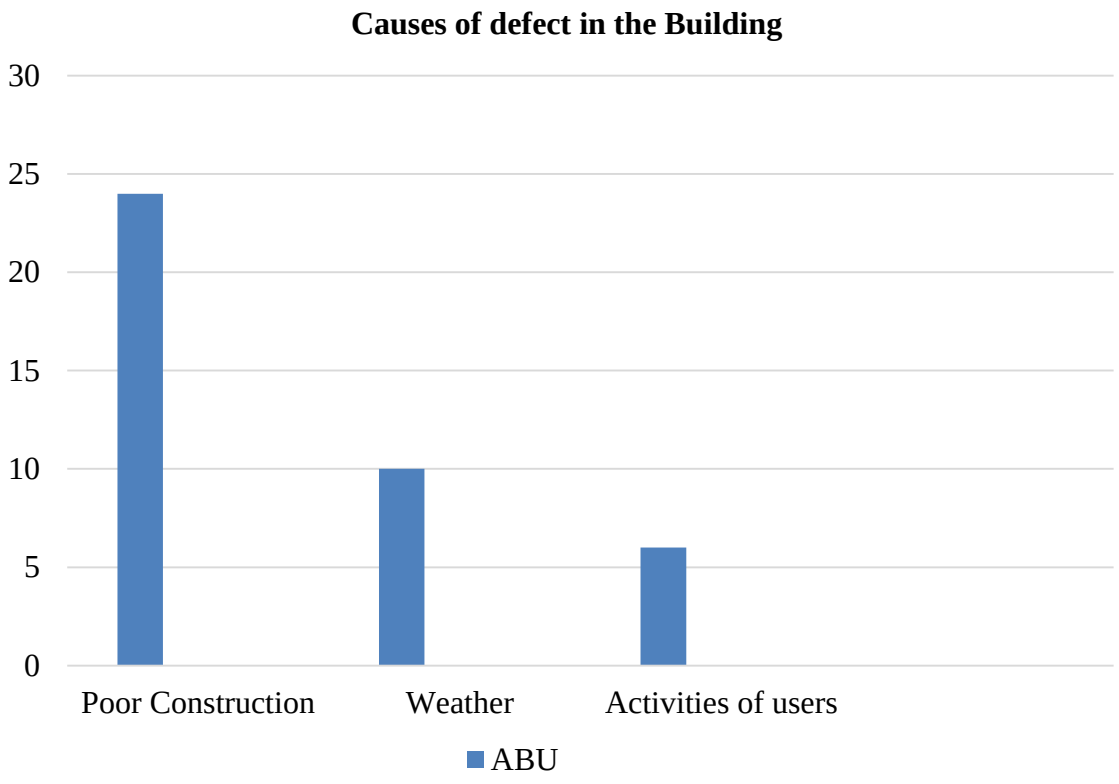


Figure 4.8: Causes of defect in the building
Source: Researcher's Field work

4.5.3 Summary of Findings

The summary presents the researcher's assessment of maintenance design considerations and the results obtained during the researcher's field survey at ABU student centre building Zaria.

4.6 Obafemi Awolowo University students centre, Ille – Ife. Results

Results from Table 4.8, Figure 4.9 and Figure 4.10 shows the demographic data of facility workers and managers of the student is 33.3% male and 66.7% female,13.3% of the staffs are within the age of 22 – 5, 66.7% within the ages of 26 – 30, 11.1% within the ages of 31 - 39 years and 8.9% above 40years. However 44.4% were single while 55.6% where married. There were 5 facility managers and 40 maintenance workers with percentages of 11.1 and 88.9 respectively. An average maintenance worker is educated with SSCE was 88.9% and 11.1% of facility managers had HND.

Table 4.8a Users bio data information
Source: Researcher's Field work

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
	Male	15	33.3
Sex	Female	30	66.7
	18 - 21	Nil	Nil
	22 - 25	6	13.3
Age	26 - 30	30	66.7
	31 - 39	5	11.1
	Above 40	4	8.99
Marital Status	Single	20	44.4
	Married	25	55.6

Table 4.8b Users bio data information

QUESTION	OPTION	NO OF RESPONDENT	PERCENTAGE
	Facilty	5	11.1
Position / Rank	Manager		
	Facility worker	40	88.9
	0 – 1 Year	Nil	Nil
	1 – 3 Years	7	15.6
Working	4 - 5 Years	18	40.0
Experience	6 – 10 Years	15	33.3
	Above 10 Years	5	11.1
	SSCE	40	88.9
Educational Status	B.sc / HND	5	11.1
	Above B.sc	Nil	Nil
	Others	Nil	Nil

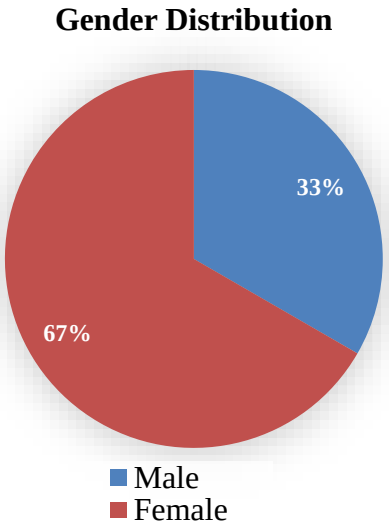


Figure 4.9: Gender Distribution
Source: Researcher's Field work

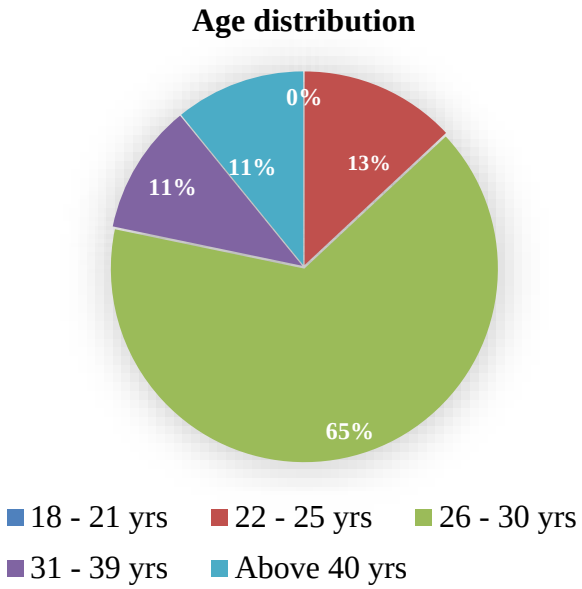


Figure 4.10: Age Distribution
Source: Researcher's Field work

4.6.1 Maintenance policy in Student Centre

This section deals with workers and facility manager's perception on the effectiveness of the maintenance policy in student centres. Table 4.9 shows that 77.8% stated that daily maintenance was carried out in the building, 11.1% stated that periodic maintenance was adopted and 11.1% says both daily and periodic maintenance was carried out, 66.7% of the staffs agree that the roof is the part of the building that requires frequent maintenance due to rainfall and heavy wind, 11.1% agrees to the floor as the major building component that requires frequent maintenance, 11.1% prefers the ceiling to be maintained more and 11.1% agree that the wall of the building requires more maintenance. 86.7% acknowledged the fact the maintenance equipment's and access stand alone, 4.4% stated that these equipment's are component of the building and 8.9% agrees that the maintenance equipment's and access both stand alone and are integrated in the building. Figure 4.11 shows that the roof is the building part that requires more maintenance.

Table 4.9 Maintenance policy of the student centre
Source: Researcher's Field work

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
Type Of	Daily	35	77.8
Maintenance	Periodic	5	11.1
	Both	5	11.1
Building Part That	Floor	5	11.1
Requires More	Wall	5	11.1
Maintenance	Ceiling	5	11.1
	Roof	30	66.7
Integration Of	Stand alone	39	86.7
Maintenance	Component of the	2	4.4
Equipment	building		
	Both	4	8.9

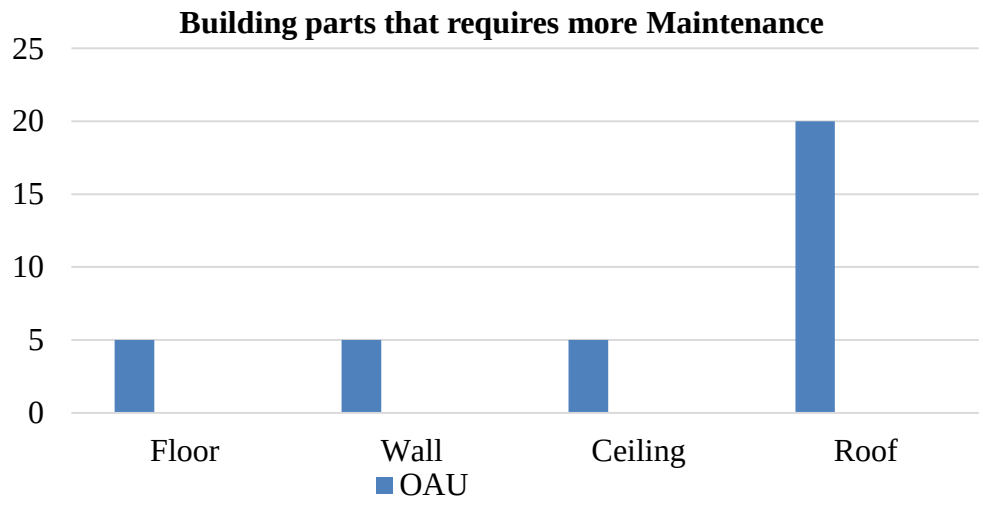


Figure 4.11: Building parts that require more Maintenance
Source: Researcher's Field work

4.6.2 Maintenance challenges in Student Centres

This section deals with workers and facility manager's perception on the maintenance problem in student centres. Table 4.10 Where 91.1% stated that the toilet is the major space in the building with maintenance, 2.2% agrees that the garden and recreational area are spaces that require frequent maintenance and 6.7% stated that the shops are spaces with the most maintenance challenges because of its nature of activities. 77.8% stated that the major cause of defects in the building is caused by poor design and construction method adopted, 17.8% agrees that weather is the major cause of defects in building and 4.4% stated that the activity of the users causes defect in the building, 84.4% very unsatisfied with the maintenance access of the building which attributes to the negligence in maintaining various part of the building, 11.1% were unsatisfied with the access as many buildings has no maintenance access and 4.4% were neutral. Figure 4.12 shows that poor construction method causes defects in the building.

Table 4.10a Maintenance challenges in the student centre
Source: Researcher's Field work

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
Spaces That	Toilet	41	62.5
Requires More	Shop	3	12.5
Maintenance	Theatre	Nil	Nil
	Recreation / garden	1	20.0
	Poor construction	35	77.8
Causes Of Defect	Weather	8	17.8
	Users activities	2	44.0
	Very Unsatisfied	35	84.4

Table 10.b Maintenance challenges in the student centre

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
Maintenance	Unsatisfied	5	11.1
Access To	Neutral	2	4.4
Building	Satisfied	Nil	Nil
Component	Very Satisfied	Nil	Nil

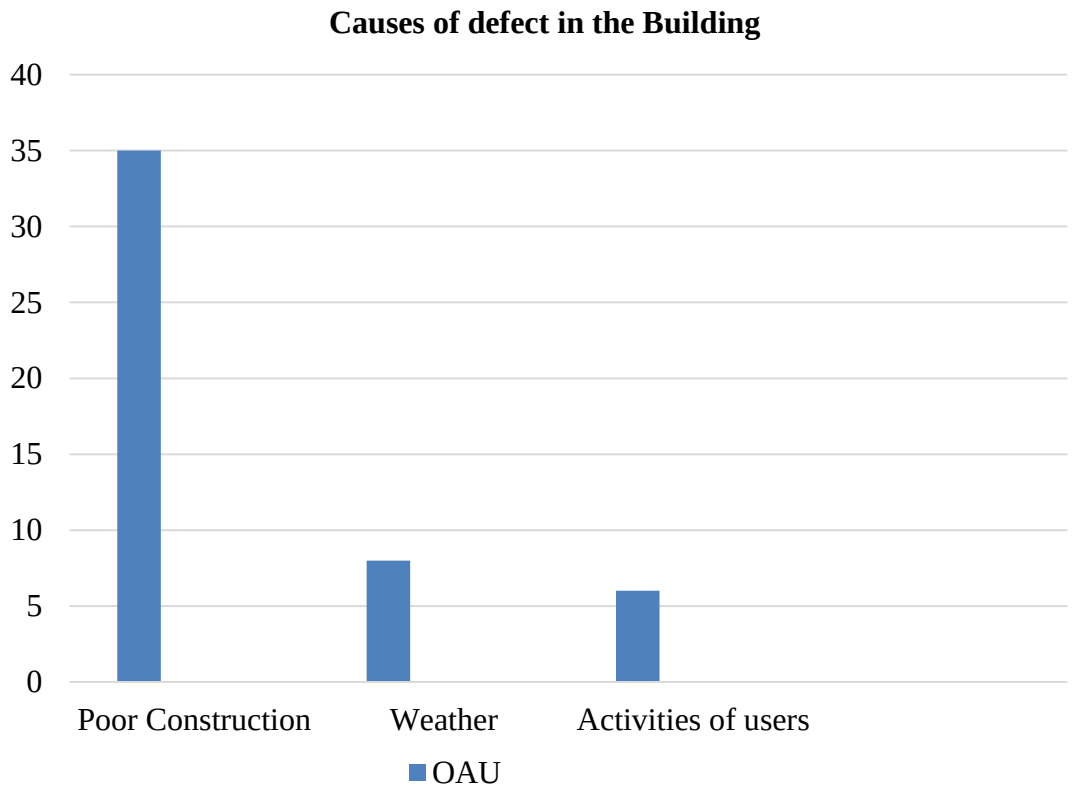


Figure 4.12: Causes of defect in the building
Source: Researcher's Field work

4.6.3 Summary of Findings

The summary presents the researcher's assessment of maintenance design considerations and the results obtained during the researcher's field survey at OAU student centre building Ille - Ife.

4.7 University of Jos Students Centre Results

Results Table 4.11, Figure 4.13 and Figure 4.14 shows the demographic data of facility workers and managers of the student is 26.2% male and 73.8% female,19.0% of the staffs are within the age of 22 – 5, 66.7% within the ages of 26 – 30, 7.1% within the ages of 31 - 39 years and 7.1% above 40years. However 47.6% were single while 52.4% where married. There were 3 facility managers and 39 maintenance workers with percentages of 7.1 and 92.8 respectively. An average maintenance worker is educated with SSCE was 69.0% and 7.1% of facility managers had HND. This result shows that the facility management of the centre had SSCE.

Table 4.11a Users bio data information
Source: Researcher's Field work

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
	Male	11	26.2
Sex	Female	31	73.8
	18 - 21	Nil	Nil
	22 - 25	8	19.0
Age	26 - 30	28	66.7
	31 - 39	3	7.1
	Above 40	3	7.1
Marital Status	Single	20	47.6

Table 4.11b Users bio data information

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE
	Married	22	52.4
	Facilty Manager	3	7.1
Position / Rank	Facility worker	39	92.8
	0 – 1 Year	Nil	Nil
	1 – 3 Years	14	33.3
Working Experience	4 - 5 Years	15	35.7
	6 – 10 Years	10	23.8
	Above 10 Years	3	7.1
	SSCE	29	69.0
Educational Status	B.sc / HND	3	7.1
	Above B.sc	Nil	Nil
	Others	Nil	Nil

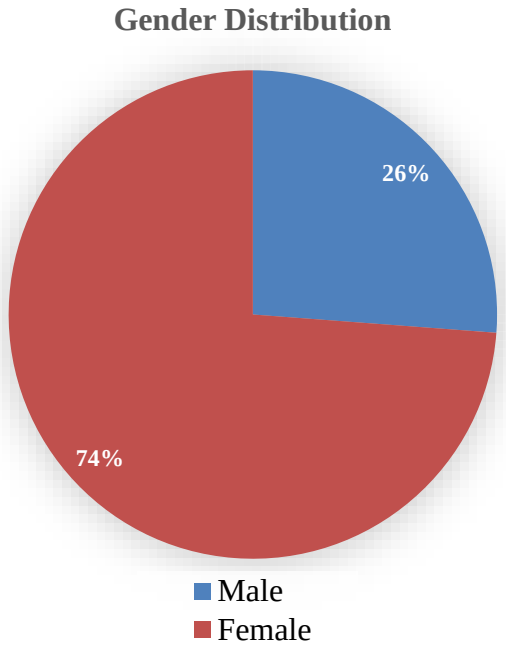


Figure 4.13: Gender Distribution
Source: Researcher's Field work

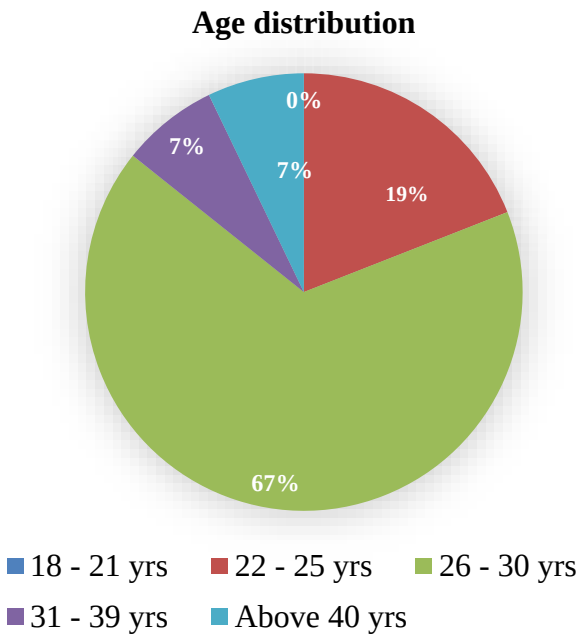


Figure 4.14: Age Distribution
Source: Researcher's Field work

4.7.1 Maintenance policy in Student Centre

This section deals with workers and facility manager's perception on the effectiveness of the maintenance policy in student centres. Table 4.12 shows that 76.2% stated that daily maintenance was carried out in the building, 4.8% stated that periodic maintenance was adopted and 19.0% says both daily and periodic maintenance was carried out, 71.4% of the staffs agree that the roof is the part of the building that requires frequent maintenance due to rainfall and heavy wind, 2.4% agrees to the floor as the major building component that requires frequent maintenance, 2.4% prefers the ceiling to be maintained more and 23.8% agree that the wall of the building requires more maintenance. 85.7% acknowledged the fact the maintenance equipment's and access stand alone, 7.1% stated that these equipment's are component of the building and 2.4% agrees that the maintenance equipment's and access both stand alone and are integrated in the building. Figure 4.15 shows that the roof is the building part that requires more maintenance.

Table 4.12 Maintenance policy of the student centre
Source: Researcher's Field work

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
Type Of Maintenance	Daily	32	76.2
	Periodic	2	4.8
	Both	8	19.0
Building Part That	Floor	5	2.4
Requires More	Wall	5	23.8
Maintenance	Ceiling	5	2.4
	Roof	30	71.4
Integration Of	Stand alone	39	85.7
Maintenance	Component of the	2	7.1
Equipment	building		
	Both	4	2.4

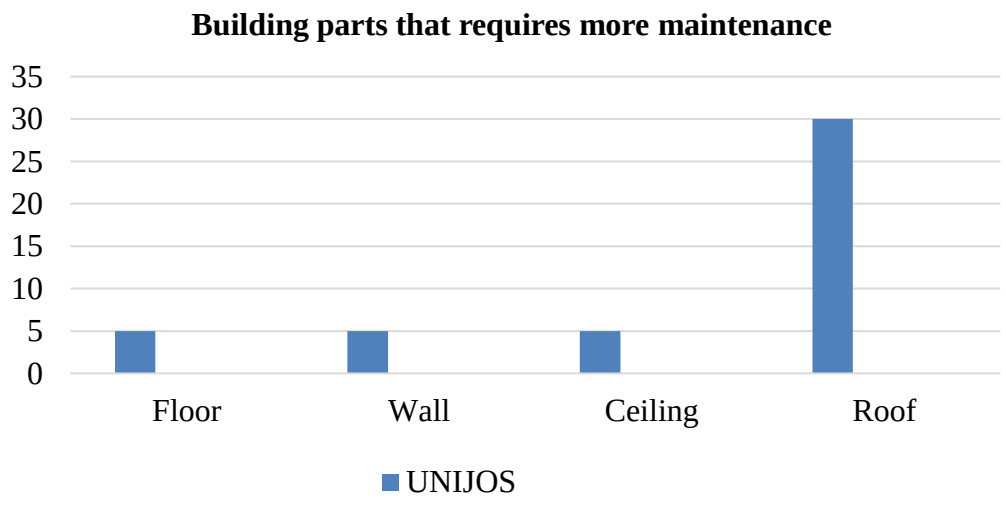


Figure 4.15: Building parts that require more Maintenance
Source: Researcher's Field work

4.7.2 Maintenance challenges in Student Centres

This section deals with workers and facility manager's perception on the maintenance problem in student centres. Table 4.13 shows that 95.2% stated that the toilet is the major space in the building with maintenance, 2.4% agrees that the garden and recreational area are spaces that require frequent maintenance and 2.4% stated that the shops are spaces with the most maintenance challenges because of its nature of activities. 71.4% stated that the major cause of defects in the building is caused by poor design and construction method adopted, 23.8% agrees that weather is the major cause of defects in building and 4.8% stated that the activity of the users causes defect in the building, 76.2% very unsatisfied with the maintenance access of the building which attributes to the negligence in maintaining various part of the building, 19.0% were unsatisfied with the access as many buildings has no maintenance access and 4.8% were neutral. Figure 4.16 shows that the poor construction method is the major cause of defect in the building.

Table 4.13a Maintenance challenges in the student centre
Source: Researcher's Field work

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
Spaces That	Toilet	40	95.2
Requires More	Shop	1	2.4
Maintenance	Theatre	Nil	Nil
	Recreation / garden	2	2.4
	Poor construction	30	66.6
Causes Of Defect	Weather	13	28.8
	Users activities	2	4.8
	Very Unsatisfied	35	76.2
	Unsatisfied	5	19.0

Table 4.13b Maintenance challenges in the student centre

QUESTION	OPTION	NO OF RESPONDENTS	PERCENTAGE %
Maintenance	Neutral	2	4.8
Access To	Satisfied	Nil	Nil
Building	Very Satisfied	Nil	Nil
Component			

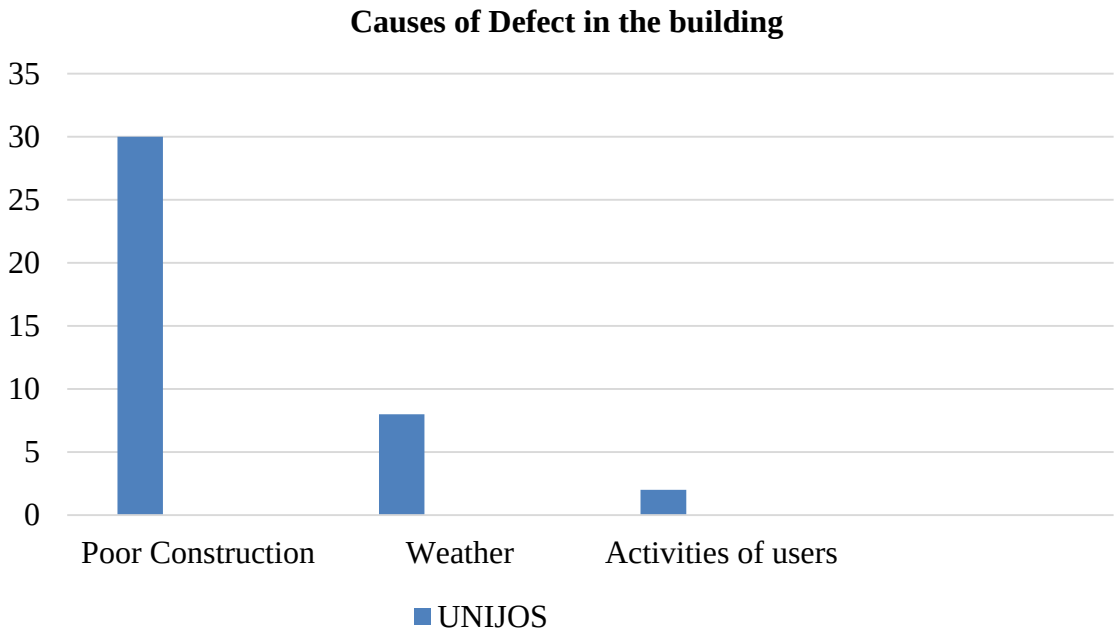


Figure 4.16: Causes of defect in the building
Source: Researcher's Field work

4.7.3 Summary of Findings

The summary presents the researcher's assessment of maintenance design considerations and the results obtained during the researcher's field survey at UNIJOS student centre building.

5.0 PROPOSED SITE

5.1. Site Location

Kaduna is a state in north – western Nigeria as shown in figure 5.1 below. It has latitude $10^{0}20^{/}$N and longitude $7^{0}45^{/}$E, On the Kaduna River, is a trade centre and a major transportation hub for the surrounding agricultural areas with its rail road junction. The population of Kaduna was at 760,084as at the 2006 Nigerian census, and this is believed to have grown to over 1.8 million as of 2013. The symbol of Kaduna is the crocodile, called Kada in the native Hausa language.



Figure 5.1: Location of Kaduna State in Nigeria

Source: http://www.kaduna.gov.ng

Kafanchan is a town in Jema'a Local Government area, southern Kaduna State in north – central Nigeria. It is has latitude $9^{0}34^{/}$N and longitude $8^{0}18^{/}$E. It is the location of a

junction station of the Nigerian Railway Corporation, and it sits on the line connecting Porthacourt, Enugu, Kafanchan, Kuru, Bauchi, and finally Maiduguri. As of 2007 Kafanchan had an estimated population of 83,092. Kafanchan is dominated with the Kaninkon people known as nikyop and with minor the fanstuwam. Fantsuam foundation is located in Bayan Loco, a peril – urban slum of Kafanchan as shown in figure 5.2 below.



Figure 5.2: Location of Kafanchan in Kaduna State.

Source: http://www.kafanchan.gov.ng

5.2. Kaduna State University District

Kaduna State University is located in Kaduna state. It was established in 2004, it has a total of 7 faculties with over 39 departments, and the school library contains over 17,000 volumes of books. It has two campuses, the main campus in Kaduna town and kafanchan campus in Kafanchan. The campus in Kafanchan is located in the Kafanchan central area which consists of basic remedial programme and two faculties namely: Agriculture and Environmental science. Figure 5.3 and 5.4 shows Kafanchan district where Kaduna state university is located.

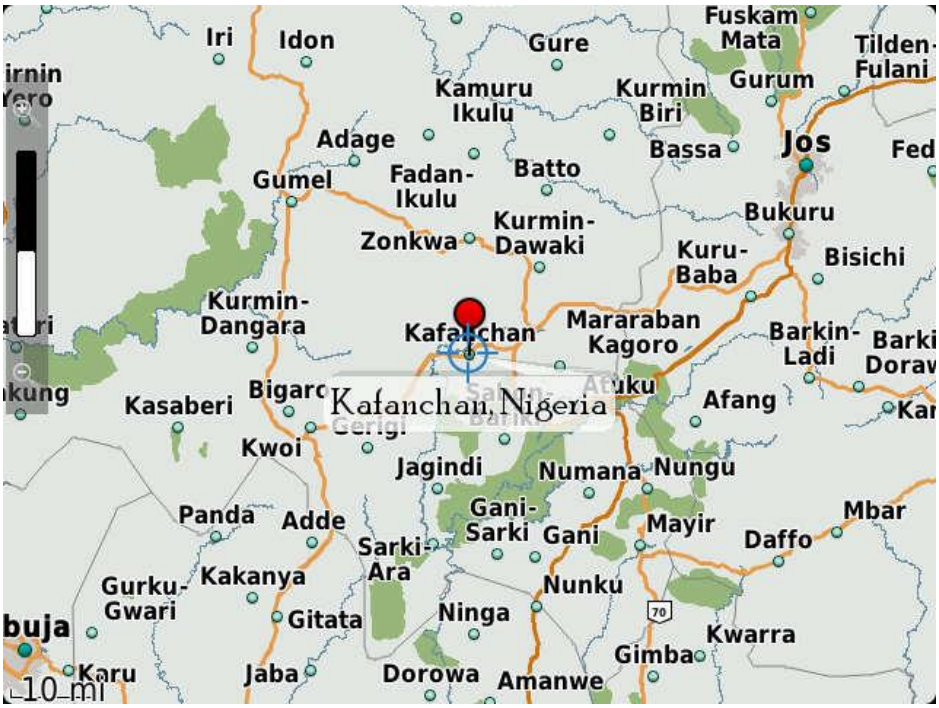


Figure 5.3: Kafanchan District

Source: Google Maps 2014



Figure 5.4: The Site Location Map

Source: Google Maps 2014 101

5.3. Site Selection

The site was selected after considering the Master Plan of the University and examination of the various factors that have direct and indirect impact on the building function. These considerations include: the accessibility to the site, proximity to the hostel and other related function, land use, availability of land and visual amenity.

The selection, which is based on the major land use map prepared by Kaduna State University Committee, which allocated the site and the surrounding land strictly for Student activities. It is located in the sports area of the campus. It is situated adjacent the female hostel.

5.4. Site Analysis

5.4.1. Size and Surrounding

The site is a 49,200sqm. In size, to the east facing access road, the south football pitch, to the south an access road and to the north undeveloped lands and then the surrounding roads, to the east, it borders unfinished girls hostel, and on the access road to the south which is backing faculty of agriculture building

5.4.2. Topography

The site is relatively flat, with the adequately spaced contours sloping towards the north direction. It generally lies on the approximately 724m platform above sea level of the Northern Highlands.

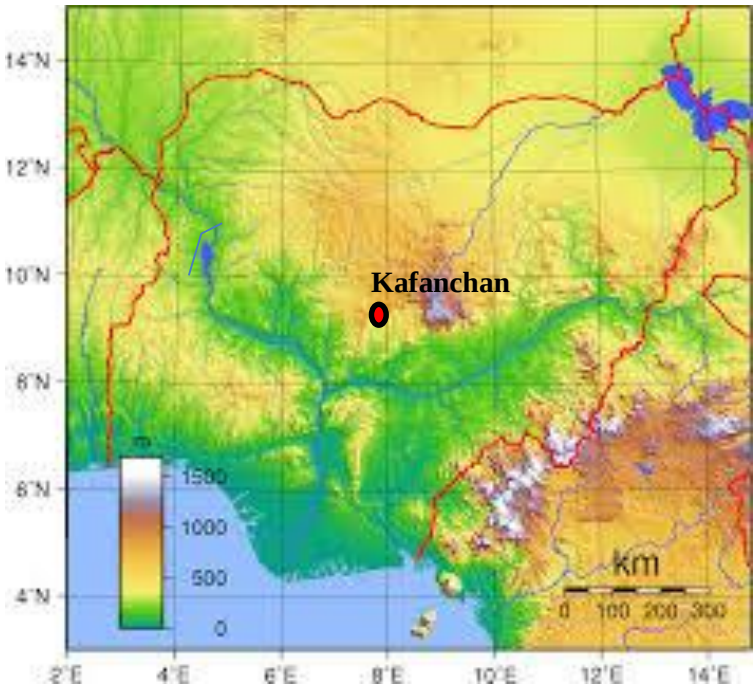


Figure 5.5: Topography of Kafanchan

Source: http://www.google.com.ng/search_kaduna_vegetation

It is devoid of any major rock outcrop, landforms and or any water body. The site therefore, is considered flat in the design. Drainage systems flow towards the roads where drains are situated. Figure 5.5 above shows the topography map of Nigeria.

5.4.3. Geology and Soil Type

Kafanchan generally is on a rocky granite residuals form, and the soil type is Ferruginous and Lateritic soil, which is made from decayed organic nutrients. The site has a varying loamy soil, and is very suitable and hard enough for construction wise. The granite rock from adjacent lands usually surfaces at 1-3m underground and then varies with locations on the area. This type of granite is good for the foundation of the building but may be disadvantageous in providing underground water.

5.4.4. Vegetation

As a guinea savannah region, the vegetation is mixed leguminous Sudan woodland with trees rising from 4m to 8m except for naturally taller trees and shrubs from 0.5m to 3m in height. Grasses and weeds grow out seasonally on inhabited soil except if grown otherwise. Figure 5.6 below show the vegetation class of Kafanchan.

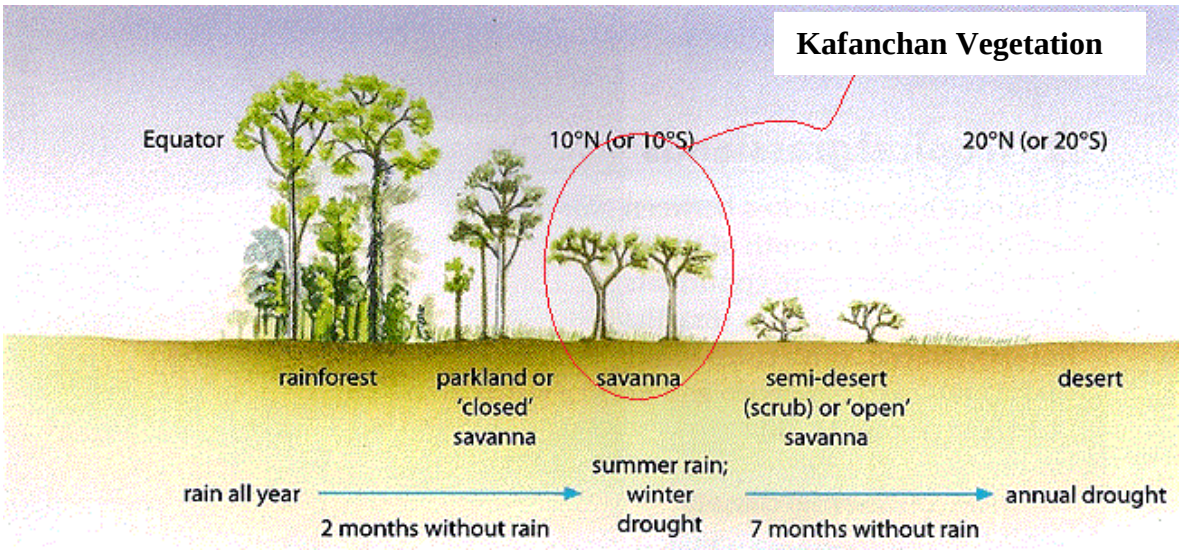


Figure 5.6: Vegetation Characteristics of Kafanchan

Source: http://www.geogonline.org.uk

5.5. Climatic Condition of the Area

Putting into cognisance the climatic condition of an area during the design stage, is one of the most important solutions to the design problems. Apart from providing a habitable environment, it also helps in postponing the deterioration of the property. Figure 5.7 below shows the climatic characteristics of Kafanchan

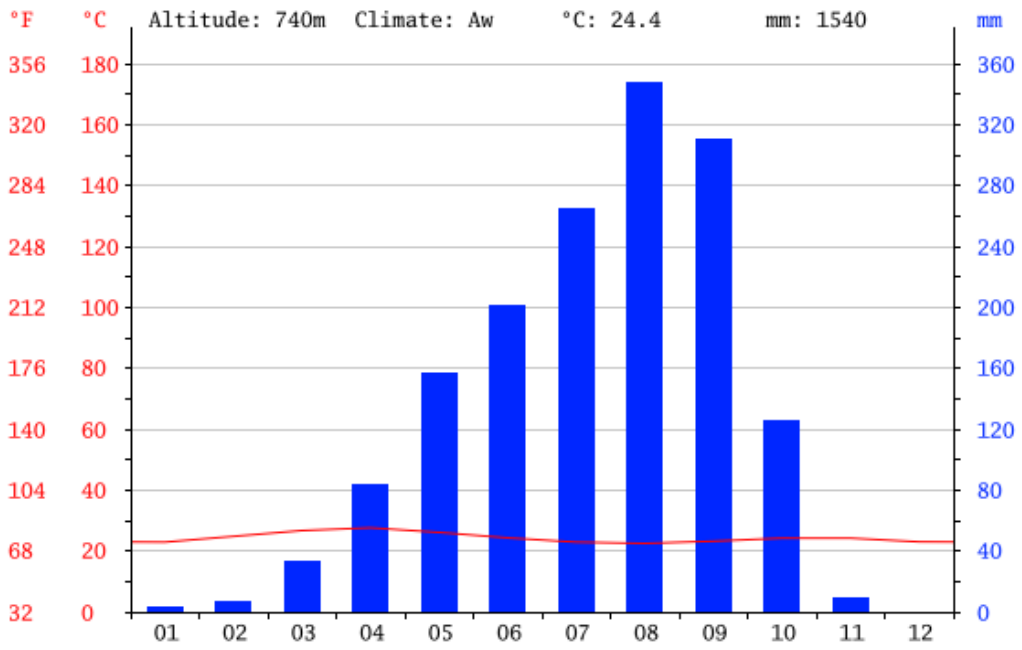


Figure 5.7: Climatic Characteristics of Kafanchan

Source: http://www.climatemps.com/kaduna

5.5.1. Temperature

Kafanchan has a mean temperature that ranges from 22°C to 28°C. Lowest temperatures fall to as low as 13°C and 10°C in mountainous region, during the nights in December to February, and the maximum temperature rise up to 34.2°C as shown in figure 5.8

month	1	2	3	4	5	6	7	8	9	10	11	12
mm	0	1	11	52	132	170	259	296	217	52	2	0
°C	21.9	23.8	26.0	27.6	26.2	24.5	23.0	22.4	23.2	24.2	23.4	22.0
°C (min)	13.9	15.6	18.3	21.0	21.1	19.5	18.8	18.5	18.3	17.7	15.5	13.7
°C (max)	30.0	32.0	33.8	34.2	31.4	29.6	27.3	26.3	28.2	30.8	31.3	30.3
°F	71.4	74.8	78.8	81.7	79.2	76.1	73.4	72.3	73.8	75.6	74.1	71.6
°F (min)	57.0	60.1	64.9	69.8	70.0	67.1	65.8	65.3	64.9	63.9	59.9	56.7
°F (max)	86.0	89.6	92.8	93.6	88.5	85.3	81.1	79.3	82.8	87.4	88.3	86.5

Figure 5.8: Annual Temperatures in Kafanchan in °C and °F

Source: http://www.kaduna.gov.ng

These temperature differences are recorded for the four seasons witnessed in the state which based on temperature, are: (mid-January to February), marked by coolness; the hot season, (March to mid-May) when temperatures climb up to 38°C; the rainy season, (mid-May to September), marked by very low temperature.; and another cold season, (October to mid-January) is the season when the lowest temperature is recorded.

Base on the data above, the design should cater for controlling the heat gain. As noticed, high temperature is distorts human comfort in buildings more than any other factor in Kafanchan, therefore, openings should be minimized, except otherwise, needed, which should be protected from direct sun rays. The larger openings should be made to orient in the south and north direction to reduce the heat gain. Materials that have low or no impact with temperature should be specified to reduce maintenance.

5.5.2. Rainfall

Rainy season in Kafanchan commences in the period around March to October, which is. Kafanchan sees an average of about 1540mm of precipitation per year, the bulk of which falls from June through September. This rain distribution varies with locations in the area, where mean annual rainfall ranges from over 1,000mm in Mountainous region and a little less than 1,000mm in Non-mountainous region.

Shading device should be provided on windward sides, to avoid splashing and driving rain. As a public building, the roof system should be designed in such a way that it will not retain the water except if it is for harvesting; gutters on the roofs should be minimized and the rain drain should be redirected to the water drainage system on the site. Materials that are to be specified should be water resistant, and with little or no effect on humidity.

5.5.3. Wind and Air Masses

In Nigeria there are two major air masses, which vary as the location differs from North to South. Figure 5.9 shows the air masses which are Maritime and Tropical Continental air masses. The maritime Air mass flows from the Atlantic Ocean through the South-West towards the North-East, which is characterized by warm and moist air. This air mass is responsible for the rainy seasons in the country, therefore as locations move farther from the South-West, so does the rain. The Tropical Continental air mass, flows from the Sahara desert in the North-East to the South-West. This wind is associated with dryness and dust, and comes with the cold season. Areas closer to the extreme North-East in the country have the harshest climate.

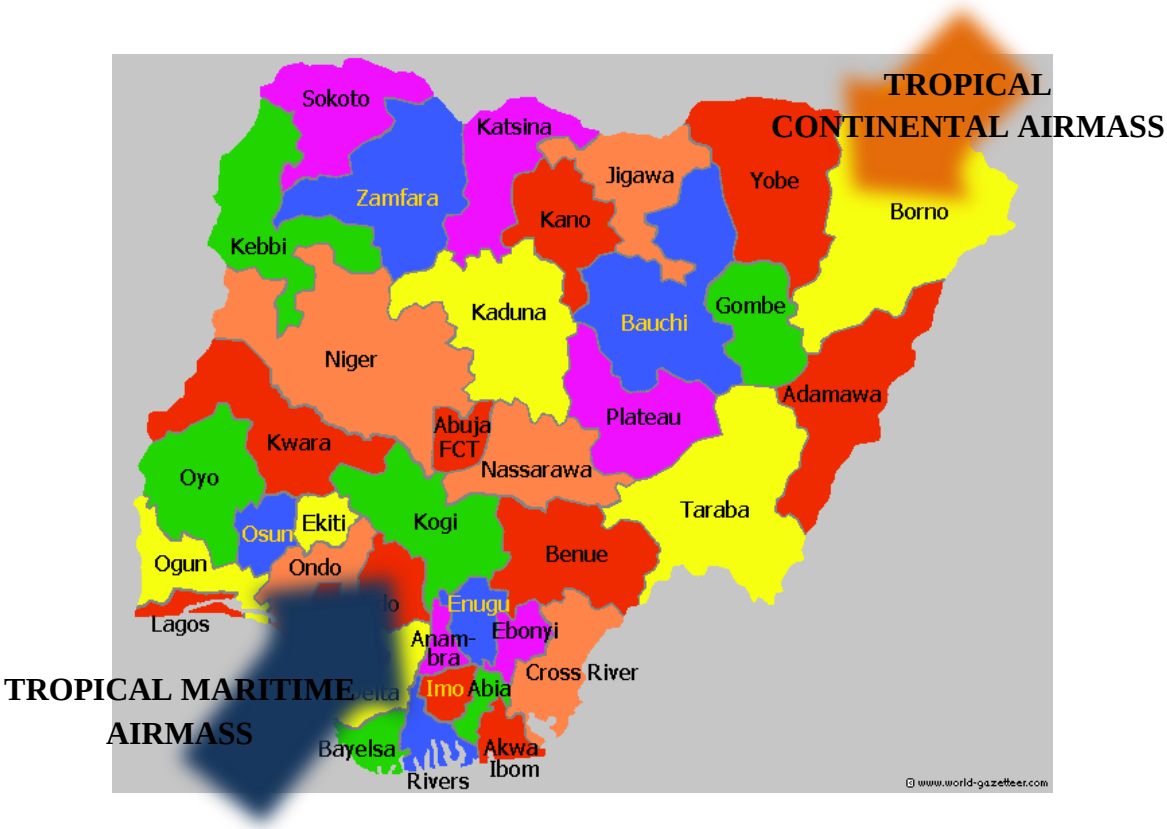


Figure 5.9: Air masses around Kafanchan

Source: Author

From Figure 5.9 above, it is deduced that, the building should be shaded appropriately to harness and make good use of these air masses. The building should be oriented to North and South instead of South-West and North-East to achieve adequate ventilation from Giovani's angle of tilt. Shading devices at the southern face should be made to trap air, and let it in, while on the north, it should be made as possible to do away with the dust it comes with. Perforations that are likely to retain dust should be avoided especially on the northern face, to reduce the maintenance in cleaning. Proper landscaping should be used to break the wind velocity.

5.5.4. Other Climatic Factors

Other climatic factors for Kafanchan are as follows:

Humidity: the relative humidity for Kafanchan ranges from 450-70%, with the minimum humidity record to be 15% during the dry season and the maximum to be 70% during the wet season.

Cloud Cover: Relatively, Kafanchan experiences a clear sky, with bright and light blue tropical sky. Clouds are often few except during rainy season.

Average Sunlight hours per day: the average sunlight hours per day varies seasonally throughout the year, with 6hours in August and 8hours in October and November.

5.6. Site Suitability

The site is subjected to various considerations of locating social activities on the Kaduna State University master plan. The site selected, is situated in the sports centre complex of the campus. The criteria of selecting a site vary with the project type, and thus, for a Student centre complex, the criteria considered include:

5.6.1. Accessibility

This is the consideration of the ease to get to the site. The area must present the minimal hindrances to be accessed. The site is accessible from the Kwoi – Kogoro access road which are all linked to major roads, especially the Abuja Road and the access road to sports centre Centre Roads. The site is opposite the faculty office buildings and adjacent the girl's hostel and the football field as shown on figure 5.10 below.

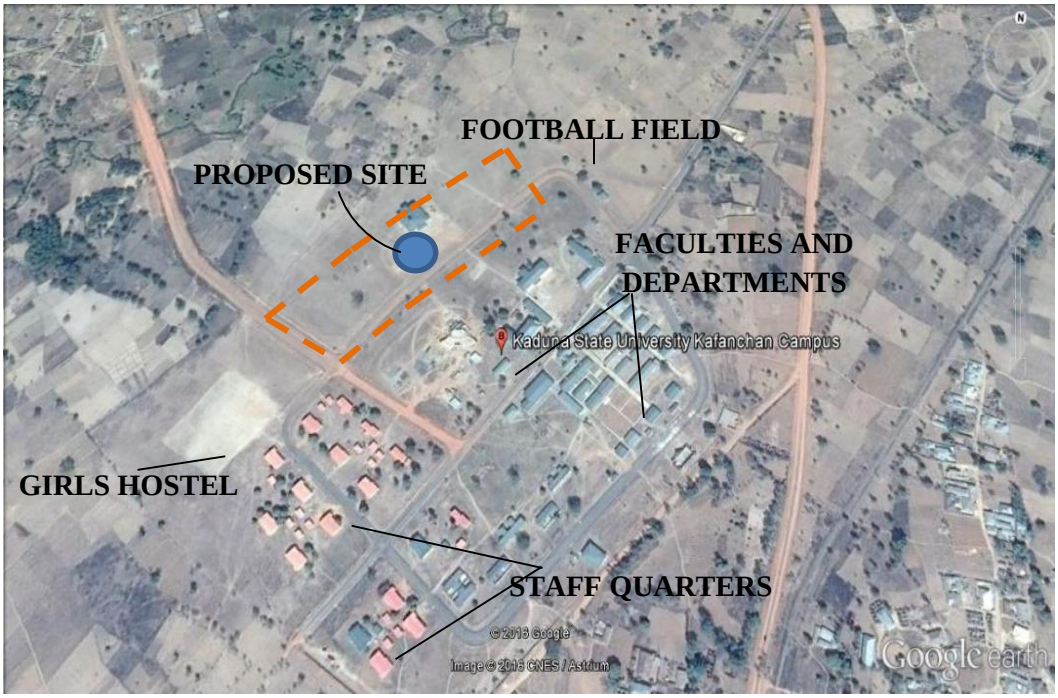


Figure 5.10: Site surrounding and criteria

Source: Author

5.6.2. Land use

From the Kaduna State University master plan, the location of Students centre is appropriately within the student activity area. The site location for this project is Kaduna State University, Kafanchan, which as mentioned earlier, is on one of the campuses of the university.

5.6.3. Visual Amenity

The site is located on a vast landscape in the campus. The buildings surrounding the site are mainly used by students such as hostels, lecture theatre and sports centre, but other areas are not developed. Thus, the site is good and suitable for student centre complex.

5.6.4. Proximity to other commercial buildings

The site is surrounded by other sports facilities, faculty building and hostel, this will ensure a good patronage and easy proximity to the Student centre complex.

5.7. Chapter Summary

The chapter discussed the reason why the site was selected. It also talks about the site location, and intently discussed the facilities and buildings around the site and the overall Kaduna State University area.

The site is also analysed and various characteristics and various features of the site are analysed to see how they could be used to improve the design and at the same time proffer solutions to maintenance problems.

The site and its suitability for the kind of the design is also checked. The surrounding features, accessibility, views and proximity to other functions alike was also checked.

6.0 DESIGN REPORT

6.1. Introduction

This chapter demonstrates the research findings through a design proposal of a Student Centre Complex located in Kaduna State University, Kafanchan. The chapter talks about the preliminary studies; from the brief formulation, design concepts, building concept, schedule of accommodation and others. It also discusses on the design itself, the various components of the design and lastly, the integration of the maintenance design features in the design.

6.2. Preliminary proposal

The preliminary proposal starts with the brief formulation, concepts, relationships and organizational charts, schedule of accommodation which is all discussed below:

6.2.1. Brief Formulation

The Kaduna state university intends to have a student centre, to be located in the Kafanchan campus and the design entails the provision of building to an international standard. The structure will be an entertainment centre, serving both functions as an educational facility for workshops, sports, seminars and so on as well as spaces for both relaxation and recreation. The building is expected to incorporate both recreational, educational, sports and entertaining activities open to students in the university and the general public. The centre is expected to provide an enhanced learning, performing and production environment and also enhance the utilization of various spaces.

The student centre will therefore accommodate the following facilities as shown in figure 6.1;

ADMIN FACIITIES

Main concourse

Offices

ATM Gallery

Store

Let table Offices

COMMERCIAL FACILITIES

Restaurant

Shops

Cyber Cafe

Computer Centre

Kitchen

Store

Changing room

ANCILLARY FACILITIES

Parking lot

Toilets

Landscaped Garden

Refuse chutte

LEISURE AND RECREATIONAL FACILITIES

Multi – purpose Hall

Changing room

Stage

Changing room

Library

Concourse

Gymnasium

Video / Computer games

Indoor Court

Changing room

Equipment Store

Outdoor Sport

Office

Figure 6.1: Brief breakdown

Source: Author

6.2.2. Concepts

I. Spatial concept

The building, which is a two storey building, is designed in such a way that, various floors of the buildings houses different units, such that, each unit can independently operate without hindrance from the activities of other units. The organizational flow chart as the planning concept is designed to have a prototype floor planning design, so that, on the various floors, each should have a technical facilities area, where various technical offices are to be located and are partitioned for the various spaces needed related to that particular unit. Figure 6.2 below shows the organizational flow chart for typical floors.

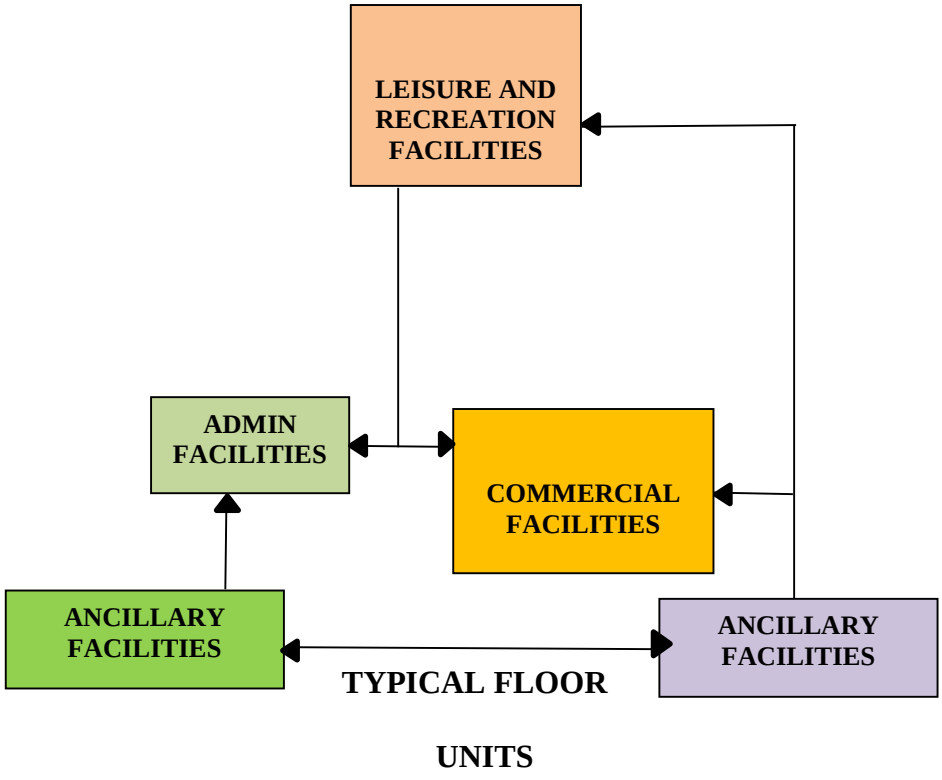


Figure 6.2: Organizational Flow Chart for Typical Floors

Source: Author

The administrative unit is organized in such a way that the entrance is through the main concourse from where there will be a link that will connect to other spaces of the building.

The let-able shops to be provided would be attached to a side of the building with separate entrance and exit systems. A security post and offices are to be provided around the main entrance to the student centre of the building, so that the most frequent and crowd gatherings are attended to at the main concourse.

II. Organisation Level

In ensuring that, the running of the various activities goes smoothly, each of the departments mentioned in student centre Building Design should be given integrated properly for easy accessibility for students

III. Form Concept

As noted from the research, for an easy maintainable building, the building form, shape and complexity should be such that, it is made from simple rectilinear shapes, from square and rectangular shapes, and that it should avoid all unnecessary complexities that may make the accessing of the various parts of the building difficult. Putting this into consideration, simple square and rectangular shapes are extruded to give the form desired. This process of form concept formulation is described on figure 6.3 below.

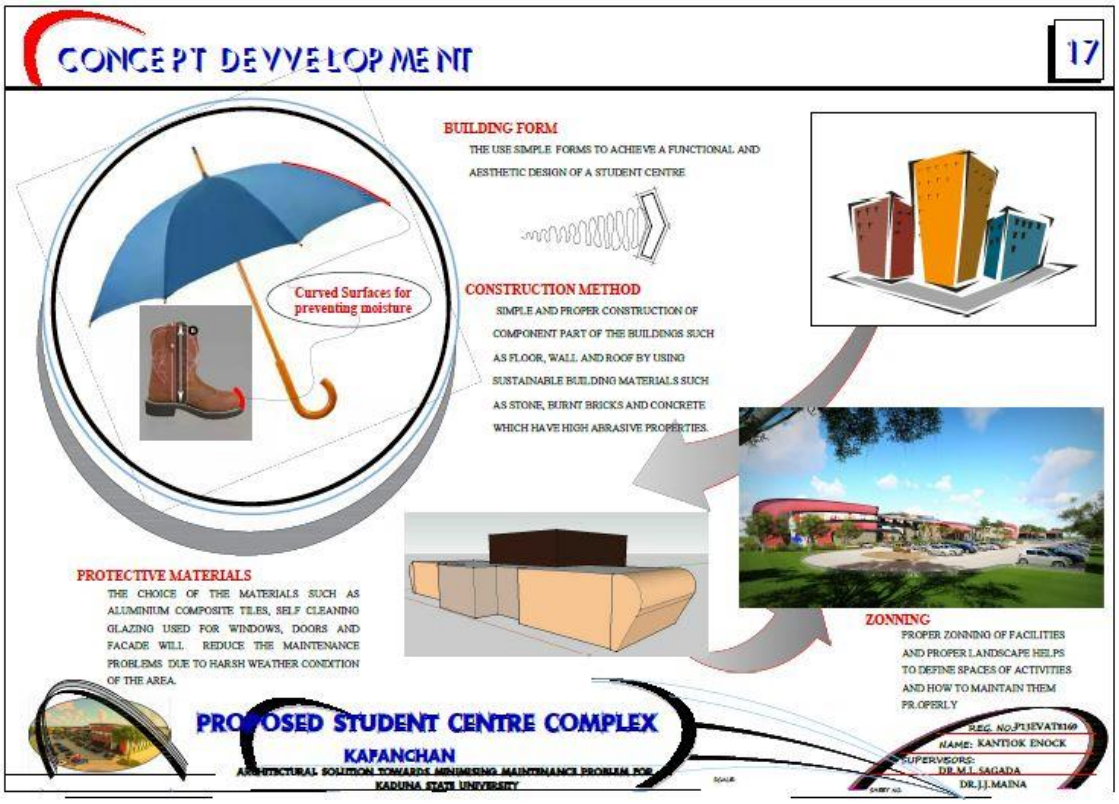


Figure 6.3: Form Concept Formulation

Source: Author

6.2.3. Schedule of Accommodation

The sizing of the various spaces needed in a public building especially student centre building where the structural systems have to be fully checked and coincided to have a uniform carrying capacity due to the number of users and nature of activities. The spatial organization of the spaces should be in such a way that it provides access for maintenance in high levels of the building, below is the breakdown of how the various dimensions and floor areas of the different functions are derived. The values presented on table 6.1 and 6.2 below, are serving as a guide towards the design, thus, alterations can be made when necessary by the designer.

Table 6.1a: Schedule of Accommodation for Student centre complex

ADMIN FACILITIES

S/N	SPACES	DIMENSION		AREA (m^2)	NUMBER	TOTAL AREA (m^2)
		L (m)	B (m)			
1	Main Concourse	12	8	96	2	192
2	General Offices	5	4	20	2	40
3	Facility Managers	3	3	9	1	9
4	Asst. Facility Manager	3	3	9	1	9
5	Utility Store	8	5	35	1	35
6	SUG Conference room	9	6	54	1	54
7	SUG President Office	3	3	9	1	9
8	Security Guard	3	3	9	2	18
9	ATM Gallery	3	3	9	1	9
10	Store	3	3	9	1	9
11	Let table Offices for clubs	3	3	9	5	40
12	Accountant's Office	3	3	9	1	9

LEISURE FACILITIES

S/N	SPACES	DIMENSION		AREA (m^2)	NUMBER	TOTAL AREA (m^2)
		L (m)	B (m)			
1	**Multi – Purpose Hall**					
a	Hall	30	18	540	1	540
b	Stage	6	4	24	1	24
c	Back Stage	6	6	36	1	36
2	Campus FM Room	3	3	9	1	9
3	Common room	9	6	54	1	54
4	Library / Book club	12	9	108	1	108
8	Book Store information	2	2	4	1	4
9	Exhibition Space	6	3	18	1	18
10	**Ball room**					
a	Office	3	3	9	1	9
b	Stage	12	9	108	1	108

Table 6.1b: Schedule of Accommodation for Student centre complex

COMMERCIAL FCILITIES

S/N	SPACES	DIMENSION		AREA	NUMBER	TOTAL AREA
		L(m)	B (m)	(m^2)		(m^2)
1	**Restaurant (hall)**					
a	Service area	2.5	2	5	4	20
b	Drinks	2.5	2	5	2	10
c	Store	3	3	9	8	18
d	Outdoor kitchen	6	4	24	2	48
e	Kitchen	6	4	24	4	96
2	Central laundry	3	3	9	2	18
3	Snack bar and grill	6	3	18	2	36
4	Barbing Saloon	3	3	9	2	18
5	Beauty Saloon	3	3	9	2	18
6	Boutique	12	9	108	2	216
7	Super Market	12	9	108	1	108
8	**Pharmacy**					
a	First aid room	2	2	4	1	4
b	Drug and Sales area	6	4	24	1	24
9	Let table Shops	3	3	9	10	90
10	Computer Centre	6	3	18	4	72
11	**Cyber Café**					
a	Server	2	2	4	2	8
b	Office	3	3	9	2	18
c	Browsing hall	12	9	108	2	216

Table 6.1c: Schedule of Accommodation for Student centre complex

RECREATIONAL FACILITIES

S/N	SPACES	DIMENSION		AREA	NUMBER	TOTAL AREA
		L (m)	B (m)	(m^2)		(m^2)
1	**Gymnasium**					
a	Hall	12	9	108	1	108
b	Office	3	3	9	1	9
2	**Indoor Computer game**					
a	Foosball	3	3	9	2	18
b	Chess	3	3	9	1	9
c	Scrabble	3	3	9	1	9
d	Video games	6	6	36	2	72
e	Store	3	3	9	2	18
f	Office	3	3	9	2	18
3	**Indoor games**					
a	Changing room	6	4	24	2	48
b	Pitch Floor area	40	30	1200	1	1200
c	Office	6	3	18	2	36
d	Equipment store	6	6	36	1	36
e	Snooker / Table tennis	3	3	9	3	18
4	**Outdoor Sports**					
a	Swimming pool	30	15	450	1	450
b	Volley ball	18	9	162	2	324
c	Basketball	26	18	468	2	468

ANCILLARY FACILITIES

S/N	SPACES	DIMENSION		AREA	NUMBER	TOTAL AREA
		L (m)	B (m)	(m^2)		(m^2)
1	Landscaped garden	18	9	162	2	324
2	Toilets	1.8	1.5	2.7	14	37.8
3	Parking spaces	30	15	450	2	900
4	Refuse chute	2	1.5	3	2	6

The above standards were collected from the following:

(a) Architects Data third edition

(b) Standards collected from Nigerian University Guide January 2013.

6.3. Site Planning and Landscape

The site is properly zoned according to nature of activities such as recreation, sports, and leisure, ancillary and commercial areas as shown in Figure 6.4. The shape of the site is planned such that the parking lot serves the students and the facility staffs. The designed site plan in figure 6.5 below shows the scaled positioning of the various units of the design, parking spaces, pedestrian and vehicular circulations, and the position of the main building and the sports complex. This is subject to a professional consideration.

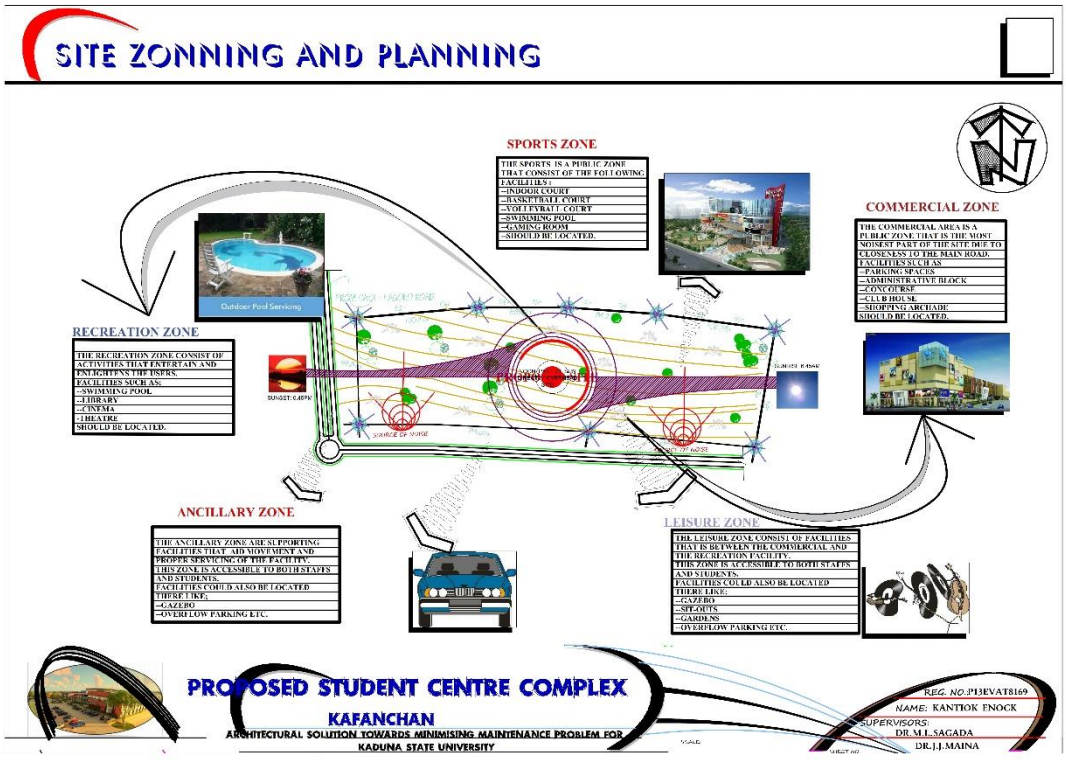


Figure 6.4: Site Zoning

Source: Author

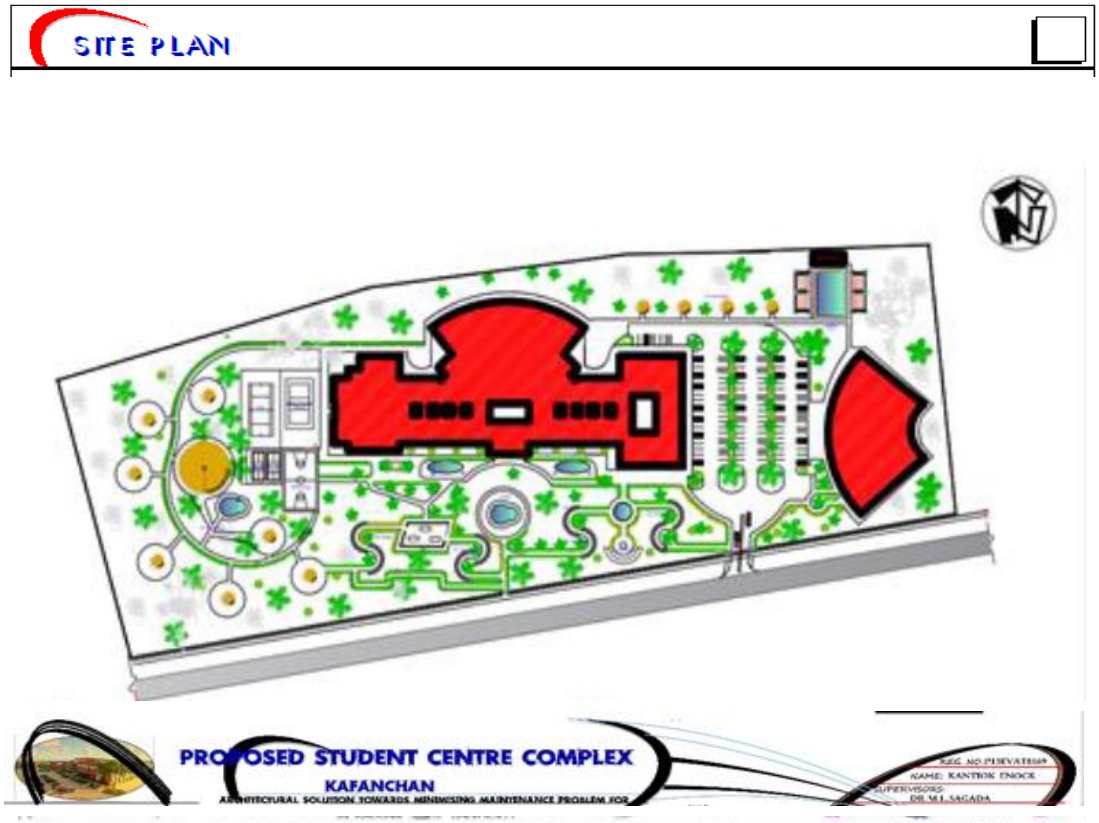


Figure 6.5: Site plan

Source: Author

6.4. Design Discussions

The various ideas and reasons that guided the designer in coming up with the design will be discussed here.

6.4.1. Administration Unit

The facility staffs related units of the building consist of the maintenance staff office, SUG offices, let table offices, exhibition area, information unit and Concourse which is at the entrance.

The concourse is a double volume space and links up other facilities such as the offices, the commercial area and the information unit. Access to the upper floor by the student is provided through the staircase and ramp for disabled users.

Some of the offices are at the first floor of the main building where student union officials and maintenance staffs holds meeting and congresses as shown on figure 6.6.

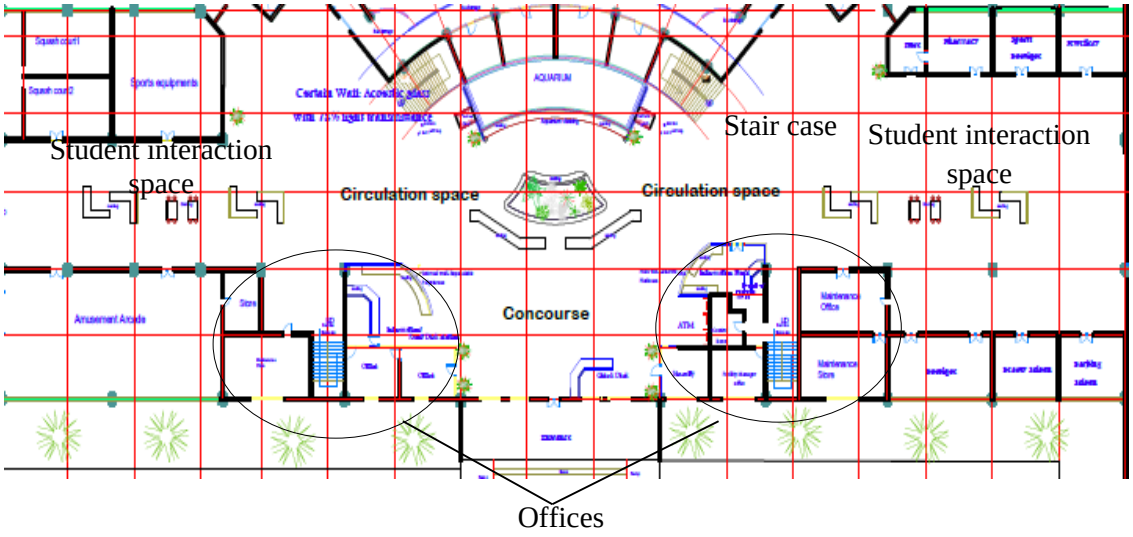


Figure 6.6: Administration Unit

Source: Author

6.4.2. Leisure and Recreation Facility unit

The leisure and recreation area includes gymnasium, indoor sports hall and performance theatre where students engage in extracurricular activities. The deigned is done in such a way that, there is efficient lighting and sound connection between the spaces as shown on figure 6.7.

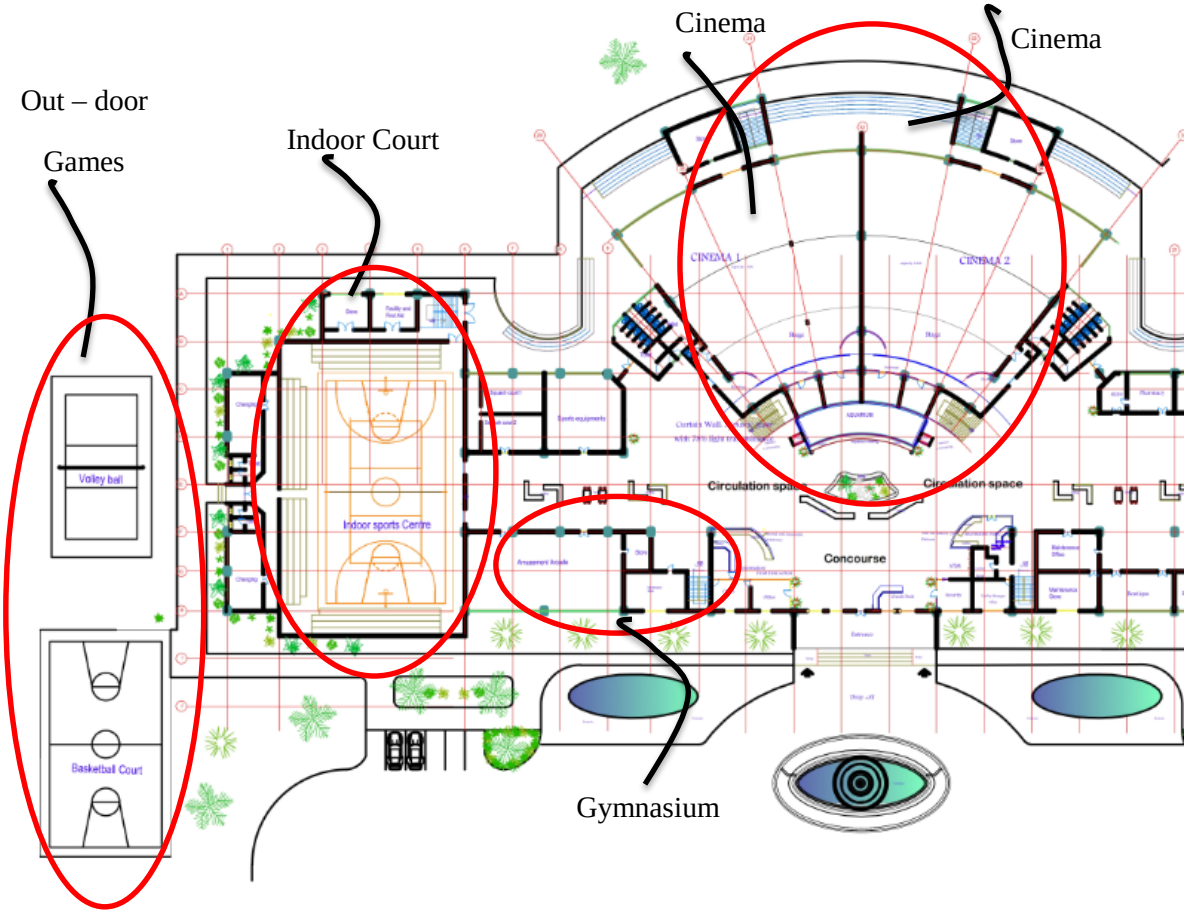


Figure 6.7: Leisure and recreation Facility Area

Source: Author

6.4.3. Commercial Facility unit

The commercial unit is an area that accommodates a lot of users; the unit consist of restaurants, shops, cafe, boutique, pharmacy and let table shops where different business can be done. The deigned is done in such a way that, there is efficient lighting and ventilation by creating a courtyard to link up the spaces as shown on figure 6.8.

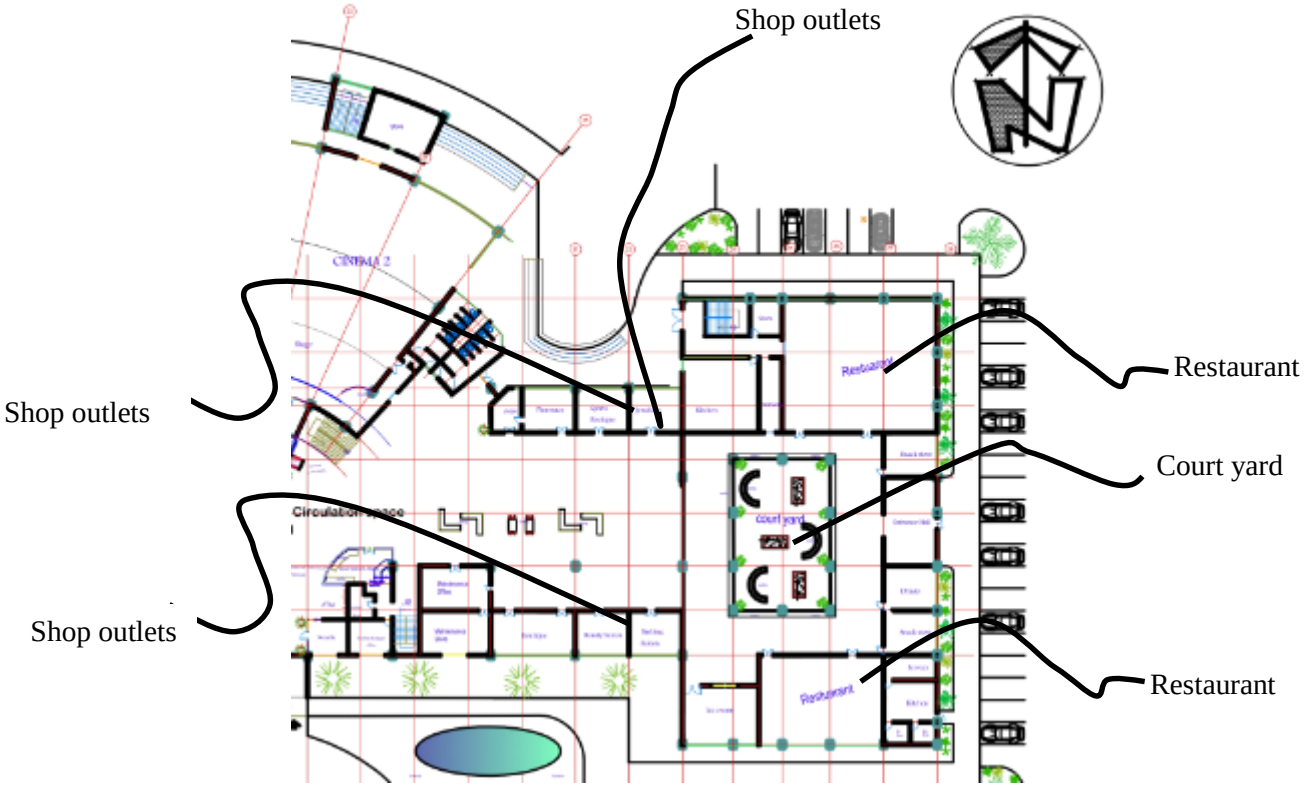


Figure 6.8: Typical Commercial Area

Source: Author

6.5. Maintenance Design Considerations

The maintenance design features outlined earlier, and how they are integrated into the design of the Student centre is discussed here. As noted, the solutions given by researchers on how to make student centre buildings easily maintainable include; the building form, materials used, maintenance access, considering environment and weather condition and also relating material selection to climatic condition. They are discussed in relation to their integration into the design below.

6.5.1. Building Form and Complexity

To make a building easily maintainable, a building should have a regular form, rectilinear forms preferred. Plastic forms are more difficult to construct and then maintained, therefore, simple rectangular shapes are used in forming the student centre building as

shown on figure 6.9 below. The designer paid attention in not curving any part of the building, and also avoiding complex designs. Proper details are provided for all sections of the building that may seem difficult to construct.



Figure 6.9: Building Forms Used

Source: Author

6.5.2. Materials Used

The materials specified in a building have so much impact on the maintainability of that building. It is the designer's task to specify the kind of materials they want in the building. Materials that requires frequent cleaning, replacing and repainting and or other maintenance issues are not suitable for an easily-maintainable building. Very qualitative materials that can last through the lifetime of the building and need only little or no maintenance are the ones specified here. Tiling that requires strong adhesive are minimized, while aluco bond finishes, texcote paints on plastered surfaces, crack tiling are some of the finishes. These finishes have so much to do with the general outlook of

the building, and thus lighter colours that does not attract dust and that have little or no effect when subjected to a climate like Kafanchan'.

The basic building materials used are, sandcrete blocks, toughened glasses, for cladding, while steel and structural concrete are used for the frames. Other easily mountable and replaceable materials used include, danpalon coverings, steel blinds, and 0.7mm gauge aluminium roofing sheets as shown on figure 6.10 below. Full specifications for the materials is provided.

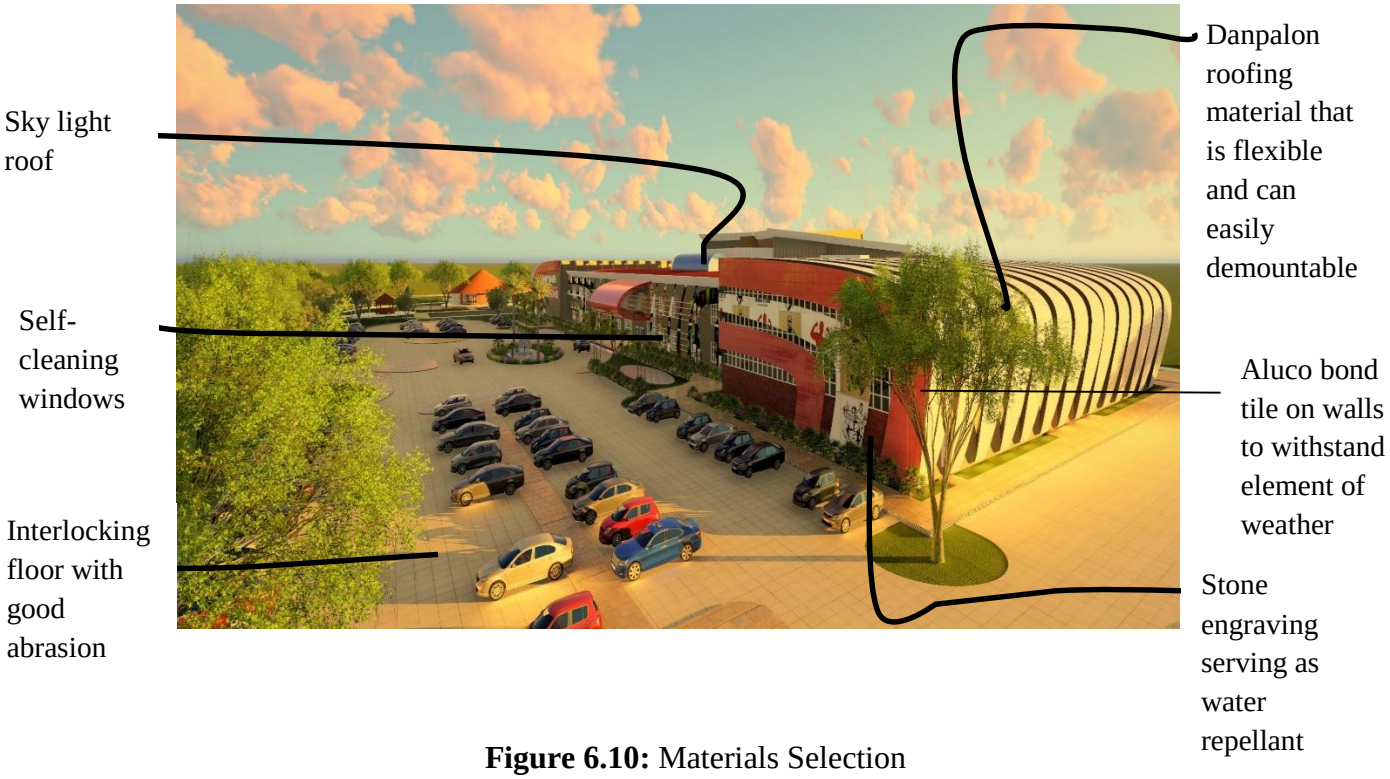


Figure 6.10: Materials Selection

Source: Author

6.5.3. Maintenance Access

Access to various parts of a building is a required factor in building maintenance. It is these access systems that simplifies maintenance of a building, so the designer incorporate various design accesses into the design as discussed below:

I. Building Envelope: For accessing the various parts of the external faces of the building, for either replacing, inspecting, cleaning or other maintenance activities, there

are certain types of accesses provided, a staircase to the roof, slabs around glazed areas and access is possible through the steel bracings provided and internally recessed window as shown in figure 6.11

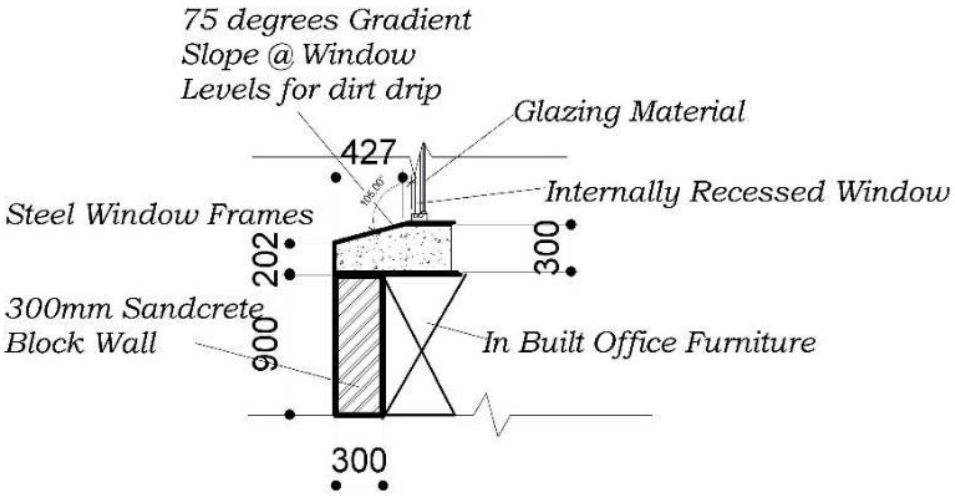


Figure 6.11: Internally Recessed Window

Source: Author

Complete flip-over glass screens are used on the student centre, so that window glasses can be flip over and cleaned from the inside, Around the lifts lobby on the outside, the windows provided are recessed inside so that accessing will be a lot easier from the outside, as fenestrations and perforations as stated in the research provides a stepping stone for access.

Hooks for rope climbing, and plates for cleaning cradle is also installed. And there are track and rail provisions for temporary maintenance platforms on the deck and parapet walls of the building.

Self-cleaning glass which contains titanium dioxide are also used for glazing and some parts of the facade.

6.5.4. Considering Environment and Weather Condition

In considering the environment and weather condition, the building is also aligned to Givoni's angle of tilt and tilted almost 45^{o} to North and South orientation, such that adequate ventilation can be achieved. The sides to the East are shaded with devices from the radiation, while the West sides have most of the glazing which only sees the solar radiation when the sun is cooler in the evenings.

The building is painted mostly with emulsion paints and stone engraving used as skirting for the lower part of the exterior wall, which is protected from the glaring sun by the application of vanish on it. Provisions are made on the roof to properly drain rain water completely out from the building by using large roof overhangs and in areas of courtyard, provisions were made for Polyvinyl Chloride (PVC) pipes underground to drain out water to some limited strategic points, so that it can be collected and controlled at ease.

The environment as an academic environment is considered in designing a befitting building that will form the continuation of the existing landscape. The design is also made to satisfy the University master plan and NUC standards, so that no further amendments are to be done.

6.5.5. Relating Exterior Material Selection to Climatic Condition

As a tropical climate, the materials specified is concrete and steel, with adequate expansion joints provided for thermal movements.

Normal glazing is not ideal for this type of climate due to solar radiation, but again, as a student centre building, glazing is a required building materials to create the type of openness needed in such building types. It is therefore, viewed that a partially transparent glass which is a little bit coloured, would be used strategically to create what is needed. The roofing system is aluminium, which does not rust due to the effect of sun, water and air, and have an insulating capacity from solar radiation. Also, the concrete used in

columns, beams and floor slabs. There was no decked spaces as this will result in increased maintenance challenges such as regular cleaning of roof gutters, blockages of drainage pipes and leakages.

Parapet walls are only used where efficiently necessary, that is, for protection against prevailing winds.

6.6. Chapter Summary

This chapter shows generally the design itself. The client's brief, the concepts, spatial and form, Schedule of accommodation and other preliminary studies. The design was performed showing the site planning and site landscaping.

The chapter also looked into the design proper, where the various functions and planning were independently categorized and looked into. Finally, how the maintenance design features are integrated into the design and its effect on the design was looked into.

7.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1. Introduction

This chapter generally concludes the research conducted by giving a more detailed explanation of the results obtained and the researcher's discussion. It will also provide summary, recommendations and suggestion of how the research results can be fully harnessed and be used for further application and continued research.

7.2. Summary of Findings

I. The findings of the study reveals that designers of student centre buildings used glazing and other finishing materials that requires cleaning but do not necessarily consider how the cleaning can be, and thus, rely on facility managers to devise a way to access their buildings for them. This mostly ended up, forcing the facility managers to even break and add some components of the buildings to make the provisions for their machines which was omitted by the architect.

II. Also, apart from providing access to the roof, the study reveals that the architects pay no attention to providing access to façade, thus complicating issues when it comes to cleaning and replacing of components. It is understood that, architects are just in a hurry to glaze their buildings without paying attention to the effect of that on the maintenance.

III. It also reveals that poor selection of building materials used in relation to the weather is another maintenance problem, and that architect should provide proper specification of building materials to minimized maintenance challenges.

IV. The study finally found that from the summary of findings in chapter four, it can be generalized that maintenance design considerations and integration is being neglected by the architects of student centre buildings, because none of the cases studied considered the five features stipulated to check the considerations of maintenance in the buildings.

7.3. Conclusion

The problems of maintenance starts from the drawing board of the architects who are responsible for every single stroke of line drawn. From the first research question in chapter one (How have maintenance design features shaped student centre buildings?); the study reveals that maintenance design features and considerations are of course shaping the design of student centre buildings in the aspect of making buildings easier to maintain by simplifying forms and shapes. Therefore, maintenance is one of the design consideration shaping buildings to a more regular and rectilinear form for easy access. This is in line with Al Khatami (2003), who argued that design complexity contribute to the maintenance problems of buildings. The research revealed that maintenance problems could be outrageous if proper care of certain key factors which were discussed during the course of the research are not taken into cognisance during the design stage. Moreover since it is impossible to provide maintenance-free structures, architects to an extent could provide less maintenance buildings by considering the shape of the building, roofing system and the maintenance access. This on the long run could minimize maintenance problems.

The second research question asked for the maintenance design features that can be integrated into the design to enhance the maintenance of student centres?; the study reveals the components that can be in cooperated into the student centre buildings are the roof design and type of roof covering of a building, which most at times leak, thereby, allowing water into the interior parts of the building and at the same time spoiling the ceiling and so many other issues, the building materials on walls and the finishes used, the method of construction used and its provision of maintenance access to the component part of the building.

Based on these several important factors at the design stages where listed out during the course of the research to guide architects alongside the formulation of design ideas to achieve a less maintenance structure.

7.4. Recommendations

From the findings of the research, the following recommendations are deduced which will help to avoid the negligence of various facilities due to non-utilization:

I. Student centre buildings which incorporates glazing system and other finishing materials that requires cleaning must compulsorily specify the materials and consider the cleaning process by giving a clear description of how it can be achieved. The designers must provide proper design details to give a full description and support the considerations the designer identifies.

II. Architectural professionals should be enlightened on futuristic projections and adopting a more open-minded approach toward maintenance during the design stages of building. Special attention therefore should be adhered since the amount of maintenance work that will be needed after the building is completed is a ripple effect of the design stage.

III. There should be provision of access to the roof if necessary and façade of the building. It is recommended that architects identified the access system to all the points and parts of the building at the same time make the building secure, such that the access cannot be compromised by unknown personnel.

IV. There should be proper planning and building regulation authorities, to make it a law that all building drawings especially public buildings must be accompanied with proper detailing of equipment, considerations and components integration.

7.5. Contribution to Knowledge

The study to knowledge through the following findings:

1. The study provided a framework for the selection of architectural design features that will minimize maintenance problems in student centre design.

2. The criteria to check the design features of maintenance being integrated into a building are simply brought out for the usage of architects.

3. The study shows an integration of the design features for maintenance practically in a live design with details and sketches.

4 The study identified key maintenance challenges facing student centres in Nigeria which included deterioration of both roofing and walling materials, specification of materials which were in contradiction with its usage or climate, increase of indoor climate and humidity due to moisture, poor drainage system of roofs resulting in leakages and accessibility hindrances by maintenance personnel to areas of faults and design problems.

5. The study established a relationship between architectural features of student centres and maintenance challenges.

6. The study demonstrated the finding in the design of a low maintenance student centre applying the various design strategies from the design stage.

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APPENDICES

Appendix A: Questionnaire

DEPARTMENT OF ARCHITECTURE AHMADU BELLO UNIVERSITY, ZARIA

This questionnaire is for a M.Sc. thesis research in the above mentioned department and school, intended to gather information on the maintenance problems in student centres. The information you provide will be used strictly for research. It will also be treated with utmost confidentiality. Thank you.

SECTION ONE: USER BIODATA (*Please fill this section as a Facility Manager or Maintenance worker)*

1. **Gender of Respondent:** Male [ ] Female [ ]
2. **Age:** 18 – 21 [ ] 22 – 25 [ ] 26– 30 [ ] 31-39 [ ] Above 40 [ ]
3. **Marital Status:** Single [ ] Married [ ] Divorced [ ] Others [ ]
4. Educational status:
   First school leaving Cert. [ ] SSCE [ ] Bachelor's degree/HND [ ] Above bachelor's degree [ ] none [ ]
5. Position/Rank:
   Facility manager [ ] maintenance worker [ ]
6. Income level: below 18,000 [ ] 18,000-35,000 [ ] 36,000-50,000 [ ] 51,000-100,000 [ ] Above 101,000 [ ]
7. How long have you worked in this Facility?
   0 – 1 year [ ] 1 – 3 years [ ] 4 – 5 years [ ] 6 – 10 Years [ ] 11 and above [ ]

SECTION TWO: MAINTENANCE PROBLEMS (*Please choose the option that applies to you).*

8. How do you carry out maintenance of facilities?
   Daily [ ] Periodic [ ] Both [ ] None at all [ ]
9. Which of these do you carry out on a daily basis?
   Sweeping [ ] Mopping [ ] Scrubbing [ ] Others [ ] (*please specify*)…….
10. Which of these components of the building requires periodic maintenance routine?
    Floor [ ] Wall [ ] Ceiling [ ] Roof [ ]
11. What periodic maintenance activities do you carry out?
    Painting [ ] component replacement [ ] Others (*please specify*)…….
12. What equipment(s) do you use to access high level of the building?
    Scaffold [ ] ladder [ ] Both [ ] Others [ ](*please specify*) ……..
13. How are these equipment integrated in the building?
    Stand -alone [ ] Components of the building [ ] Both [ ] None of the above [ ]
14. Which of these building components on high elevation needs frequent maintenance?
    Roof [ ] Windows [ ] Doors [ ] Ceiling [ ] Others [ ] (*please specify*)…….
15. How will you describe your level of satisfaction on the maintenance access of the student centre building?

Very Satisfied [ ] Satisfied [ ] Neutral [ ] Unsatisfied [ ] Very Unsatisfied [ ]

16. What do you think are the cause of damage to the facilities?
    Building's design [ ] Poor construction methods [ ] Students' usage lack of maintenance [ ] Others [ ] (*please specify*)…….
17. What do you think are the factors responsible for defects in this building?
    Weather [ ] poor maintenance culture [ ] low standard materials [ ] poor workmanship [ ]
18. What spaces require much maintenance?
    Shops [ ] Toilets [ ] Theatres [ ] Recreational and sport facilities [ ] Others [ ] (*please specify*)…….
19. Which part of the building do you think require less maintenance?
    Wall [ ] Floor [ ] Roof [ ] Ceiling [ ]
20. What are the challenges faced by different departments and maintenance staffs?
    Availability of maintenance equipment [ ] Damaged maintenance equipment [ ] low labour force [ ]
    Others [ ] (*please specify*)…….
21. What way(s) can the deterioration in student centre be minimised? Effective maintenance policy [ ] increase in labour force [ ] orientation of facility users Others [ ] (*please specify*)……
22. How will you describe your level of satisfaction with the with the maintenance policy?
    Very Satisfied [ ] Satisfied [ ] Neutral [ ] Unsatisfied [ ] Very Unsatisfied [ ]
23. How will you describe your level of satisfaction on the architect's considerations of maintenance in the student centre building?
    Very Satisfied [ ] Satisfied [ ] Neutral [ ] Unsatisfied [ ] Very Unsatisfied [ ]
24. What way[s] can the deterioration in student centre are prevented?
    Repairing of damaged parts [ ] Replacing of damaged parts [ ] Others [ ] (*please specify*)……
25. . Kindly write any comments/suggestions/recommendations.
    ……
    ……
    ……
    ……

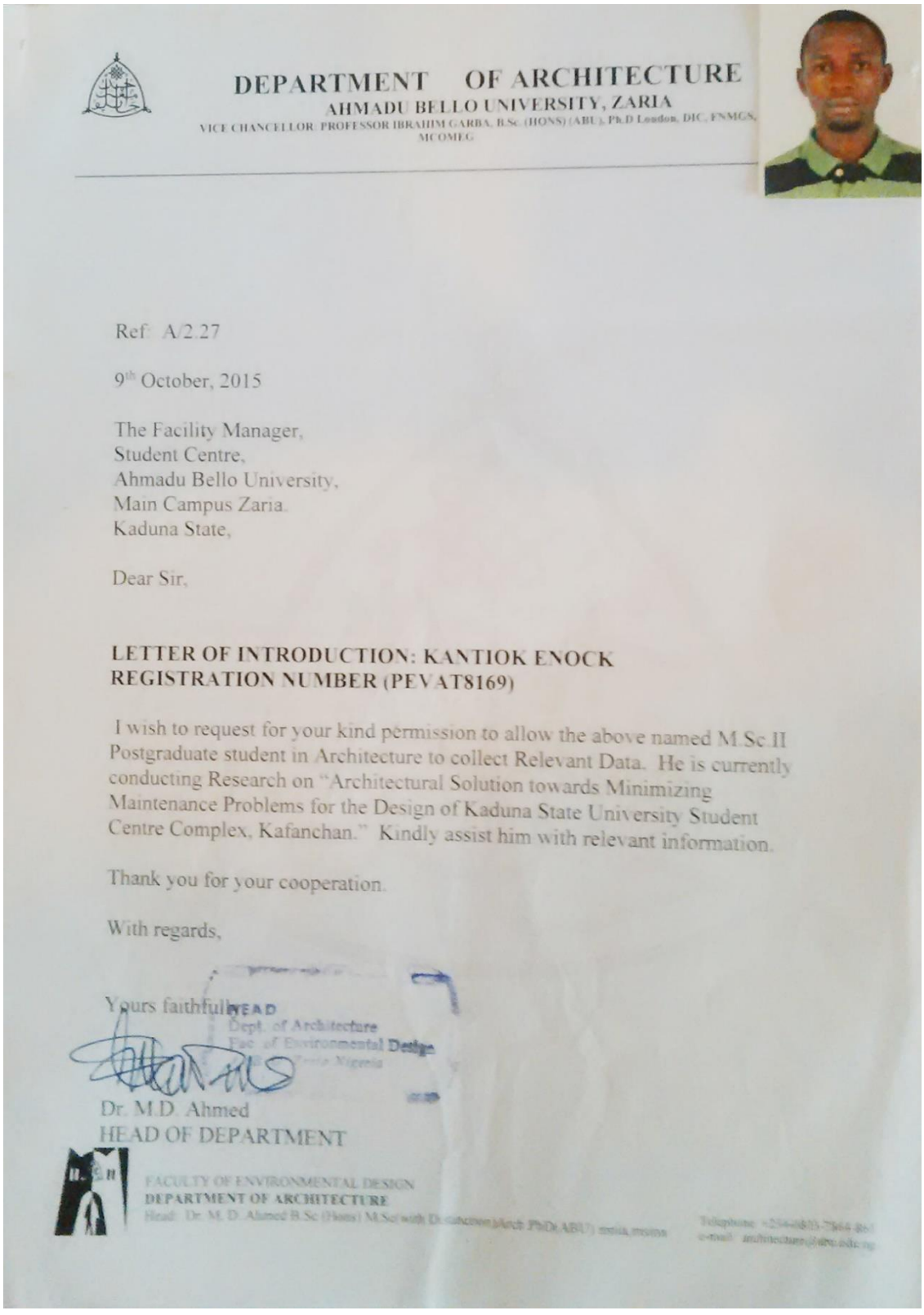
THANK YOU!

Appendix B: Visual survey checklist

S/N	VARIABLES	FEATURES	SCALE FACTOR 1 2 3 4 5	REMARKS
1	**Building form**	Adequate detailing Simple and rectilinear plan Drainage layout based on the form		
2	**Materials used Considering environmental and climatic condition**	Qualitative materials that is easily available and replaceable. Materials suitability to the climate of the region		
3	**Site planning and landscaping**	Use of low maintenance landscape element. Adequate drainage layout		
4	**Construction system Considering environmental and climatic condition**	Suitability to climate and Environment. Flexibility of construction method		
5	**Maintenance Access**	Access to roofs and various strategic elevations especially where will be prone to maintenance.		
6	**Integrating Maintenance Technology in the building**	Incorporating parts of maintenance equipment in the building		

SCALE FACTOR: Excellent= 5, Very Good= 4, Good= 3, Fair= 2, Poor= 1

Appendix C: Letter of Introduction to ABU Student centre, Zaria, Kaduna State.



DEPARTMENT OF ARCHITECTURE
AHMADU BELLO UNIVERSITY, ZARIA
VICE CHANCELLOR: PROFESSOR IBRAHIM GARBA, B.Sc. (HONS) (ABU), Ph.D London, DIC, FNMGS, MCOMEG

Ref: A/2.27

9th October, 2015

The Facility Manager,
Student Centre,
Ahmadu Bello University,
Main Campus Zaria.
Kaduna State,

Dear Sir,

LETTER OF INTRODUCTION: KANTIOK ENOCK
REGISTRATION NUMBER (PEVAT8169)

I wish to request for your kind permission to allow the above named M.Sc.II Postgraduate student in Architecture to collect Relevant Data. He is currently conducting Research on "Architectural Solution towards Minimizing Maintenance Problems for the Design of Kaduna State University Student Centre Complex, Kafanchan." Kindly assist him with relevant information.

Thank you for your cooperation.

With regards,

Yours faithfully,

HEAD
Dept. of Architecture
Fac. of Environmental Design

Dr. M.D. Ahmed
HEAD OF DEPARTMENT

FACULTY OF ENVIRONMENTAL DESIGN
DEPARTMENT OF ARCHITECTURE

Appendix D: Letter of Introduction to OAU Student centre, Ille – Ife, Osun State.



DEPARTMENT OF ARCHITECTURE
AHMADU BELLO UNIVERSITY, ZARIA
VICE CHANCELLOR: PROFESSOR IBRAHIM GARBA, B.Sc. (HONS) (ABU), Ph.D London, DIC, FNMGS, MCOMEG

Ref: A/2.27

9th October, 2015

The Facility Manager,
Obafemi Awolowo University Student Centre,
Ile –Ife,
Oyo State.

Dear Sir,

LETTER OF INTRODUCTION: KANTIOK ENOCK
REGISTRATION NUMBER (PEVAT8169)

I wish to request for your kind permission to allow the above named M.Sc.II Postgraduate student in Architecture to collect Relevant Data. He is currently conducting Research on "Architectural Solution towards Minimizing Maintenance Problems for the Design of Kaduna State University Student Centre Complex, Kafanchan." Kindly assist him with relevant information.

Thank you for your cooperation.

With regards,

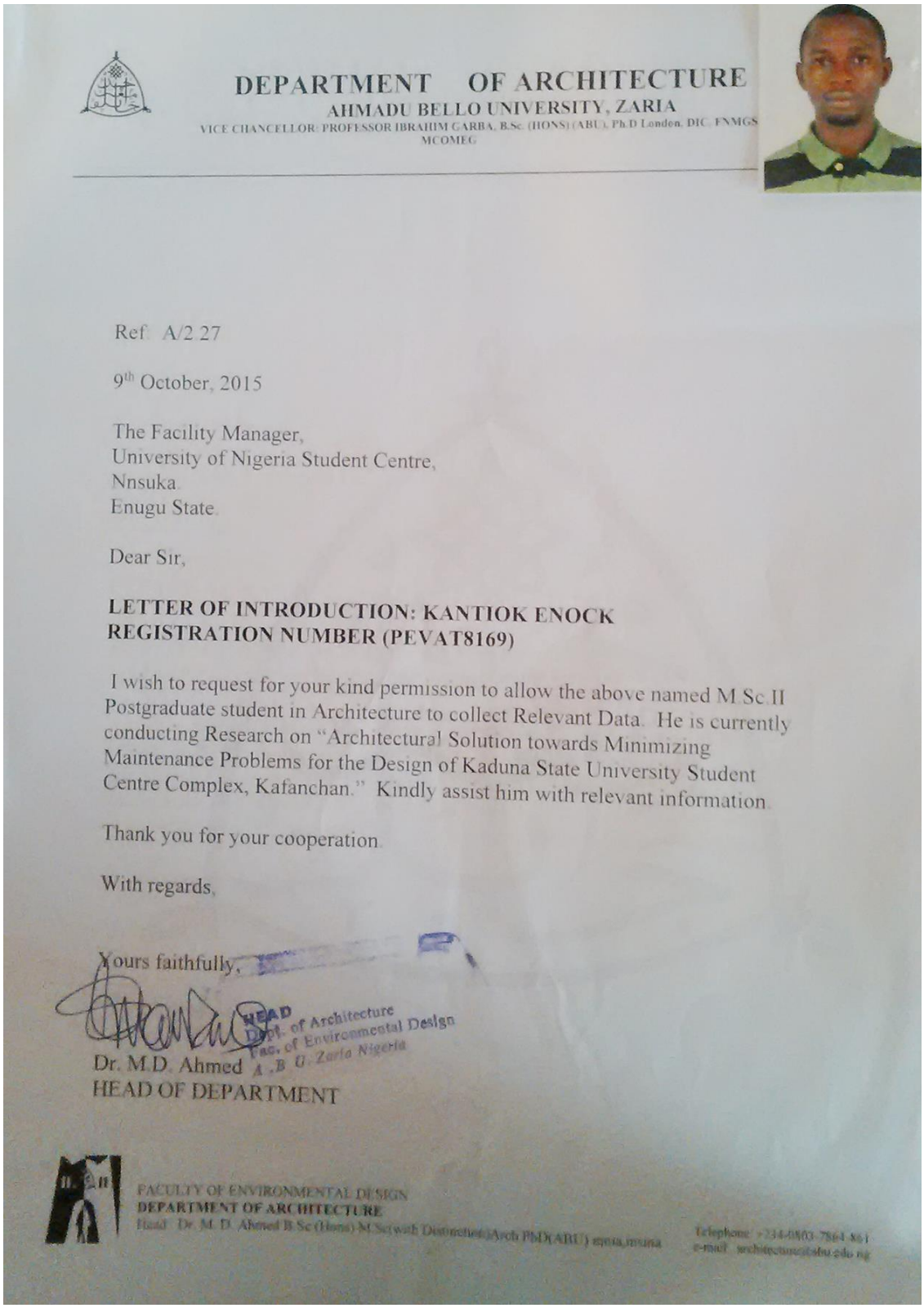
Yours faithfully,

HEAD
Dept. of Architecture
Fac. of Environmental Design
A.B.U. Zaria Nigeria

Dr. M.D. Ahmed
HEAD OF DEPARTMENT

FACULTY OF ENVIRONMENTAL DESIGN
DEPARTMENT OF ARCHITECTURE
Head: Dr. M. D. Ahmed B.Sc (Hons) M.Sc(with Distinction)Arch PhD(ABU) mnia,msina
Telephone: +234-0803-7864-861
e-mail: architecture@abu.edu.ng

Appendix E: Letter of Introduction to UNIJOS Student centre, Plataeu State.



DEPARTMENT OF ARCHITECTURE
AHMADU BELLO UNIVERSITY, ZARIA
VICE CHANCELLOR: PROFESSOR IBRAHIIM GARBA, B.Sc. (HONS) (ABU), Ph.D London, DIC, FNMGS MCOMEG

Ref: A/2 27

9th October, 2015

The Facility Manager,
University of Nigeria Student Centre,
Nnsuka.
Enugu State.

Dear Sir,

LETTER OF INTRODUCTION: KANTIOK ENOCK
REGISTRATION NUMBER (PEVAT8169)

I wish to request for your kind permission to allow the above named M.Sc.II Postgraduate student in Architecture to collect Relevant Data. He is currently conducting Research on "Architectural Solution towards Minimizing Maintenance Problems for the Design of Kaduna State University Student Centre Complex, Kafanchan." Kindly assist him with relevant information.

Thank you for your cooperation.

With regards,

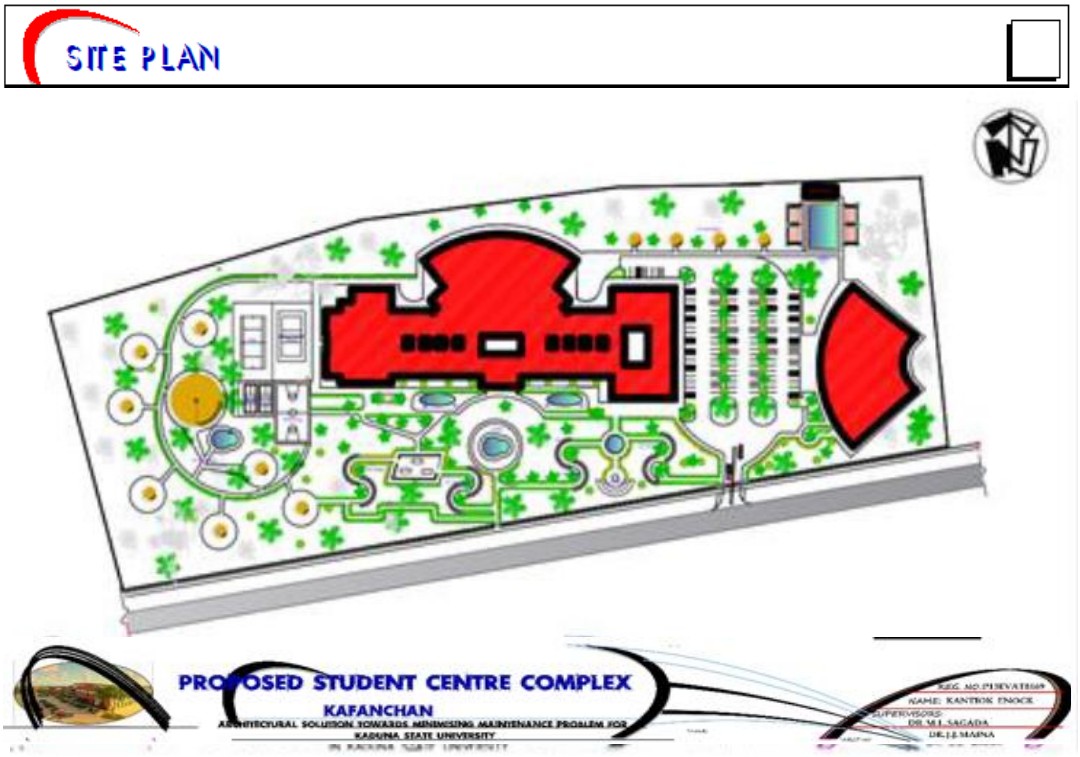
Yours faithfully,

HEAD
Dept. of Architecture
Fac. of Environmental Design
A.B.U. Zaria Nigeria

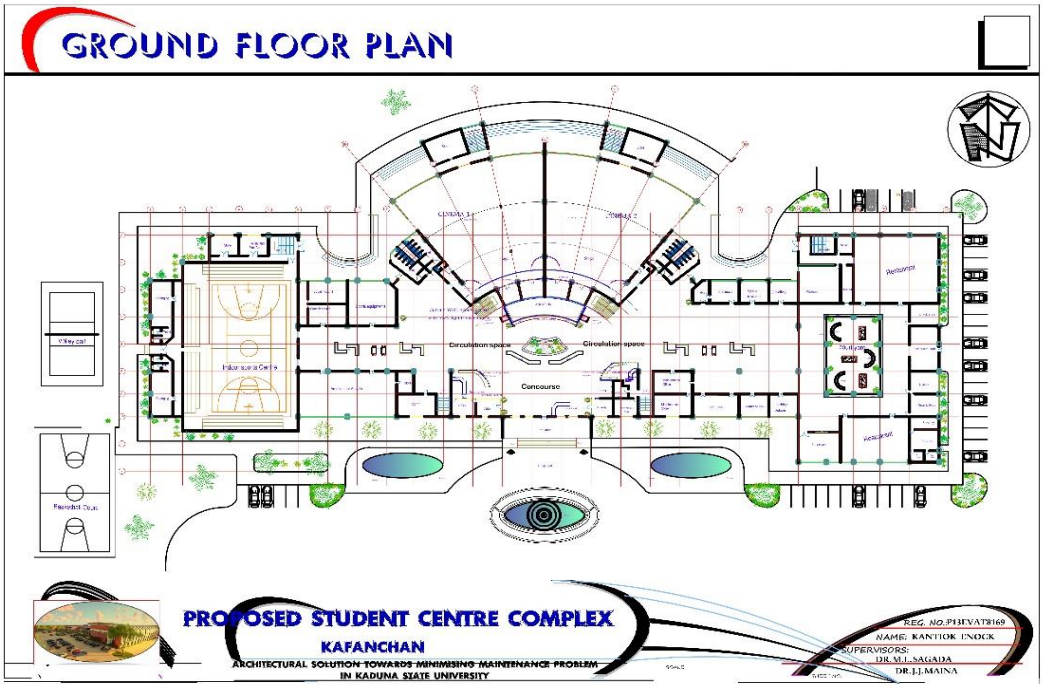
Dr. M.D. Ahmed
HEAD OF DEPARTMENT

FACULTY OF ENVIRONMENTAL DESIGN
DEPARTMENT OF ARCHITECTURE

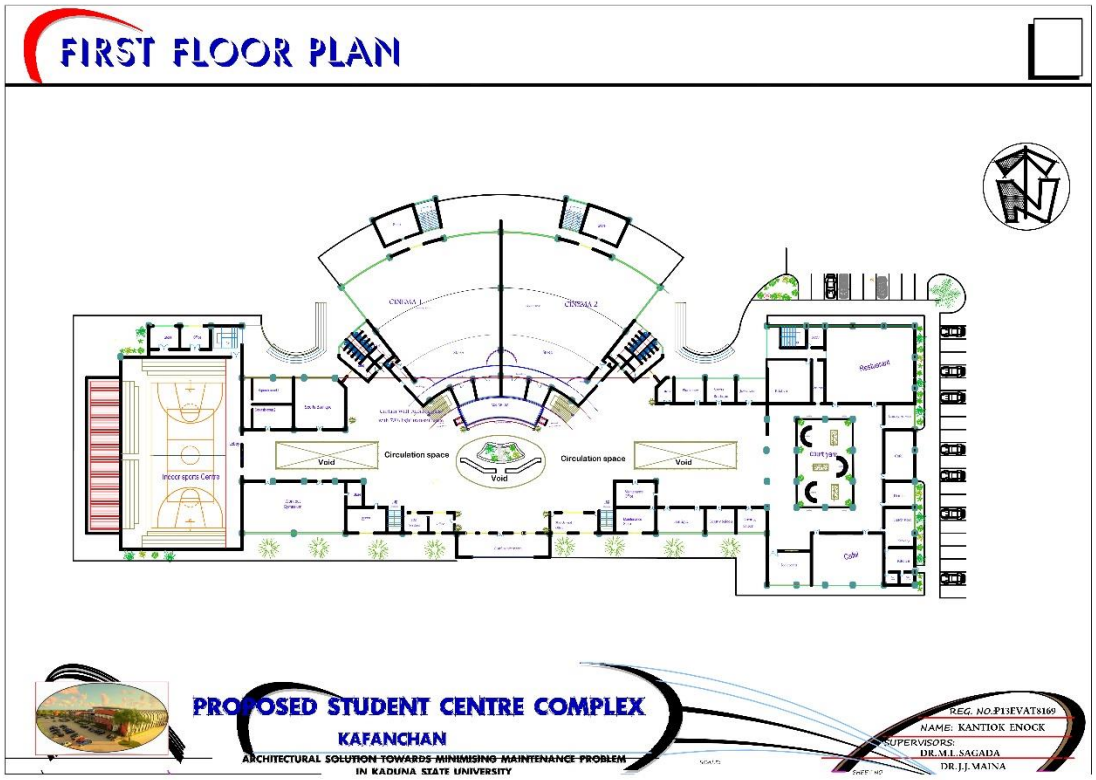
Appendix F: Site Plan



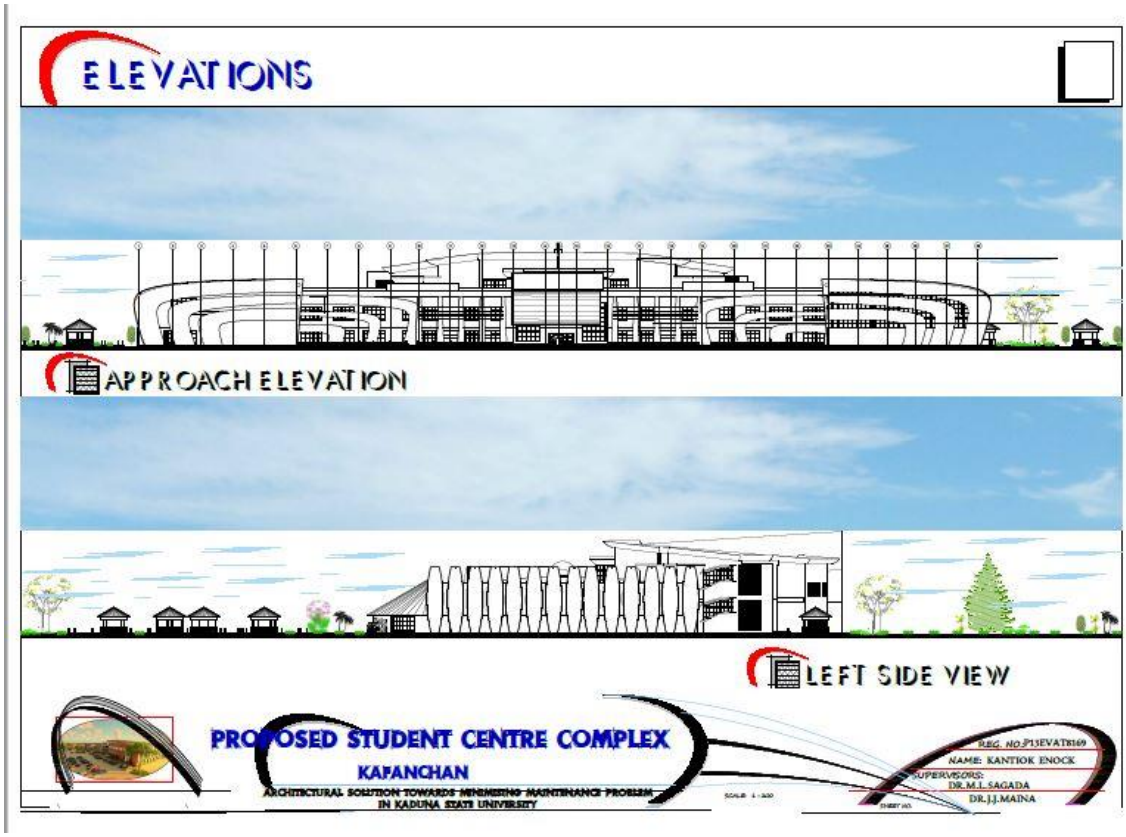
Appendix G: Ground Floor Plan



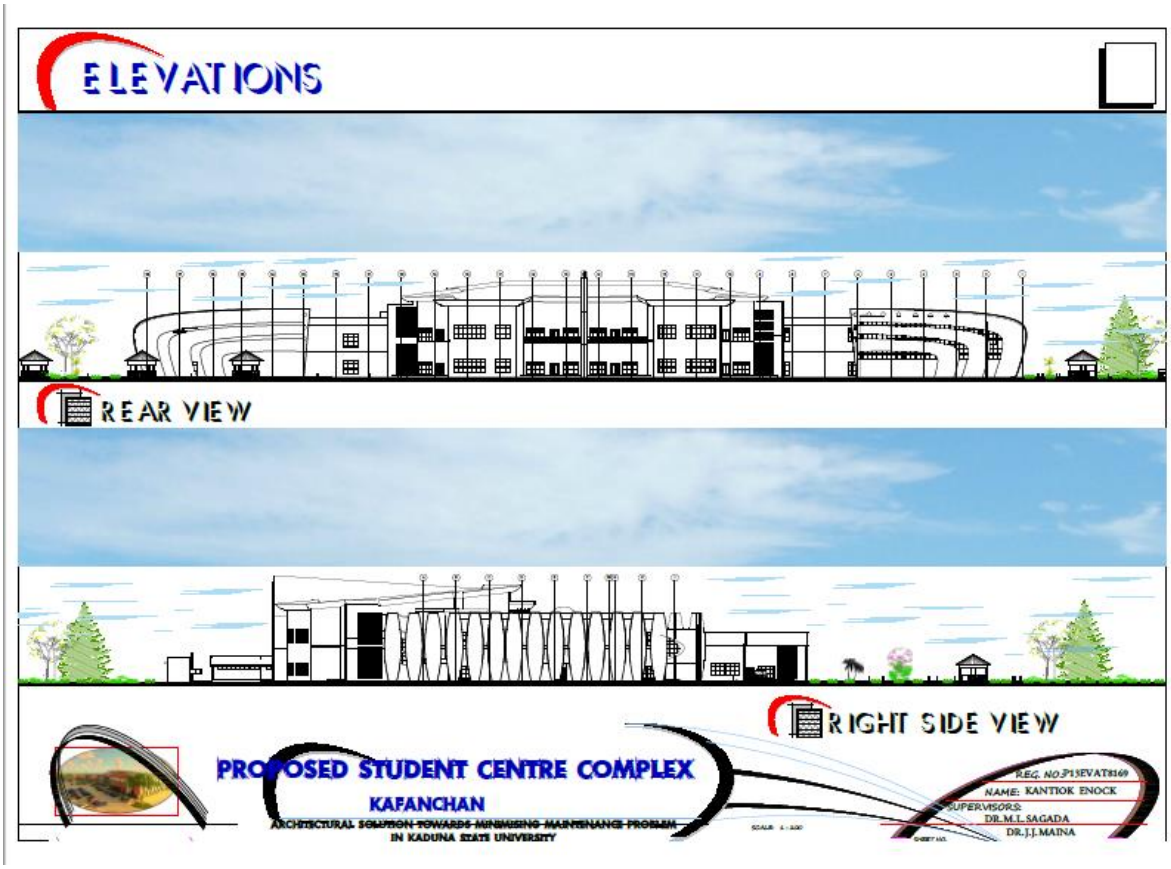
Appendix H: First Floor Plan



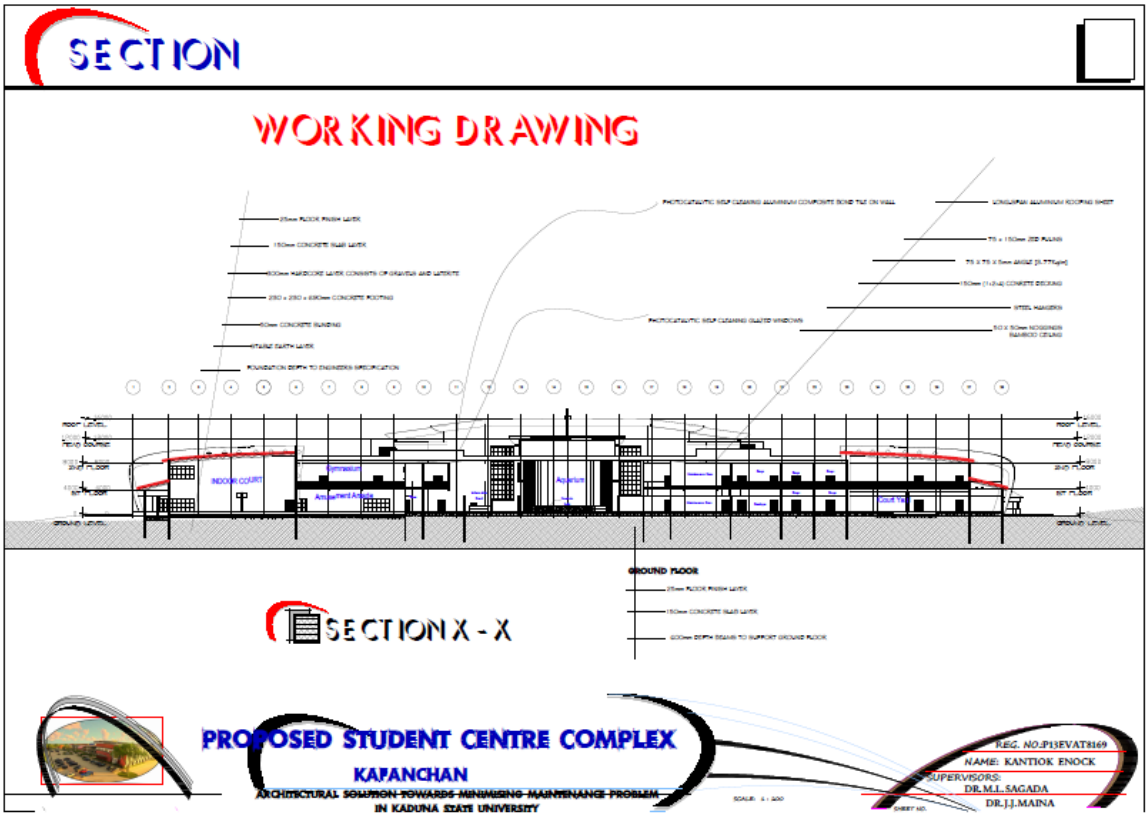
Appendix I: ELEVATION



Appendix J: First Floor Plan



Appendix K: First Floor Plan



Appendix L: Approach View



Appendix M: Arial Perspective View



Appendix N: Side Perspective View



Appendix O: Outdoor Perspective View

