Sustainable Design Principles in the Design of Office Complex

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Certification

This is to certify that, Aliu Ayobami HUSSAIN with matriculation number LCU/PG/002752 carried out this research work titled 'Sustainable Design Principles in The Design of Office Complex.' in the department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, Oyo State, for the award of Master Degree in Architecture. The thesis is an outcome of an independent and original work. I have duly acknowledged all the sources from which the ideas and the extracts have been taken. The project is free from any plagiarism and has not been previously submitted.

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(Head of Department)

Dedication

I dedicate this research work to Almighty God and my loving family.

Acknowledgement

My sincere and profound greeting goes first to almighty God for seeing me through right from the beginning of this program till this moment and given me the knowledge, wisdom and understanding in my research. Your wonderful name will be glorified forever (amen).

My appreciation goes to Lead City University who gave me the platform to engage in this MSc program. I will always be grateful for their guidance, and constructive criticism and for sharing brilliant knowledge with me throughout the duration of the program.

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I want to also acknowledge the assistance and guidance of some highly placed people who have contributed to the successful completion of this project, and others who spared their time to afford me the real life application of classroom theoretical knowledge as part of my project topic, I'm indeed grateful.

Abstract

It is now essential to the creation of office complexes that sustainable design principles are incorporated, as it has become with modern architecture and urban planning. The importance and use of sustainable design principles in office complex projects are discussed in this essay. This study emphasizes the many advantages of sustainable design, including energy efficiency, less environmental impact, and enhanced occupant well-being, by studying numerous case studies and pertinent literature. The application of important sustainable design principles to the development of office complexes is examined, including passive design methods, effective building systems, the integration of renewable energy sources, and responsible material choices. Additionally, the financial benefits of implementing sustainable practices are looked at, with a focus on the higher market value and long-term cost reductions connected to green buildings. According to the study's findings, the application of sustainable design concepts in office buildings promotes environmental responsibility while also fostering the creation of healthier, more productive work environments and a more sustainable future.

This research offers crucial insights and recommendations for architects, developers, and politicians in the development of sustainable and resilient office complex buildings as corporations and governments prioritize environmental stewardship and human-centric design.

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Chapter One

Introduction

1.1 Background to the Study

Architecture is the art and science of designing and superintending buildings. The need for appropriate space, for specific activity in any given design must be taken into consideration (Spenser, Robert, Eunkyu, & Andrew, 2016).Administration involves the performances, management of a business operations, decision making as well as the efficient organization of people and other resources to direct activities towards common goals and activities.(Akhimienetal.2018). According to Perez-Lombardo et al., (2008), the administrative body is the chief academic organ of every university or college. It is a governing body in all universities and colleges, and is typically the supreme academic authority for all institution. The administrative building serves as the administrative center of all institution. The major function of the building is to encourage better relationship between members of staff, students and visitors. The building serves as office to all principal officers of the school and the supporting administrative staff. The Administrative building also serves as the center where major decisions that concern the institution are taken. Matters of academic character which affect the school as a whole, the development of the institution, the decision making process, approval of all program of study, publishing of the school calendars, decisions on conduct of examinations, awards and terms of fellowships, operating budget of the institution, building and other capital facilities required by the school, establishment of policy governing the central academic services of the institution, are issues deliberated on at the administrative chambers. The administrative is made up of a small group of individuals. This group of individuals forms normative organizational structure through which schools exercise their role in college and university governance (Perez-Lombard, 2008; Brown, 2010; Mu'azu, 2012). They are needed to deal with the full range of academic and administrative matters, they plan programme which spring from the basic mission of the institution; they also plan specific objectives for each of those programme. Units and levels involved in the planning process of an institution depend entirely upon the administrative structure of the institution. The administrative building can be in the form of a bureaucracy, collegiums or a political system. Although, school governance consequently cannot be fully democratic, some of the principles and structures of democracy appropriately modified played a major role in the governing of the school. The identification of the senate's role in decision making and the emphasis upon goal-setting, resource allocation, and evaluation suggest an implicit view of the admin as an integral part of a hierarchical, rational organization (bureaucracy). As a political system, the admin are seen as a forum for the articulation of interests and as the setting in which decisions on institutional policies and goals are reached through compromise, negotiation, and the forming of coalitions. An office is generally a room or other area where administrative work is done, but may also denote a position within an organization with specific duties attached to it (see officer, office-holder, and official); the latter is in fact an earlier usage, office as place originally referring to the location of one's duty.

The office complex, an iconic edifice that has always beautify the skyline of cities, office complexes are great varieties of structures that plays a prominent role in the economic growth of urban centers, (Francis 1997). This means anything from a two-storey suburban building to a 100-storey urban high-rise. The building may be constructed purely on speculation, to house whatever tenants choose to locate in it, or it may be built to suit the specific needs of a corporate headquarters. Whatever its size or type, the office complex is a complex building type and is affected by many forces. It's most important role to provide accommodation for tenants, visitors and equipment, at same time facilitating office activities, however, its design greatly affects their performance, (Stewart 1994). The number of individuals and firms involved in the design of a speculative or corporate office complex is significant. Obviously, office complex is driven by user type, such as investment banks, professional firms, or high-tech companies (Stewart 1994). The needs of these users normally dictate the floor size, concept and marketable location of the building. The need for office complexes to have more flexible spaces, adaptable office equipment and materials, built in services etc. is beginning to be a standard practice in the tropics and in developing countries since electricity might not be constant and sufficient to run most office buildings. Therefore, the need to make office complex design environmentally friendly is highly emphasized with the provision of alternate lightening solutions, proper ventilation system in buildings in case of power outage, incorporating open-office plans for increased office space flexibility. (Zhang, Athalye, Hart, Rosenberg, Xie, Goel, Mendon, and Liu 2013). An office is generally a room or other area where administrative work is done, but may also denote a position within an organization with specific duties attached to it, office as place originally referring to the location of one's duty, (Long 2004). When used as an adjective, the term "office" may refer to business-related tasks. In legal writing, a company or organization has offices in any place that it has an official presence, even if that presence consists of, for example, a storage-silo rather than an office. An office is an architectural and design phenomenon; whether it is a small office such as a bench in the corner of a small business of extremely small size, through entire floors of buildings and including massive buildings dedicated entirely to one company. In modern terms an office usually refers to the location where white-collar workers are employed. James (2012), a business administrator, defines office is that part of business enterprise which is devoted to the direction and coordination of its various activities. Offices in classical antiquity were often part of a palace complex or a large temple, the High Middle Ages (1000–1300) saw the rise of the medieval chancery, which was usually the place where most government letters were written and where laws were copied in the administration of a kingdom, (Hamilton 2011). With the growth of large, complex organizations in the 18th century, the first purpose-built office spaces were constructed. As the Industrial Revolution intensified in the 18th and 19th centuries, the industries of banking, rail, insurance, retail, petroleum, and telegraphy dramatically grew, and a large number of clerks were needed, and as a result more office space was required to house these activities. The time and motion study, pioneered in manufacturing by F. W. Taylor led to the "Modern Efficiency Desk" with a flat top and drawers below, designed to allow managers an easy view of the workers. However, by the midpoint of the 20th century, it became apparent that an efficient office required discretion in the control of privacy, and gradually the cubicle system evolved, (Eugene and Paul 2002). The main purpose of an office environment is to support its occupants in performing their job. Work spaces in an office are typically used for conventional office activities such as reading, writing and computer work. There are nine generic types of work space, each supporting different activities, (Cheshire and Hilber (2008). In addition to individual cubicles, there are also meeting rooms, lounges, and spaces for support activities, such as photocopying and filing. Some offices also have a kitchen area where workers can make their lunches. There are many different ways of arranging the space in an office and whilst these vary according to function, managerial fashions and the culture of specific companies can be even more important. While offices can be built in almost any location and in almost any building, some modern requirements for offices make this more difficult, such as requirements for light, networking, and security. The primary purpose of an office complex is to provide a workplace and working environment primarily for administrative and managerial workers, (Juriaan and Hermen 2010). These workers usually occupy set areas within the office building, and usually are provided with desks, PCs and other equipment they may need within these areas. Therefore, this project centers on integrating the natural environment as a major element influencing the design of office complexes, it will also explore alternate ways of achieving safety, sustainability, adaptability and comfort in office complexes at the lowest possible cost.

1.2 Statement of Problem

Sustainable development and its larger connections to the environment have made the problem of energy use in buildings a focal point of global discourse. Multiple studies (Perez-Lombard, 2008; Brown, 2010; Mu'azu, 2012). One major and common problem in office complexes is minimized energy efficiency in the building which is a major design consideration for office buildings which is now a global problem, mostly in developing nations like Nigeria. It has been discovered that when there is power outage in these office complexes, office activities are at a standstill due to inadequate consideration at the design stage in the use of natural lighting and ventilation (tropical Architecture) (Zhang et al 2015) thus this project seek to discover best practices on how to utilize these natural elements in order to achieve an office complex design that blends with our environment and adapt to its natural features. (UNEP, 2022).

1.3 Aim and Objectives

The research aim is to explore the sustainability design principles suitable for office complex buildings.

The objectives of this research are to:

1. To identify architectural design elements influencing sustainability of office complex buildings.
2. To examine how architectural design elements can be manipulated to promote sustainability of office buildings in Nigeria.
3. To propose a design of a sustainable office complex/administrative building for Federal College of Education, Ekiadolor, Benin City taking into consideration modern technology and building materials to conform to modern day requirement.

1.4 Research Questions

This research intends to answer the following questions:

1. How do architectural design elements influence the sustainability?
2. How can architectural design elements be used in the design of an office buildings to promote sustainability?
3. To produce a design of a sustainable office complex

1.4 Significance of Study

Recent architectural publications are focused on office design and space planning with emphasis on contemporary furniture in office complexes, but mention very little on sustainable concept in the overall aspects of office design and influences. Sustainable development in office design appears to be ignored. Designers are most concerned with the most expensive devices for heating and refrigeration, although there are exceptions where architects and engineers do consider sustainability in construction and design, but more in residential and commercial buildings, but a few on office buildings.

This paper will focus on the study and analysis of the sustainable office complex design, in the term of research, the innovation planning, construction methods and renewable energy sources used in Nigeria, to assess what level the office building in Nigeria is, how the office complex in Nigeria is developing, and what changes will need to be considered.

1.5 Scope of Project

A careful study of early building design technology around the globe will be compared with contemporary designs using case studies from existing office buildings, then explore the various office buildings as it relates to sustainability and the ability of these buildings to adapt in times of power outage which will also stop the air-conditionals from working and retard visibility. Information gathered from case studies in descriptive analysis and also carry out investigations on safety measures that needs to be incorporated in office buildings. An overview of existing office buildings will be conducted, gathering important information about the technology adopted in the sustainability and adaptability of the building. Useful literature materials such as books, magazines, journals and the internet will also be very instrumental and will be consulted in the course of the research work.

1.6 Definition of Terms

An operational definition of term id the definition of variables in terms of the operations or techniques used to measure or manipulate it. The following are the terms used:

i. Sustainability: the ability to maintain and preserve the ecological balance and usability of something, in this context it is the ability for an office building to be maintained at little or no cost. Microsoft Encarta (2009). It can also be referred as the use of the ecological environment to continue the existence of the office building.

ii. Sustainable Design: Sustainable design seeks to reduce negative impacts on the environment, and the health and comfort of building occupants, thereby improving building performance. The basic objectives of sustainability are to reduce consumption of non-renewable resources, minimize waste, and create healthy, productive environments. Utilizing a sustainable design philosophy encourages decisions at each phase of the design process that will reduce negative impacts on the environment and the health of the occupants, without compromising the bottom line. It is an integrated, holistic approach that encourages compromise and tradeoffs.

iii. Design principles: The principles of design are the rules a designer must follow to create an effective and attractive composition. The fundamental principles of design are: Emphasis, Balance and Alignment, Contrast, Repetition, Proportion, Movement and Unity.

iv. Office complex: In common vernacular, an office complex is simply a place where people collectively perform office work in location that exceeds the scope of one small office complex maybe one storey or multistorey.

Chapter Two

Literature Review

2.1 Conceptual Review

An office is generally a room or other area where administrative work is carried out, but may also denote a position within an organization with specific duties attached to it, office as place originally referring to the location of one's duty, ((Long (2004). When used as an adjective, the term "office" may refer to business-related tasks. In legal writing, a company or organization has offices in any place that it has an official presence, even if that presence consists of, for example, a storage-silo rather than an office. An office is an architectural and design phenomenon; whether it is a small office such as a bench in the corner of a small business of extremely small size, through entire floors of buildings and including massive buildings dedicated entirely to one company. In modern terms an office usually refers to the location where white-collar workers are employed. (James (2012), a Business Administrator, defines office is that part of business enterprise which is devoted to the direction and co-ordination of its various activities. The main purpose of an office environment is to support its occupants in performing their job.

While offices can be built in almost any location and in almost any building, some modern requirements for offices make this more difficult. These requirements can be both legal (e.g. light levels must be sufficient) or technical (e.g. requirements for computer networking). Alongside, other requirements such as security and flexibility of layout, has led to the creation of special buildings which are dedicated only or primarily for use as offices. ((Ghillyer (2012). An office building, also known as an office block or business center is a form of commercial building which contains spaces mainly designed to be used for offices. The primary purpose of an office building is to provide a workplace and working environment primarily for administrative and managerial workers. These workers usually occupy set areas within the office building, and usually are provided with desks, Personal Computers and other equipment they may need within these areas. An office building will be divided into sections for different companies or may be dedicated to one company. In either case, each company will typically have a reception area, one or several meeting rooms, singular or open-plan offices, as well as toilets. ((Richard (2006).

There are many different ways of arranging the space in an office and whilst these vary according to function, managerial fashions and the culture of specific companies can be even more important. Choices include, how many people will work within the same room. At one extreme, each individual worker will have their own room; at the other extreme a large open plan office can be made up of one main room with tens or hundreds of people working in the same space. Open plan offices put multiple workers together in the same space, and some studies have shown that they can improve short term productivity, i.e. within a single software project. At the same time, the loss of privacy and security can increase the incidence of theft and loss of company secrets. A type of compromise between open plan and individual rooms is provided by the cubicle desk, possibly made most famous by the Dilbert cartoon series, which solves visual privacy to some extent, but often fails on acoustic separation and security. Most cubicles also require the occupant to sit with their back towards anyone who might be approaching; workers in walled offices almost always try to position their normal work seats and desks so that they can see someone entering, and in some instances, install tiny mirrors on things such as computer monitors. ((Richard (2006).

2.1.1 New Office Space Requirement in Nigeria

New office space requirements increased by 29 per cent in second quarter of 2021 compared to first quarter in Nigeria and other Africa countries, according to Knight Frank. This increased office market activity has been attributed to the 'flight to quality' trend that has seen businesses taking advantage of weakened prime office rents to occupy office spaces that place employee wellbeing at the forefront. Data from Knight Frank indicates that the share of new office space requirements across the nine countries that are located in Africa was dominated by professional services (29 per cent), Industrial and Logistics (16 per cent), financial services (14 per cent), healthcare 12 per cent and Non-governmental organisation (NGOs) (8 per cent), who together accounted for almost 80 per cent of new office space requirements across Africa. The countries are Kenya, Uganda, Tanzania, Zambia, Zimbabwe, Malawi, Botswana, South Africa and Nigeria. (Lechner, 1991; Izzet and Tülay, 2019).

Knight Frank also observed that businesses that had previously put office requirements on hold due to the pandemic were reactivating their searches with landlords becoming more flexible by allowing for discounted rents and lease concessions such as increased rent-free periods in a bid to attract and retain tenants (Izzet & Tülay, 2019). Nigeria recorded increased occupier activity in the market driven by office relocations from the Central Business District (CBD) to the suburbs, as occupiers gravitated to locations offering both better quality accommodation, as well as more affordable lease rates. Nigeria has since resumed business as usual due to the economy being highly dependent on labor. Although, the Pandemic led to a lot of organizations closing up, it also let to new organizations being established, especially tech and logistics companies. There was a shift in the perception of shared office space hence, an increase in the demand. There was also an increase in residential property development including workstations and study rooms.

In Nigeria occupiers remain focused on occupying best-in-class offices that offer greater flexibility around lease terms. The trend presents a real opportunity for landlords of slightly older buildings to refurbish their buildings to a new, modern standard which can compete effectively for tenants looking for high quality office (International Energy Agency IEA, 2015).

2.1.2 History of Sustainable Office Building

It has been over 40 years, when the petroleum crisis of 1973 occurred. In developed countries, sustainable architecture has passed 3 phases. At the beginning, it was called "energy efficiency buildings", then it became "energy conservation in buildings", which means reducing the energy release in the building. Recently, it has evolvedto "energy saving in buildings". It is to say, the energy has not been saved negatively, but has been actively improving efficiency. In China, it was called "building energy saving", and it is now at the third of the stated phase. Sustainable development is a recent trend. Responsible architecture must take into account energy and ecology environment. In office building design, green design and sustainable code have become more and more popular and important. The architects' aim is reasonable and effectively using energy (UNEP, 2022).

However, sustainable office design may also have some problems, during its development in some countries. Architects pay little attention in the past to the sustainable development of buildings. They are only working to achieve their design targets, ignoring sustainable principles. In the broadest scene, design just meets the client's needs for good office use, but neglects the needs of offices and furniture generations. It does not consider the more protection of the environment, and a rational balance of the use of natural resources.

2.1.3 The Concept of Sustainable Building

'Sustainability' is not considered as a new concept as it was used since the 1970's (Grevelman & Kluiwstra, 2010) even though the practice during the time was still largely hold a preservationist philosophy. The concept only had gained global political recognition since it was introduced by the Brundtland Report titled 'Our Common Future' in 1987 at the United Nation Conference on Environment and Development (Lowe & Zhou, 2003). The report was the first which focuses on global sustainability which explicitly addressed the links between social, economic and environmental dimensions of development and sustainability towards devising a new development model, that of 'sustainable development'. Since then, many progressive world events had taken place to increase the sustainability agendas. Some of the sustainability key documents that have been produced in order to realize the agenda are ((Agenda 21 (1992), The Rio Declaration on Environment and Development (1992), The United Nations Framework on Climate Change (1992) and its Kyoto Protocol (1997), The Millennium Declaration (2000) and The Johannesburg Plan of Implementation (2002).)

The concept of sustainability is a non-rigid doctrine. The term and concept of sustainability are actively redesigned for the specific purpose at any given time and context. In construction industry, a variety of sustainable based concepts are used such as sustainable and green building, sustainable and green construction and sustainable and green project management and so on. The fact shows that the words green and sustainable are often used synonymously and interchangeably. However, according to the Bruntdland Report published in 1987, sustainable means 'meeting the needs of the present generation without compromising the needs of future generations' (WCED, 1987). Due to flexible nature of the concept, many definitions currently exist for the term 'sustainable' and 'sustainable development' which most of them have been extended to be based upon the three pillars of 'triple bottom line' concept that developed in 1997 by John Elkington (Edward, 1998; Grevelman&Kluiwstra, 2010; Larsen, 2009; Magis& Shinn, 2009; Popea et al., 2004). Summing up the arguments, sustainable building is considered as an approach for the building industry to move towards sustainable development by taking into account environmental, social and economic issues (Akadiri et al, 2012). On the other hand, green building is meant to be a building that exhibits energy efficiency, resource depletion, impact on environment and protection of health and environment (Beatley, 2008; Lutzkendoft& Lorenz, 2006).

Most published works relating to the concept of sustainable building, however undeniably was influenced by the initial concept of sustainability which are about limited resources and to reduce impact to the natural environment with emphasis on the technical issues such as materials, building components, construction technologies and energy related design concepts (Md Darus et al., 2009; Zainul Abidin, 2009). This concept is seen to be inclined by the Bruntdland's definition in 1987. For instance, ((Kibert (2005) highlighted that the practice of sustainable building refers to the creation and operation of a healthy built environment based on resource efficiency and ecological design with an emphasis on seven core principles across the building life cycle which are,

1) Reducing resource consumption,

2) Reusing resources,

3) Using recyclable resources,

4) Protecting nature,

5) Eliminating toxics,

6) Applying life cycle costing, and

7) Focusing on quality.

It was noticed that the definitions are imbalanced which tend to focus more on environmental measure which is regularly called as 'green building' while the other sustainable development measures have been relatively forgotten. Added to that, much attention has been given on green design and green construction rather than on the complete project life cycle (Wu & Low, 2010).

Various techniques and methodologies exist to measure the sustainability principles of building including BPASs. Even though the BPASs are skewed towards green measures, they were developed to assist the delivery of buildings that better suited to their physical settings and that impact positively towards sustainability (Kaatz et al, 2006). Some BPASs only consider very specific aspects of building performance such as energy usage (for example Energy Star), materials used or waste generated during construction or operation. Others try to take a broader view, through a set of design and operational criteria. For commercial building for instance, the two most commonly used criteria are BREEAM and LEED (CBRE, 2009). The development of assessment system for buildings (BPASs) has its origin in the 1990s as this was the year when the first BPAS, the BREEAM was introduced. Following the launch of BREEAM, many other BPASs were developed around the world. (Cole (2006) stated that the BREEAM has become the source of many succeeding methods which many of them have similar roots such as LEED (United States), Green Star (Australia) and HK-BEAM (Hong Kong). However, most of them are actually covering a range of schemes for assessing environmental performance of buildings (CBRE, 2009; Cole, 2006; Du Plessis, 2005; Kaatz et. al, 2005; Todd et al, 2001). The BPASs are generally having similar categories such as energy, indoor environmental quality, site and waste management, water, building materials and innovations, even the number of criteria categorized under each category varies. Different systems also often categorized similar criteria under different category. BPASs which address several non-environmental issues such as proper location and accessibility are also relate to the basic environmental concern. Very few BPASs address purely non-environmental issues such as health and safety, creating job for local people, excellent labour practices, economic aspects or others.

The definition of sustainable building should go far beyond the environmental aspect according to (Adler et al. (2006). In accordance with the three aspects of sustainable development, which are economic, social and environmental, sustainable buildings can benefit human well-being, community, environmental health and life cycle costs. Fortunately, nowadays the significance of the non-technical issues such as economic, social and cultural aspects have been emphasized gradually (DETR, 2000; Zainul Abidin, 2009). This practice is not only to help the environment but also improves economic profitability and relationships with stakeholder groups or in other words, it can be benefited to both; the economic and social aspects. (Akadiri et al (2012) and, (Hill and Bowen (1997) added that sustainable building is consisting of four principles; social, economic, biophysical and technical. Sustainable building also is about the integration of sustainable development considerations throughout the whole life of building process (Gething &Bordass, 2006; Yudelson, 2009).

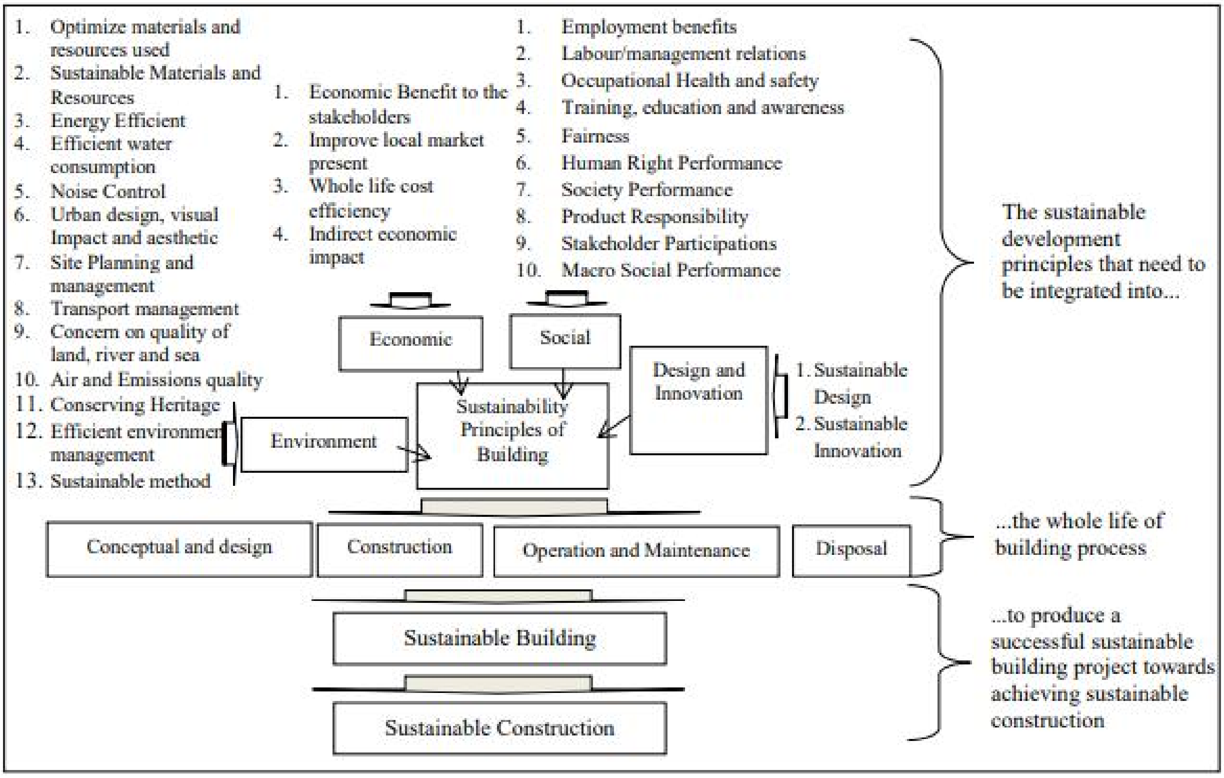


Figure 1: *A theoretical framework of sustainability principles of building*

2.2 Design Considerations

2.2.1 Principles of Sustainable Designs for Buildings

Sustainable design seeks to reduce negative impacts on the environment, and the health and comfort of building occupants, thereby improving building performance (Izzet & Tülay, 2019).. The basic objectives of sustainability are to reduce consumption of non-renewable resources, minimize waste, and create healthy, productive environments. Design and construction of buildings and related infrastructure create major direct and indirect impacts on the environment. For example, in the United States, buildings:

- consume 39% of total energy use

- consume 12% of total water consumption

- consume 68% of total electricity consumption

- cause 38% of carbon dioxide emissions.

In recognition of this growing issue the concept of "sustainable design" has arisen in recent years. Unfortunately this approach is frequently described as "integrated" or "synergistic" or "holistic" or similar terms that are not particularly definitive. Utilizing a sustainable design philosophy encourages decisions at each phase of the design process that will reduce negative impacts on the environment and the health of the occupants, without compromising the bottom line (Izzet & Tülay, 2019). It is an approach that encourages compromise and tradeoffs. Such an approach positively impacts all phases of a building's life-cycle, including design, construction, operation and decommissioning.

Government agencies at all levels as well as increasing numbers of private companies are committed to incorporating principles of sustainable design and energy efficiency into all of its building projects. The result is an optimal balance of cost, environmental, societal and human benefits while meeting the mission and function of the intended facility. Sustainable design should ideally be incorporated as seamlessly as possible into the existing design and construction process.

Principles are the road map of sustainable design. Opportunities are things that may be done to optimize a specific project in recognition of one of the Principles. Resources are published manuals, guides and data bases that are available to assist in optimizing implementation of an opportunity.

2.2.1.1 The six principles of Sustainable Design

There are six principles of sustainable design

i. Optimization of site potential

ii. Optimizing energy use

iii. Protection and conservation of water

iv. Selection and use of environmentally preferable products

v. Enhancement of indoor environmental quality

vi. Optimization of operations and maintenance practices

i. Optimization of Site Potential

Creating sustainable buildings starts with proper site selection, including consideration of the reuse or rehabilitation of existing buildings. The location, orientation, and landscaping of a building affect the local ecosystems, transportation methods, and energy use. Siting for physical security has become a critical issue in optimizing site design. The location of access roads, parking, vehicle barriers, and perimeter lighting must be integrated into the design along with sustainable site considerations.

Opportunities

Sustainable site planning should seek to minimize development of open space by the selection of disturbed land or building retrofits; control erosion; reduce heat islands; minimize habitat disturbance; restore the health of degraded sites; incorporate transportation solutions; and consider site security concurrently with sustainable site issues. Here are some opportunities that should be considered in order to sustainably optimize site potential:

Minimize Development of Open Space

• Renovate and/or expand an existing building

• Use previously disturbed land

Control Erosion through Landscaping Practices

• Use vegetation, grading and soil stabilization measures to minimize erosion

• Capture and retain storm water runoff on site and incorporate retention features such as pervious pavement in project design

• Reduce runoff of site using vegetated swales and depressions

Consider Energy Implications in Site Selection and Building Orientation

• Site buildings to maximize opportunities for use of active and passive solar systems

• Take advantage of natural ventilation

• Optimize daylighting opportunities

• Examine the potential impacts future development adjacent to the site may have on opportunities such as solar systems and daylighting

Use Building Design and Landscaping Techniques to Reduce Heat Islands

• Use new and existing trees to shade parking lots, walkways and other open areas

• In warm, sunny climates consider covering parking lots, walkways and other areas that are paved or constructed with low reflective materials

• Use roofing systems with a top layer of light colored and/or high reflectance and high emissivity material to reduce cooling load

• Use roofing products that meet or exceed Energy Star standards

Minimize Habitat Disturbance

• Minimize land disturbance and retain prime vegetation to the extent possible

• Reduce building and paving footprints

• Minimize disturbance of site around building perimeter, such as by locating it closer to existing utilities

• In cold climates, site parking lots and walkways so they have sun exposure to assist in melting snow

• In cold climates, use ice and snow removal methods that are non-toxic

Restore Degraded Sites

• Minimize land disturbance and retain prime vegetation

• Optimize utilization of native and drought-resistant plants

Design for Sustainable Transportation

• Site the building to coordinate with public transportation systems

• Use porous paving materials where practicable

• Reduce on-site parking to encourage use of public transit

• Incorporate features to encourage bicycling, carpooling, walking

• Provide refueling/recharging facilities for alternative energy vehicles

Coordinate Site Sustainability with Safety and Security

• For example, site features such as retention ponds and berms can also limit access to a building

• Existing and new trees and vegetation can conceal buildings and people for security reasons

ii. Optimizing Energy Use

Improving the energy performance of existing buildings is important to increasing energy independence. Operating net zero energy buildings is one way to significantly reduce dependence on fossil fuel-derived energy. On an annual basis, buildings in the United States consume 39% of America's energy and 68% of its electricity. They generate 38% of the carbon dioxide, 49% of the sulfur dioxide, and 25% of the nitrogen oxides found in the air. The vast majority of this energy is produced from nonrenewable, fossil fuel resources. With America's supply of fossil fuel dwindling, concerns for energy supply security increasing, and the impact of greenhouse gases on world climate rising, it is essential to find ways to reduce load, increase efficiency, and utilize renewable fuel resources in federal facilities Geissler et al. (2018).

Opportunities

During the facility design and development process, building projects must seek to reduce heating, cooling, and lighting loads through climate-responsive design and conservation practices; employ renewable energy sources; specify equipment and systems that consider part-load conditions and utility interface requirements; optimize building performance by employing energy modeling programs and optimize system control strategies; and monitor building performance through metering and reporting. Here are some opportunities that should be considered in order to sustainably optimize energy use:

Reduce Cooling, Heating and Lighting Loads by Using Climate Responsive Design and Conservation Practices

- Use passive solar design
- Orient, size and specify windows to maximize energy efficiency
- Use high performance materials in building envelope based on thermal properties and durability
- Locate landscaping with solar energy and building load requirements in mind

Employ High-Efficiency and Renewable Energy Sources

- Solar water heating
- Photovoltaic devices
- Biomass
- Geothermal heat pumps
- Consider purchasing electricity from renewable and low-pollution sources

Specify Efficient HVAC and Lighting Systems

- Specify systems and equipment that meet or exceed 10 CFR 434
- Lighting systems < 1 watt/SF
- Energy Star approved products, exceed DOE standards

• Consider energy recovery systems

• Consider co-generation, fuel cells, thermal storage, etc.

Optimize Building Performance and System Control Strategies

• Employ energy modeling programs early in design process

• Use sensors to control systems based on occupancy, schedule, daylight and natural ventilation

• Evaluate use of modular components such as boiler, chillers, etc. to optimize part-load efficiency

• Use smart controls and building automation systems

Monitor Project Performance

• Use a building commissioning plan extension throughout life of the project

• Use metering to confirm building energy and environmental performance throughout life of the project.

iii. Protection and Conservation of Water

Freshwater resources are increasingly becoming a scarcity. A sustainable building design and construction is one that uses water efficiently to minimize the impact that affects freshwater stock. In the U.S. expenditures for water and sewer are billions of dollars annually. Reducing water consumption and protecting water quality are key objectives of sustainable design. This is critical because consumption of water in many areas of the country exceeds the ability of the supplying aquifer to replenish itself. To the maximum extent feasible, facilities should increase their dependence on water that is collected, used, purified, and reused on-site.

Opportunities

The protection and conservation of water must be considered throughout the life of the building, and federal agencies must seek to reduce, control, and treat surface runoff; use water efficiently; improve water quality; recover non-sewage and gray water for on-site use; and establish waste treatment and recycling centers; and apply best management practices to conserve water. Here are some opportunities to protect and conserve water that should be considered:

Reduce, Control, Treat Surface Runoff

• Use vegetated swales and depressions to reduce runoff

• Reduce and filter surface runoff

• Use integrated pest management to reduce water pollution from pesticides

• Consider incorporating green roofs into project

• Consider transient storm water events in the overall management of surface water runoff (such as use of retention and groundwater recharge basins

• Use EPA's Green Infrastructure guidelines

Use Water Efficiently

• Incorporate efficiency in construction specifications

• Use ultra-water efficient plumbing fixtures and integrate other water saving devices into building

• Landscape with drought resistant native plants

• Meter water usage

• Install water-conserving water towers with delimiters to reduce evaporation and drift

• Eliminate leaks by caulking around pipes and plumbing fixtures and conducting annual checks of hoses and pipes

• Specify EPA Water Sense labeled water-efficient products Protect Water Quality

• Install water quality ponds or oil/grit separators as part of runoff filtration system

• Eliminate materials can release lead pollutants

• Use non-toxic cleaning products

Recover Non-Sewage and Greywater for On-Site Use

• Use non-sewage waste water for on-site landscape irrigation, where approved by local officials

• Use groundwater and roof drainage water for on-site uses

• Use groundwater from sump pumps

Design Waste Treatment and Recycling Programs

• Use biological waste treatment systems to treat waste on-site

• Treat grey water, ground water and roof water to an acceptable standard for re-use of site

iv. Selection and Use of Environmentally Preferable Products

The composition of materials used in a building is a major factor in its life-cycle environmental impact. Facilities must use environmentally preferable of and processes that do not pollute or unnecessarily contribute to the waste stream, do not adversely affect health, and do not deplete limited natural resources. As the growing global economy expands the demand for raw materials, it is no longer sensible to throw away much of what we consider construction waste. Using a "cradle-to-cradle" approach, the "waste" from one generation can become the "raw material" of the next.

Opportunities

During the facility design and development process, building projects must have a comprehensive perspective that seeks to renovate existing facilities, products, and equipment whenever possible; evaluate the environmental prefer ability of products using the cradle-to-cradle approach; maximize the recycled content of all new materials, especially from a post-consumer perspective; specify materials harvested on a sustained yield basis such as lumber from certified forests; encourage the use of recyclable assemblies and products that can be easily "de-constructed" at the end of their useful lives; limit construction debris, encourage the separation of waste streams, and encourage recycling during the construction process; eliminate the use of materials that pollute or are toxic during their manufacture, use, or reuse; and give preference to locally produced products and other products with low embodied energy content. Here are some opportunities that should be considered in order to optimize use of environmentally preferable products and methods.

Renovate Existing Facilities, Products and Equipment

• Evaluate renovation and/or expansion of an existing building instead of constructing a new building

• Use reconditioned products, furniture and equipment whenever economically practical and resource efficient

• Consider reusing components of an existing building (such as windows, doors, etc.) in construction of a new building or renovation of an existing one

Evaluate Environmental Preferability Using Life Cycle Assessment (LCA) Tools

• Consider trade-offs among multiple environmental impacts (resource depletion, global warming, etc.)

• Utilize LCA tools such as ATHENA and BEES

• Consider trade-offs among life-cycle stages (raw materials acquisition, manufacturing, transportation, installation, use and waste management)

• Consider USDA Bio based Products

Maximize the Recycled Content of All New Materials

• Use EPA-designated recycled content products

• Purchase products described in EPA's Environmentally Preferable Purchasing Program

• Consider environmental factors along with price and performance in purchasing decisions (the "EPP "process)

• Emphasize pollution prevention as part of the purchasing process

• Examine multiple environmental attributes throughout the product life cycle

• Compare environmental impacts when selecting products

• Collect accurate and meaningful information about environmental performance of products

• Evaluate use of materials and products with the highest percentage of recycled content

• Evaluate use of materials and products with low energy content

Specify Materials Harvested on a Sustainable Yield Basis

• Use timber products verified from sustainably managed forests

• Evaluate substitution of bio-based materials or products (such as agricultural fiber sheathing) for inert or non-recycled alternatives

• Specify rapidly renewable materials that regenerate in 10 years or less (such as bamboo, cork, wool and straw)

Encourage the Use of Recyclable Assemblies and Products

• Evaluate the use of demountable or deconstructable products and assemblies

• Establish a waste management plan in cooperation with users to encourage recycling

• Consider providing locations at the project site for organic waste composting

Limit Construction Debris

• Require development and implementation of a plan for sorting construction waste for recycling

• Use products that minimize disposable packaging and storage

• Consider designing a facility for ultimate deconstruction (rather than demolition)

Eliminate the Use of Materials that Pollute or are Toxic during Their Manufacture, Use or Reuse

• Use materials and assemblies with the lowest level of volatile organic compounds (VOCs)

• Eliminate the use of asbestos, lead and PCBs in products and materials

• Eliminate the use of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) as HVAC refrigerants

Eliminate the Use of Materials that Pollute or are Toxic during Their Manufacture, Use or Reuse (continued)

• Consider specification of products and materials whose manufacture does not pollute or create toxic conditions for manufacturing workers

• Avoid ground-level ozone in buildings to protect health of building occupants and prevent damage to vegetation and ecosystems.

Give Preference to Locally Produced Materials with Low Embodied Energy Content

• Consider locally produced products and materials to reduce impacts associated with transportation from remote locales

• Consider the use of products and materials that have minimal embodied energy (energy required for their manufacture, harvest, extraction, transportation, installation and/or use)

v. Enhancement of Indoor Environmental Quality

The indoor environmental quality (IEQ) of a building has a significant impact on occupant health, comfort and productivity. In order to build cost-effective and sustainable buildings it is easy to forget that the ultimate success or failure of a project rests on its indoor environmental quality (IEQ). Employees and occupants are invariably more satisfied and productive in a quality indoor environment. Unfortunately this compelling truth is often lost, for it is simpler to focus on the first-cost of a project than it is to determine the value of increased user productivity and health. With increased interest in sustainability of buildings it is even more difficult to focus on providing a quality indoor environment. Engineers and designers need a renewed appreciation of the importance of providing high-quality, interior environments for all users.

Opportunities

During the facility design and development process, federal projects must have a comprehensive perspective that seeks to facilitate quality IEQ through good design, construction, and operating and maintenance practices; value aesthetic decisions, such as the importance of views and the integration of natural and man-made elements; provide thermal comfort with a maximum degree of personal control over temperature and airflow; supply adequate levels of ventilation and outside air to ensure indoor air quality; prevent airborne bacteria, mold and other fungi through heating, ventilating, airconditioning (HVAC) system designs that are effective at controlling indoor humidity, and building envelope design that prevents the intrusion of moisture; avoid the use of materials high in pollutants, such as volatile organic compounds (VOCs) or toxins; assure acoustic privacy and comfort through the use of sound absorbing material and equipment isolation; control disturbing odors through contaminant isolation and careful selection of cleaning products; create a high performance luminous environment through the careful integration of natural and artificial light sources; and provide quality water. Here are some opportunities that should be considered to enhance indoor environmental quality:

Value Aesthetic Decisions

• In addition to code requirements, appreciate the importance of providing windows in occupied spaces for natural ventilation and view.

• Appreciate the aesthetic dimension of buildings.

Provide Thermal Comfort

• Use ASHRAE Standard 55 -Thermal Environmental Conditions for Human Occupancy as the basis for thermal comfort

• Consider the use of under-floor air distribution using an access-flooring system for flexibility, focused personal comfort control and energy utilization efficiency

• Understand the importance of moisture control in roof and wall assemblies

• Evaluate options and benefits to be derived from specifying high-thermal performance windows.

Supply Adequate Levels of Ventilation and Outside Air

• Design ventilation systems to meet or exceed the requirements of ASHRAE Standard 62 – Ventilation for Acceptable Indoor Air Quality

• Protect key ventilation system components (ducts, etc.) from contamination during construction

• Commission HVAC systems to ensure they perform as designed (CFMs, temperatures, etc.).

• HVAC systems should be installed with filters with Minimum Efficiency Reporting Value (MERV) of 7

Supply Adequate Levels of Ventilation and Outside Air (continued)

• Evaluate thermal efficiencies that can be realized with separate outside and conditioned air distribution systems

• Ensure that outside air intakes are located away from contamination sources such as loading docks, fume exhausts from the building, etc.

• Prevent vehicles from idling near outside air intakes

• Consider installing purge fans at contaminant sources, such as parking garage exist kiosks

Supply Adequate Levels of Ventilation and Outside Air (continued)

• Consider installation of a permanent air quality monitoring system to ensure acceptable air quality levels are maintained ($CO_2 < 1000$ PPM, CO < 2 PPM, etc.)

• Consider building security when locating and designing outside air intakes

• Ensure that air filters are of the proper type and are changed/cleaned on a regular schedule

Prevent Airborne Bacteria, Mold, and Other Fungi

• Ensure HVAC system is designed to control interior humidity at the 1% humidity ratio and mean coincident dry bulb temperature, under both extreme and low load conditions

• Building envelope must contain moisture barriers to prevent moisture infiltration

• Ensure the spore count in interior air is less than that in outdoor air, and should be < 700 spores/m3

Limit Spread of Pathogens

• In hospitals and other facilities at risk of pathogen contamination, ensure proper maintenance procedures are maintained

• In hospitals and other facilities at risk of pathogen contamination, consider designing restrooms without doors (with appropriate access paths and screens to block sightlines from occupied spaces such as corridors, offices and waiting rooms) to reduce chance of acquiring infection

Avoid Use of Materials Containing High Levels of Pollutants

• Limit the use of cleaners, paints, adhesives and sealants containing high levels of volatile organic compounds (VOCs)

• Avoid products such as wall panels, cabinetry and carpet that contain formaldehyde

• In existing buildings where asbestos is present, remove it or contain it (such as by encapsulation) to prevent future exposure

• In areas where radon is a significant presence, include measures to control and mitigate its buildup

Avoid Use of Materials Containing High Levels of Pollutants

• Provide safe and secure storage spaces for cleaning supplies

• If a portion of a building is being renovated, consider isolating it and maintaining a negative pressure in it during construction to dust, fumes and odors disturbing remaining occupants

• Ensure that office equipment does not emit objectionable odors pollutants or noise ‰ Assure Acoustic Privacy and Comfort

• Minimize noise using sound-absorbing materials

• Provide walls, floors and ceilings with high sound loss transmission coefficients

• Consider sound masking or "white-noise" systems that introduce an unobtrusive background sound that reduces interference from distracting office noise.

• Note that an unobtrusive level of noise from an HVAC system can in some cases effectively provide good sound masking

Create a High-Performance Luminous Environment

• Use daylighting wherever practicable

• Supplement natural light with high-efficiency lamps, ballasts, fixtures and controls

• Use magnetic fluorescent lamps with high-frequency electronic ballasts to reduce flickering

• Reduce direct glare from natural and man-made light sources, particularly where reflective surfaces are in the field of view….such as computer screens

• Use task lighting and light colors on walls

Provide Quality Water

• Comply with EPA Safe Drinking Water Act for levels of metals and bacteria in potable water systems

• Provide proper flushing and decontamination during commissioning of new and renovated potable water systems

• Conduct periodic maintenance flushing of potable water systems to control drinking water quality issues

• Control domestic water temperature above 140o in tanks and 122o at faucets to prevent legionellae growth

• At cooling towers, consider a closed-loop rather than open system reduce potential for contamination

Control Disturbing Odors

• Directly exhaust copying and housekeeping areas and provide return air grilles to control odors and limit ozone generation

• For operations and products that produce odors and cannot be eliminated, provide architectural and HVAC isolation

• Ensure maintenance procedures remove trash and recyclables on a regular basis and do not permit undue storage on site

• If smoking is not prohibited in a building space, ensure that it has a lower static pressure than adjacent spaces, complies with ASHRAE Standard 62, and is isolated from the return air system of surrounding spaces.

Be Aware of Exposure to Electric and Magnetic Fields (EMF)

• EMF may be perceived as harmful, however there is currently insufficient evidence to make a conclusive judgment

• Sources of information are EMF RAPID-Electric and Magnetic Fields Research and Public Information Dissemination Program and the World Health Organization, Electromagnetic Fields Website.

vi. Optimization of Operations and Maintenance Pratices

Building owners face unique challenges to meet increasing demands for new or renovated sustainable buildings designs that are balanced with safe, secure and productive environments.

Through collaboration, engineers, architects, and other site contractors can specify materials and systems that simplify operational practices and reduce maintenance requirements. On-site and within the facility, these practices not only aim to reduce water and energy requirements, and requires less toxic chemicals use, but also cost-effective and reduce life-cycle costs.

There are, of course, many steps that can be taken in operations and maintenance practices that will benefit the principles of sustainability, many of the design opportunities and resources already identified have helpful impacts on operation and maintenance practices as well.

2.2.2 The Benefits of a Sustainable Buiding

Sustainable buildings impact the environment less during construction, provide healthier place for their occupants and are more cost-efficient over the life cycle than conventional structures (Doyle et al., 2009). To be commercially, socially and environmentally sustainable building, measurable and immeasurable benefits need to be revealed in order to persuade developers and clients to risk new approaches and use the new sustainable technologies. Several authors have found the net benefits of sustainable building as follows:

1. Direct Benefits

Reduce Energy Consumption, Economies in Operational Cost and Fuel Bills either for Owner or Tenant

According to Choi (2009), capital costs are not high for many green and sustainable building elements and even where upfront costs are more elevated, they can be offset by decreased operational costs. Research shows that sustainable building practices can considerably reduce the built environment's role in energy consumption (CBRE, 2009; Edward, 1998). Depending on the level of improvement, these savings at least exceed 10% and could be well over 50% (CBRE, 2009). A survey of ninety-nine sustainable buildings in the United State showed they use an average of 30% less energy than conventional buildings. Meanwhile, other research in United State also found that energy efficient design able to reduce building energy consumption by as much as 50% (The Economist, 2004). An example of a successful sustainable building is the head-quarters of NMB in Amsterdam constructed in 1990, built to meet low-energy and high environmental standards, with plenty of user control over the temperature and humidity of working areas. It was reported to have saved more than £300 000 a year in energy costs against a conventional office building of similar size. The energy consumption is one-twelfth that of the bank's former building allowing the owner to calculate that the additional cost of plant and equipment was paid for in three months of occupation. Furthermore, NMB have found that absenteeism is 15% lower than in the old building adding considerably to the bank's performance. Therefore, it has proved a success in financial and productivity term.

Although initial costs of sustainable construction can be higher than conventional projects, it is widely held that longer-term cost savings in operations and maintenance can help recover those costs. Sustainable buildings are expected to decrease operating costs between 8-9%, increase total building value by about 7.5% and increase occupancy rates by 3.5% (USGBC, 2006a; b). More examples of worldwide successful sustainable buildings are shown in Table 1. **Market Advantage and Lower Long-Term Exposure to Environmental or Health Problems**

The evidence record for this is limited, but analysis from the US indicates that the sustainable buildings do attract higher rents than conventional ones and also enjoy higher rates of rental growth (CBRE, 2009). A survey by developer St James' on their Kennet Island sustainable residential scheme in Reading, England revealed that four-fifths of residents would pay up to £3,000 for each of a select group of green and sustainable features, including solar PV tiles, solar hot water tiles, Powerpipe hot water heat exchangers, grey water recycling and wind turbine. A research by real estate experts in Australia found out that majority of Australian investors are willing to pay more for a Green Star building (Muldavin, 2010). The improved marketability subject of sustainable buildings is the main current competitive advantage which are easier to sell and lease, which reduces vacancy times and hence income losses (McKee, 1998). The buildings also able to fulfill user satisfaction, benefits to health and comfort, increase company image, having commercial advantage for environmental ethics, value for money in long term, adding the sale value of buildings and simpler to re-lease in the future (Edward, 1998; and McKee, 1998).

Greater Productivity of Workforce

Sustainable buildings also have social impacts on the health and wellbeing of building occupants. Design features that promote sustainability have resulted in lower absenteeism and higher productivity rates among employees. A study conducted after Lockheed Martin completed sustainable engineering and design facility in Sunnyvale, California showed that absenteeism rates dropped by 15% in the new building. Another California study of test scores from 21,000 students concluded that students in classrooms with more natural light scored 29% higher on math tests and 26% higher on reading tests than students in rooms with less natural light (USGBC, 2003).

2. Indirect Benefits

Healthier to Use

The use of more natural sources of light, solar energy and more organic materials in a sustainable building, end up with a healthier building than a traditional building. Edward (1998) and USGBC (2003) reported that, the building has been proven to contribute in lower levels of sickness and absenteeism.

Psychological Advantage

People feel better in a sustainable building. Research in the USA by Edward (1998) claimed that people are not only healthier but they claim an enhance sense of wellbeing. 1% absenteeism reduction in the building able to pays for the energy costs of a conventional building.

Enhances Company Image

Sustainable building is normally the result of holistic thinking by a team of professionals, including the client, who share similar sustainable ideas which spread from a company to its buildings, the building to the company and the company to the individual thereby enhances its image (Edward, 1998; & McKee, 1998).

3. Global Benefits

The philosophy of sustainable buildings is about considering the whole range of environmental and ecological impacts. Therefore, the design and construction of the building has to consider global warming, ozone layer depletion, biodiversity, product miles and recycling (Edward, 1998; Zainul Abidin, 2009).

Authors	Case Studies	Benefits of Sustainability
Edward (1998)	Student residences at Strathclyde University	- Contented student - The attraction of good quality academic staff - Improved output
Francis (1998)	Mixed-use development- Sheppard Robson's Helicon Building, City of London	- Energy running costs – £50/m^2 per year which is significantly less than that of conventional office buildings. - Displacement air-conditioning which uses water-filled panels at ceiling level for cooling - The system costs 15% more, but 16% cheaper to run.
Shuttleworth (1998)	Mistral Building, Reading	- Energy bills about 20% off those of a more conventionally design office.
Grut (1998)	Daimler Benz Building, Berlin	- Facade cost 20% higher than usual (facade costs are 9% of total building cost) but help to reduce running cost by 60%, annual energy consumption predicted as 75kWh/m^2 which is a quarter of that consumed by a typical building office. - Embodies energy and CO_2 emission 30% less than typical office building in Berlin.
Roy et al (2005)	LEO Building, Putrajaya, Malaysia	- Energy savings 100-150kWh/m^2 year compared to the design without the energy features. - Payback time – less than 10 years - Energy savings of more than 50% compared to conventional building design

Table 1: The successful sustainable building worldwide

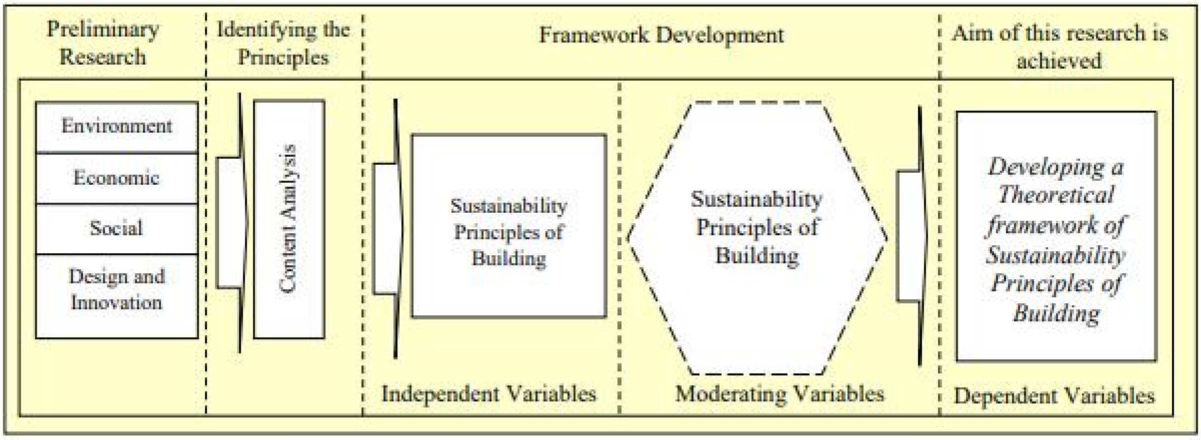


Figure 2: *The research model for developing the theoretical framework of sustainability principles of building.*

Chapter Three

Research Methodology (Case Study)

3.1 Research Design

This section involves the method adopted to assess the approaches used to source information and the study of the proposed building type base on the literature reviewed.

The study encompasses the exploration of architectural design element for sustainable design in the design of in the office complex building.

The goal of this study is to explore architectural design element for sustainable design in the design of in the office complex building. The explorative method is selected for the study because it is proper when the focusing study is to examine the peculiarity of a region.

In this study, it becomes clear that it is qualitative in nature; this is due to the difficulty of the subject and the difficulty by which perception is quantified. Thus, it is important to understand what makes an office building an energy efficient building before trying to quantify it and its underlying factors.

3.2 Case Study Method

Case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. It tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result. In order to fully understand the principle behind designing any building typology, an initial assessment of the existing building typology would have to be done. The initial assessment on the documented buildings was in terms of spatial, functional, equipment and operational efficiencies and standards which informs necessary provisions for future needs which may arise in such building typology

A case is a chronologically and geographically isolated event (Johansson, 2003). (Veal (2006) notes that a case study may refer to both a research method and an analytical unit since it involves the assessment of unique occurrences (cases) of the investigated topic. Understanding a complicated instance via in-depth description and examination of the instance in connection to its surroundings is the purpose of case studies (the United States General Accounting Office, 1990). This research will apply an empirical method to gather data on a small number of instances that meet some of the topic's distinguishing qualities. The basis for these conclusions is a mixed qualitative case study analysis and a thorough examination of relevant published and grey literature. In this case study, we analyses social interaction based on its qualities.

3.2.1 Case Studies Selection Criteria

Architectural processes depend on a knowledge repertoire of circumstances from direct experience or established precedents (Schon (1991),(Veal (2006) discovered that picking examples for a case study was comparable to sampling in quantitative research; in both situations, the cases were selected on purpose. In light of these studies, (Oluigbo (2010) suggested that identifying instances necessitates possessing certain intrinsic qualities that pertain to the issue under consideration.

I carefully selected the case studies that would serve as the foundation of my thesis.

- As a building with adequate analysis in scope of facilities required to make it operate as an office building.
- As a facility that has employed the concept of energy efficiency strategies.

3.3 Data Collection

Case studies for theoretical study in Architecture may need the use of common data collecting techniques (Oluigbo, 2010). These techniques include, among others, observation and participant observation, visual survey and checklist, interviews, questionnaire, models and simulation, and scientific measuring devices. For the purpose of this research, visual survey interview, questionnaire and checklists analysis based on the assessment of the level of successful place for social interaction on the selected case studies were adopted.

3.3.1 Instrument of Data Collection

Case study methodology will include the use of many data collection sources to adequately capture the complexity of instances (Yin, 2003; Veal, 2006; Johansson, 2003). Depending on the nature of the investigation at hand, the Visual Survey used here may be depicted in several ways. Photographs of important case studies to evaluate energy-efficient office building strategies and the extent to which they were really applied. Some case study components were also outlined. Using these illustrations, we can determine how different case studies use space. The variables of design element considered in architecture in connection to kinds of public buildings will also be mentioned in field form. In addition, the existence and kinds of supplementary amenities in the inspected region will be noted.

3.3.2 Procedure for Data Collection

In order to gather this information, we examined office buildings in our backyard and throughout the globe, taking notes on the visual features of the structures and sketching their floor plans. The analysis of the data acquired via visual survey and observation is based on descriptive narratives of what was seen and reported utilizing data collecting methods. This description covered primarily three aspects;

a) Site planning and landscaping

b) Building envelope and material types

c) Building form and shapes

3.4 Operationalization of Variables

From the review of literature highlighting methodological approaches to case study researches on office complex and energy efficiencies, it is apparent that irrespective of organizing framework, methodological and philosophical differences the strategies for designing an energy efficiency building generally comprises:

- Building Envelope
- Building Shape/Form
- Site Planning/Landscape
- Energy Efficiency Material
- Spatial Concept

In line with the strategies for designing energy efficient buildings the following variables will be adopted.

a) Site planning and landscaping

b) Building envelope and material types

c) Building Orientation and Form

3.5 List of Selected Case Studies

The case studies were aimed out on four existing senate buildings in Nigeria and 2 international administrative buildings which are:

1) Obafemi Awolowo University Senate Building

2) University of Lagos Senate Building

3) Ladoke Akintola University of Technology Senate Building

4) Kashmir University Administrative Building

5) Dhaka International University Administrative Building

The criteria for each case study are discussed base on location, architect that designed it and the client, conceptual approaches to the design of the building, functions and spatial relationships, technological, environmental and sustainability solutions, aesthetic approach(es) to the design of the building and energy consideration.

3.5.1. Case Study 1

Obafemi Awolowo University Senate Building

Location

The tallest building on campus sited at the university core, accessed through Adesoji Aderemi road (popularly called Road 1) from the university main gate. This makes it the focal point on approach to the campus; giving it a high hierarchy which a university senate building should possess.

Architect and Client

Obafemi Awolowo University's old Senate building was designed by an Israeli Architect, Arieh Sharon. The client was Late Chief Obafemi Awolowo.

Conceptual Approach

The underlying concept is proximity in spatial relationship void of clustered circulation and adapting the building envelope to the climatic condition of the location to achieve free air movement through the building thereby resulting in indoor thermal comfort. This was done by integration of different rectilinear forms with emphasis on the high-rise part of the building which gives rhythm, movement, balance, and proportion to the building as a whole.

Description

The building is characterized by a high-rise, point office block; and an L-shaped low-rise block with an entrance foyer. The high-rise office block has rectilinear, single banked floor plans which allow effective ventilation, linear arrangement of spaces with proximity where necessary. The ground floor (also known as 'Floor O') consists of the reception, exhibition hall, security post, two committee rooms, bookshop, toilets, and stair / lift lobby. The mezzanine floor is used for equipment storage and services. The first floor consists of accounts section (salaries, assistant business manager, expenditure control, projects, statistics, pensions and ledger); second floor houses the admissions (general office, senior assistant registrar, deputy bursar, secretary to the bursar and bursar) and examinations (assistant registrar, secretarial office, general office, administrative officer); the third floor consists of the registry; fourth floor – vice chancellor and deputy vice chancellor, while the fifth floor houses the council and senate.

Functional and Spatial Relationship

The function of the building defines the character, the size and location of the building. The building contains the foyer at the south entrance used as exhibition area, thereby increasing impulse buying in the bookshop; a bank and post office providing a continually functioning and lively social core for the campus. The two arms of the building have an open court enclosed on its eastern side by a pergola leading to the humanities buildings, which terminates with a sculptured gate, descending to the road level. With double volume space created by the pilots, free movement of people through and within the building is encouraged. The repetitive floors are linked to one another with properly located stair cases and two lifts which run from the lower ground floor to the topmost floor. Also, a spiral stair case: detached from the building and located at the rear serve as means of escape in emergency situation. The arrangement of horizontal, structural elements on the upper floors and; vertical sun shading device round the ground floor, shades the building from sun and give a feeling of privacy in the building. It is also supported by other ancillary spaces which enhances its functionality.

Technology and Structure

The building is characterized by a point office block and service core which provide a strong vertical landmark to the entire campus: constructed with high level of technology through the use of concrete and iron. The finneton long window on the ground floor was made possible by structural columns making the enclosing wall unnecessary. Also, the structural frame, sculptured entrance, suspended repetitive floors, and the shading device were made of reinforced concrete – a very strong characteristic feature of modern architecture.

Aesthetics

The ordered arrangement of the sun shading device, proper integration of geometric forms and shapes, emphasis on the lift shaft achieved with variation in colour, and a focal point created by a sculptural piece: add to the aesthetic value of the Senate Building. The black and white lines created by elements on the approach view, harmonize the building with the adjoining buildings and the surrounding environment, creating a feeling of unity.

Plate 1: Location of OAU Senate Building (Google earth image)

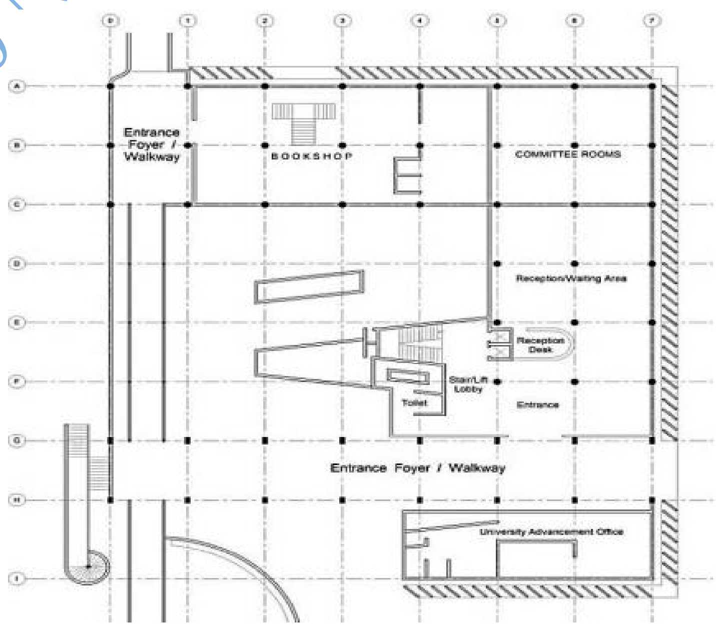


Plate 2: Ground floor plan of OAU Senate Building (Source Author's Field work)

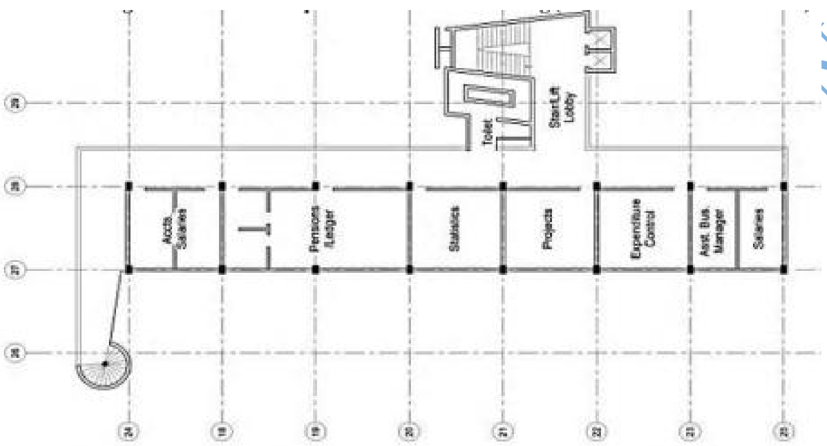


Plate 3: First floor plan of OAU Senate Building (Source Author's Field work)

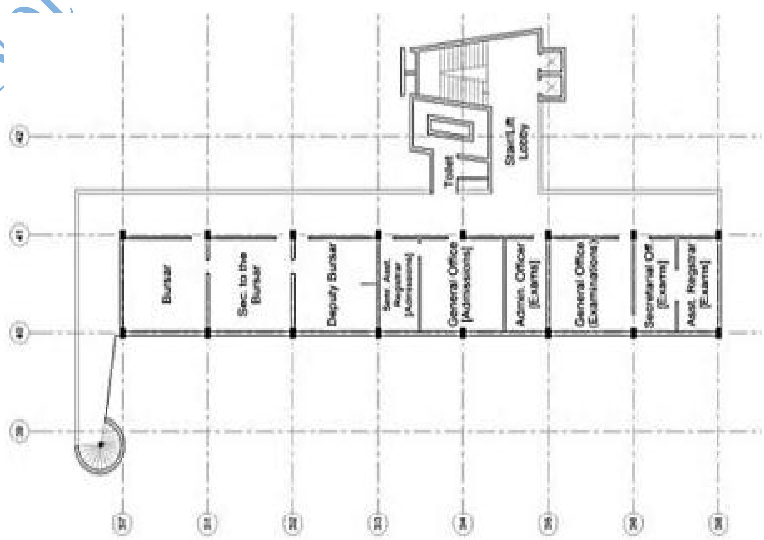


Plate 4: Second floor plan of OAU Senate Building (Source Author's Field work)

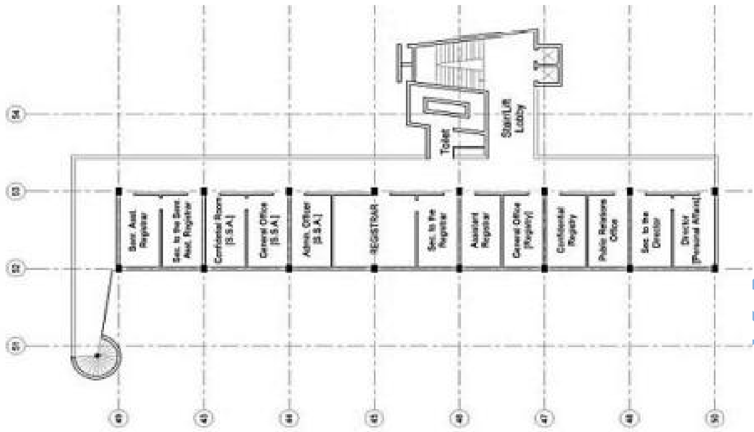


Plate 5: Third floor plan of OAU Senate Building (Source Author's Field work)

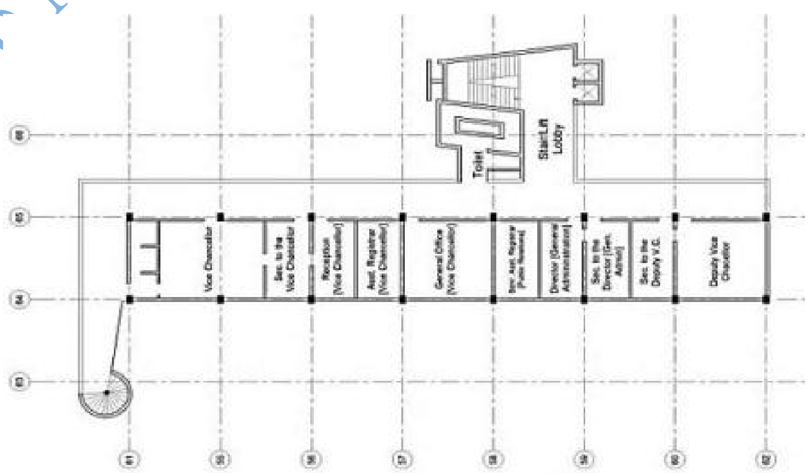


Plate 6: Fourth floor plan of OAU Senate Building (Source Author's Field work)

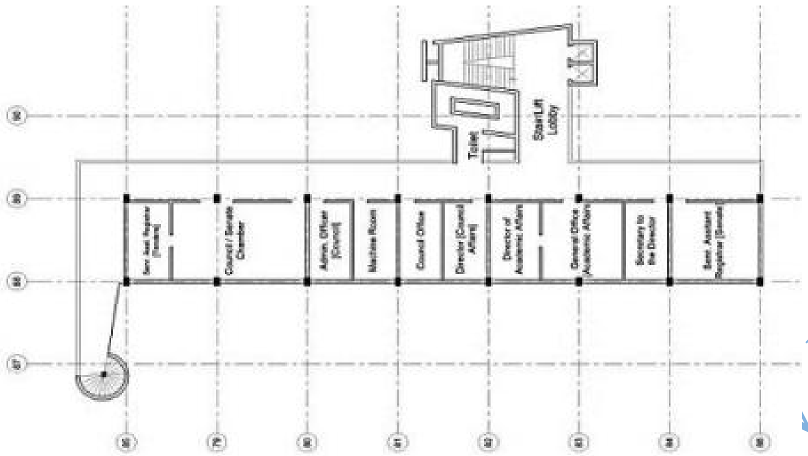


Plate 7: Fifth floor plan of OAU Senate Building (Source Author's Field work)

Plate 8: Approach view of OAU Senate Building (Source Author's Field work)

Plate 9: Left side view of OAU Senate Building (Source Author's Field work*)*

PLATE 10: Double volume space for reception, general waiting, and exhibition with 600mm diameter columns spaced @ 7m c/c (Source – Author's field work)

PLATE 11:Raised building mass with pilots for free access through the building

2.3.5 Appraisal of Building

Merits

- The ordered arrangement of the sun shading device, proper integration of geometric forms and shapes, emphasis on the lift shaft achieved with variation in colour, and a focal point created by a sculptural piece add to the aesthetic value of the Senate Building.

- The arrangement of horizontal, structural elements on the upper floors and; vertical sun shading device round the ground floor, shades the building from sun and give a feeling of privacy in the building.

Variables	**Adequate (*)**	**Inadequate (X)**	**Not Available (0)**
Architectural form	*		
Scope of Facility	*		
Construction Technology	*		
Building Material	*		
Sustainability of building		X	

S/N	Variables	Checklist	Level of application 1	2	3	4	5	Remark
1	Building envelope	Suitability of the materials to the climate					●	High efficiency glazing and external thermal envelope
		Use of external Insulation					●	
		Use of smooth surface Finishes					●	
		Use of light colours					●	
2	Natural lighting	Wall to window ratio (40%)					●	The interior naturally lit with large glazed panel
		Use of spectrally selected glass					●	
3	Natural ventilation	Use of openable Windows			●			The use of openable casement windows,
4	Site and external spaces	Use of interwoven Landscape		●				Not enough landscaping.
		Use of impervious Surfaces			●			
5	Building form	Large building surface Area					●	Appropriate building form based on climate
6	Building orientation	Sun orientation; E-W					●	The optimum orientation is NW-SE
		Wind orientation; SW-NE					●	
7	Wall/Window shading	Use of horizontal and vertical shading devices				●		There is outdoor area for green area and presence of overhang

		Use of interior blinds				●		
		Use of recessed walls		●				
		Use of overhangs			●			
		Use of plants		●				
8	Existing energy source	Use of PV cells			●			Automatic presence detectors/sensors and high efficiency lighting.
		Use of natural gas			●			

3.5.2 Case Study

University of Lagos Senate Building

Location

The senate house complex is located at the centre of the academic core of the Akoka campus of the university, set against the backdrop of the Lagos lagoon and within a beautiful landscape that includes a park and a "love garden", bounded by the Arts lecture theatre to the west, Advanced Legal Studies to the north, and the old Administrative building and Auditorium to the east. The senate house terminates the visual accessibility when approaching from the gate. The senate location could be said to be appropriate since it is supposed to be a part of call to call, hence its central position is appropriate.

Architect and Client

The senate house complex by James Cubitt and Partners consists of simple forms and was completed in 1984 and was funded by the Federal Republic of Nigeria. Conceptual Approach Double banked corridor concept for office building was adopted. The cellular office planning using both rectilinear combined with curvilinear shape, was also used. Interplay of rectangular and cubic prism with a touch of barrel vault (for the senate chamber) was adopted which is evident on the elevations squares. There was also a deliberate attempt to reduce traffic to the high-rise floors to avoid exposing large number of people to the risk factors in case of any hazard(s) within the building.

Description

It consists of a combination of rectangular configuration with varying height and a semi-circular block. The complex is twelve floors with four main units that vary in height. The machine room occupies the last floor with a square plan. The next unit is eight floors high and is also a square plan; the third unit is four floors and this contains the senate chamber. It is enclosed within a square, but it is semi-circular in shape. The fourth unit is fair floors and it's more of horizontal form.

Functional and Spatial Relationship

The ground floor is half open which allow for pedestrian's transverse the site and half closed as it encloses the porters lodge, student affairs and cash office. The first floor encloses the senate chamber as a unit and the office block houses some section of the Registry which are salary/wages, staff welfare and establishment unit. The second floor contains some section of Registry, - Examination, Admission and Records. The third and fourth floors accommodate the Bursary department, Bursars office; the fifth floor houses the post graduate unit; the sixth floor – legal section of the Registry; the seventh floor contains the continuing Education center of the university; the eight floor – Alumni offices, physical and Academic planning unit, and Unilag's consultancy unit; the ninth floor contains the information and protocol unit; the tenth floor is the office of the Deputy vice – chancellor; the vice – chancellor occupies the eleventh floor while the twelfth floor contains the machine room and it is smaller in area. For clarity, it should be noted that some of the floors discussed above contains some other functions but emphasis is being laid on the main function. The governing council chamber and other units are housed in the old administrative building; it is about 10m away from the senate building but separated by a road.

Technology and Structure

University of Lagos' Senate House is a high-rise building and as such, was built on structural frame system of cylindrical reinforced concrete columns and beams which forms the main structure of the building. The walls are non-load bearing which reduces the dead load on the building, thereby making the building structurally safe. The fins are of precast concrete 125mm thick with mosaic tiles of different colors. All windows are horizontally pivoted sash and the doors are all flush doors. The internal partitions are of blocks plastered and painted but finished with mosaic tiles. The office floor is sandcrete screed with 2mm rubber sheet finished type BS204. The building has extended floors which gives it both structural and visual balance, serves as support/ anchor for the egg-crate sun-shading device and for consistent maintenance.

Aesthetics

The egg – crate sun shading device and the prominent circular columns are the main elements used in achieving rhythm and movement on the façade – the use of colours on the sun shading device gave it a unique and captivating effect from any other building around; while integration of different sizes of rectangular prisms with a barrel vault gives the building form and creates balance, unity, proportion, emphasis (barrel vault with mural painting on the curved wall to emphasize and differentiate the senate chamber), and hierarchy by the highest part of the high-rise housing the vice chancellor and registry units.


Plate 12: Location plan of Unilag Senate House (Source – Author's field work)

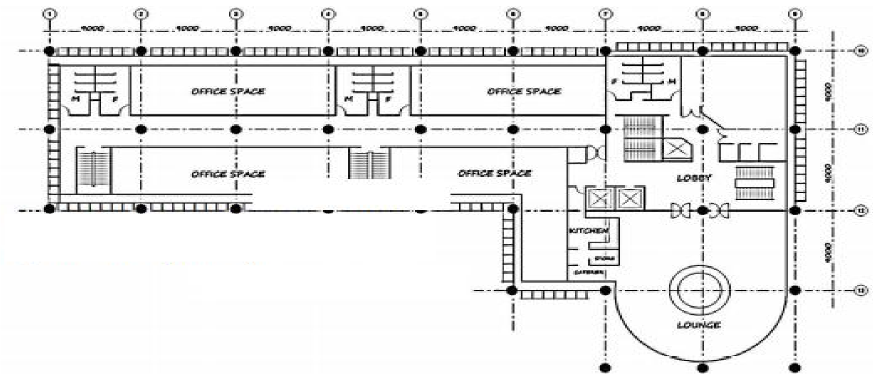


Plate 13: First floor plan of Unilag Senate House (Source – Author's field work)

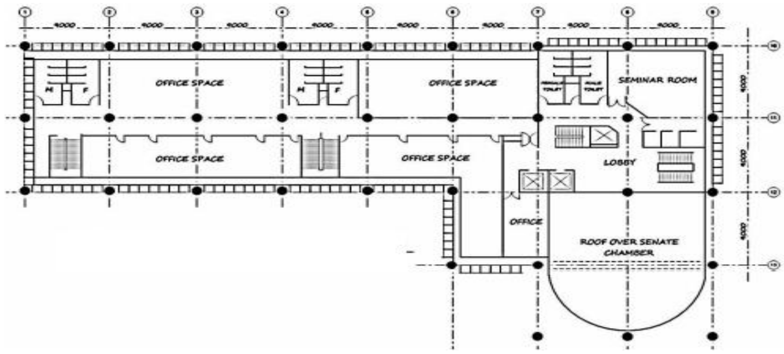
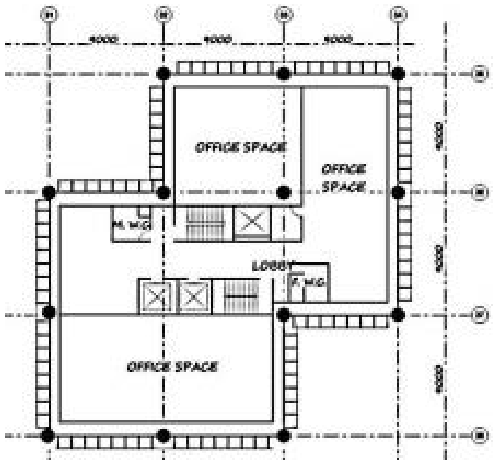


Plate 14: Typical second and third floor plan of Unilag Senate House (Source –Author's field work)



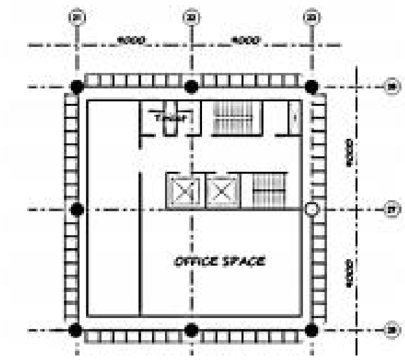


Plate 15: (a) Fourth to eight floor plan (b) Ninth to eleventh floor plan

(Source – Author's field work)

Plate 16: Approach view of Unilag Senate House (Source –Author's field work)

Plate 17: Aerial view of Unilag Senate House (Source –Author's field work)

Plate 18: (a) Mural painting on the Senate Chamber (b) Landscape with sit-out called "love garden"

(Source –Author's field work)

Appraisal of Building

Merits

- The ground floor is half open which allow for pedestrians to transverse the site easily.

- The building has extended floors which gives it both structural and visual balance, serves as support/ anchor for the egg-crate sun-shading device and for consistent maintenance.

- The use of French windows in the offices reduces the use of electrical energy in form of lighting as natural lighting and ventilation is achieved within the spaces.

- Use of curved wall in the senate chamber which enhances sound distribution and absorption within the space.

Variables	**Adequate (*)**	**Inadequate (X)**	**Not Available (0)**
Architectural form	*		
Scope of Facility	*		
Construction Technology	*		
Building Material	*		
Sustainability of building	*		

S/N	Variables	Checklist	Level of application					Remark
			1	2	3	4	5	
1	Building envelope	Suitability of the materials to the climate					●	High efficiency glazing and external thermal envelope
		Use of external Insulation					●	
		Use of smooth surface Finishes					●	
		Use of light colours					●	
2	Natural lighting	Wall to window ratio (40%)					●	The interior naturally lit with large glazed panel

		Use of spectrally selected glass					●	
3	Natural Ventilation	Use of openable Windows			●			The use of openable casement windows,
4	Site and external spaces	Use of interwoven Landscape		●				Not enough landscaping.
		Use of impervious Surfaces			●			
5	Building form	Large building surface Area					●	Appropriate building form based on climate
6	Building orientation	Sun orientation; E-W					●	The optimum orientation is NW-SE
		Wind orientation; SW-NE					●	
7	Wall/Window shading	Use of horizontal and vertical shading devices				●		There is outdoor area for green area and presence of overhang
		Use of interior blinds				●		
		Use of recessed walls		●				
		Use of overhangs			●			
		Use of plants		●				
8	Existing	Use of PV cells			●			Automatic presence detectors/sensors and high efficiency lighting.
		Use of natural gas			●			

3.5.3 Case Study

Ladoke Akintola University of Technology Senate Building

Location

The Senate building of the institution is located at the core of the university, surrounded by motion ground, Urban and Regional Planning studio and Faculty of Engineering building. Its form gave it a clear distinction from other buildings on campus which makes it notable on approach from the major road coming from the university main gate.

Description

The building can be distinguished on the campus by its circular form. The focus of the building is its centre which contains a 200 seat senate chamber on the first floor and a conference room on the third floor. The core is adjoined to other parts of the building through a lobby. The building is a framed structure partitioned with hollow sand Crete block walls. It is roofed with long span aluminum roofing sheet. The building can be referred to as a medium rise structure with circular plan on four floors. The ground floor consists of the reception hall, security post, bursary department and accounts. The first floor consists of the common room, senate chamber, kitchenette, pay roll office. The second floor houses the office of the deputy registrar for student affairs, deputy registrar planning and budgets, registrar's office, data management, registry review committee office and Deputy Registrar council affairs. The third floor houses the vice chancellor's office, corporate affairs office, kitchenette, general waiting, common room and a conference room.

Functional and Spatial Relationship

The concentric floor plans adopted enhances effective circulation within the building with high proximity between offices of the same unit and to other units. Vertical accesses are well located and easily accessible, with the main stair by the entrance wider to accommodate and distribute the incoming traffic. Hierarchy is exhibited in the order of spaces in ascending order of low-rank units to the top executive members from the ground floor to the third floor, making the senate chamber the core of the building.

Technology and Structure

Structural frame of reinforced concrete beams and columns was adopted with projected flying buttresses which gives the building structural stability while the extended floors for balconies gives dimensional stability to the building. The use of arched windows on the approach compliments the arches supported by columns on the ground floor, elevating mass of the cantilevered part of the second and third floors. Also, the slanting characteristic features of the projected fins which taper to the end on the ground floor; receives the roof dead load and transfer it to the foundation. It also serves as shield to the building as it protects the building from adverse weather conditions of driving rain and direct solar infiltration. The materials used are reinforced concrete for columns and beams, sandcrete blocks for the interior, partition and exterior walls. Glazed sliding windows with aluminum frames were used. Due to small area of window openings in the offices, there is inadequate lighting of the interior spaces and poor ventilation which makes the building dependent on active source of energy for indoor thermal comfort

Aesthetics

The aggressive use of slanting buttresses with balconies on the exterior gives the building dominance and emphasis; the arches on the approach make the entrance pronounce and clearly distinct with the arched windows to compliment and unify the similar properties in contrast to other features on the facade. Rhythm and movement was also achieved with the use of the projected slanting fins coupled with the balconies which in turn creates pattern while making the entrance the line of symmetry in the building.

Appraisal of Building

Merits

- The concentric floor plans adopted enhances effective circulation within the building with high proximity between offices of the same unit and to other units.

- The aggressive use of slanting buttresses with balconies on the exterior gives the building dominance and emphasis.

Variables	**Adequate (*)**	**Inadequate (X)**	**Not Available (0)**
Architectural form	*		
Scope of Facility	*		
Construction Technology	*		
Building Material	*		
Sustainability of building		**X**	

Plate 19: Location plan of LAUTECH Senate Building (Google earth)

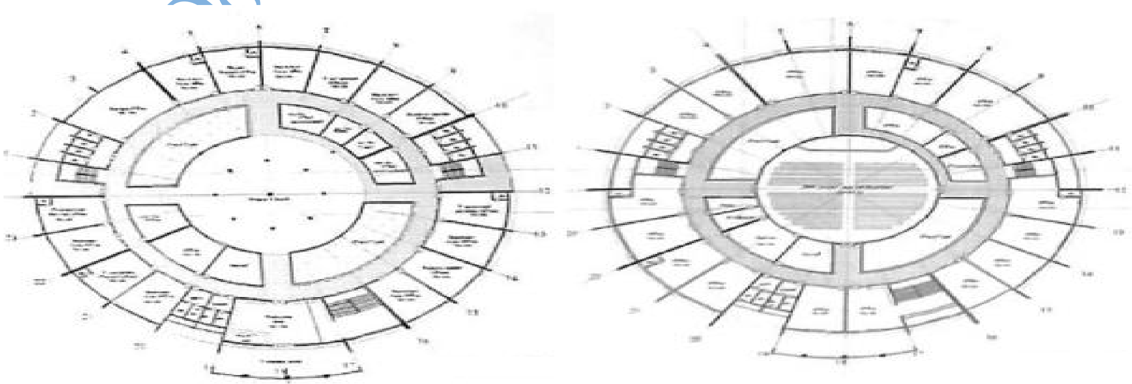


Plate 20: Ground and first floor plan of LAUTECH Senate Building (Source –Author's field work)

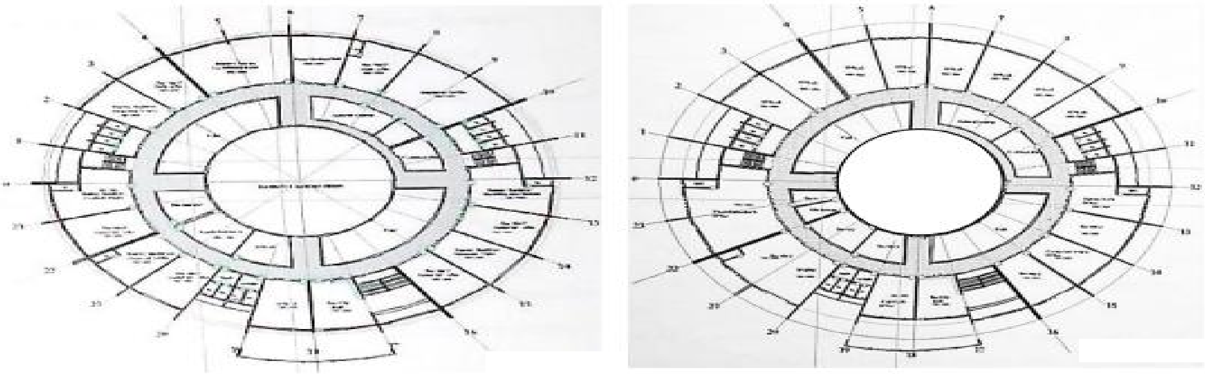


Plate 21: Ground second and third floor plan of LAUTECH Senate Building (Source –Author's field work)

Plate 22: Approach view of LAUTECH Senate Building (Source –Author's field work)

Plate 23: Rear view of LAUTECH Senate Building (Source –Author's field work)

Plate 24: Courtyard view of LAUTECH Senate Building (Source –Author's field work)

S/N	Variables	Checklist	Level of					Remark
			1	2	3	4	5	
1	Building envelope	Suitability of the materials to the climate					●	High efficiency glazing and external thermal envelope
		Use of external Insulation					●	
		Use of smooth surface Finishes					●	
		Use of light colours					●	
2	Natural lighting	Wall to window ratio (40%)					●	The interior naturally lit with large glazed panel
		Use of spectrally selected glass					●	
3	Natural ventilation	Use of openable Windows			●			The use of openable casement windows,
4	Site and external spaces	Use of interwoven		●				Not enough landscaping.
		Use of impervious			●			

5	Building form	Large building surface Area					●	Appropriate building form based on climate
6	Building orientation	Sun orientation; E-W					●	The optimum orientation is NW-SE
		Wind orientation; SW-NE					●	
7	Wall/Window shading	Use of horizontal and vertical shading devices				●		There is outdoor area for green area and presence of overhang
		Use of interior blinds				●		
		Use of recessed walls		●				
		Use of overhangs			●			
		Use of plants		●				
8	Existing	Use of PV cells			●			Automatic presence detectors/sensors and high efficiency lighting.
		Use of natural gas			●			

3.5.4 Case Study

Kashmir University Administrative Building

Location

The building is located in the main campus, at Hazratbal, adjacent to the existing Vice Chancellors secretariat. It overlooks the cricket ground, and onwards to a fabulous view of the Dal Lake, and Zabarwan hills beyond. An existing Fir tree provided the impetus to a “central” space.

Architect and Client

The building was designed by ANA Design for spatial and material optimization, energy efficiency, human interaction, comfort and the celebration of traditional timber design in a contemporary context.

Description

The building functions are developed in two distinct blocks, defined by the level of security, and planned around a central atrium space. The tree forms a focal point from the entrance, through the atrium space, with interconnecting bridges flying through the atrium space. This atrium becomes an "all weather" space for gatherings, chance meetings, discussions and setting up of temporary exhibitions. The two blocks on East and West form the bulk of the offices. All the offices are naturally lit. There is extensive usage of glass, and color, to create well defined, and yet visible "departments". Workstations and cabins are planned to encourage interactions and collaborative working. Each zone or department is independently climate controlled, using all-weather VRV air-conditioning. The air-conditioning system also has enthalpy control, so when the outdoor conditions are pleasant, the compressors shut down and only fresh air is circulated through the building. Even in very warm and cold conditions, adequate fresh air is provided to ensure healthy indoor conditions.

Functional and Spatial Relationship

The central atrium has heat sensors and mechanical ventilation fans. These switch on to flush warm air, in case it rises above a set point. The atrium is also lit with high efficiency, high bay lighting, to allow its usage after sunset.

Technology and Structure

The entire structure of the building including the façade panels, insulated roofing and beams/columns ar made from factory fabricated steel. The interior partitioning is made from dry walls, insulated with glass wool.

Aesthetics

The building is a showcase of openness, inventiveness and contemporary nature of the University, while respecting the sense of place, culture and environment.

Appraisal of Buildings

Merits

- The façade allows light to enter but controls heat entry as well as heating loss during winter.

- Adequate fresh air is provided to ensure healthy indoor conditions.

- Workstations and cabins were planned to encourage interactions and collaborative working.

Variables	**Adequate (*)**	**Inadequate (X)**	**Not Available (0)**
Architectural form	*		
Scope of Facility	*		
Construction Technology	*		
Building Material	*		
Sustainability of building	*		

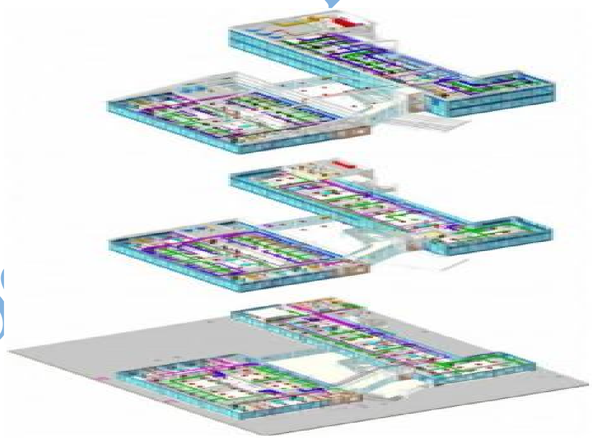


Plate 25: 3D Building Plan of Kishmar University Administrative Building (Google Search)

Plate 26: Aerial view of Building Plan of Kishmar University Administrative Building (Google Search)

Plate 27: Rear view of Kishmar University Administrative Building (Google Search)

Plate 28: a. Approach view b. Atrium view of Kishmar University Administrative Building (Google Search)

S/N	Variables	Checklist	Level of	Remark

			1	2	3	4	5	
1	Building envelope	Suitability of the materials to the climate					●	High efficiency glazing and external thermal envelope
		Use of external Insulation					●	
		Use of smooth surface Finishes					●	
		Use of light colours					●	
2	Natural lighting	Wall to window ratio (40%)					●	The interior naturally lit with large glazed panel
		Use of spectrally selected glass					●	
3	Natural ventilation	Use of openable Windows			●			The use of openable casement windows,
4	Site and external spaces	Use of interwoven		●				Not enough landscaping.
		Use of impervious			●			
5	Building form	Large building surface Area					●	Appropriate building form based on climate
6	Building orientation	Sun orientation; E-W					●	The optimum orientation is NW-SE
		Wind orientation; SW-NE					●	
7	Wall/Window shading	Use of horizontal and vertical shading devices				●		There is outdoor area for green area and presence of overhang
		Use of interior blinds				●		

		Use of recessed walls		●				
		Use of overhangs			●			
		Use of plants		●				
8	Existing	Use of PV cells			●			Automatic presence detectors/sensors and high efficiency lighting.
		Use of natural gas			●			

3.5.5. Case Study

Dhaka International University Administrative Building

Location

The background story of the building located in Dhaka city of Bangladesh is quite interesting. The prerequisite of the project was to construct a low maintenance building. Because of the client's budget , it was decided that, initially there will be as single building consisting of all facilities to run the curriculum. Then further development will be continued.

Architect and Client

The architect in charge is Nabi Newaz Khan Shomin and other associate architects are Lutfullahil Majid, Md JubairHasan, Saurav Dutta, Mehnaz Chowdhury. The building symbolizes strength in culture for centuries and the Administrative buildings were known as "LAL DALAN" (Red Buildings), in the subcontinent. "LAL DALAN" historically left an image of power in the mind, so it was quite a challenge to achieve that unique demand of the client while designing a modern academic building. The site condition also made the work very challenging, it was an earthquake prone

Description

The project, this "RED" building is configured as a space of interaction and source of inspiration for both teachers and students. The main focus was to design the building in such a way that ensures maximum compactness of the program and the minimum occupancy of the plot. This building exhibits 'Delicate Form of Craftsmanship" in brick masonry. The building is basically designed of steel structure with bracing as the site is very vulnerable for earthquakes. The approach to structural design reduces the time of construction period. Fundamental materialization of the building is handmade brick chips surface prepared with pebble wash technique. Red textured brick chips mosaic is used as floor finish. This red textured floor finish complements the handmade brick chips wall surfaces. The material is not only sustainable and maintenance free but also monolithic and has a certain permanent status. The building solely performed for two years (2016-2018). After that a new academic building was established to run the academic curriculum on a larger scale. But this "RED" one remains as an iconic and inspirational one for all. MERITS - Wide open-able glass windows are introduced to ensure plenty of

Functional and Spatial Relationship

This 3-storied building has provision for classrooms, administration rooms, multipurpose hall and library spaces. In addition, the roof of this building is designed to accommodate student's outdoor activities which represents an important feature.

Technology and Structure

The building exhibits "Delicate form of Craftsmanship" in brick masonry. The building is basically designed of steel structure with bracing as the site is very vulnerable for earthquakes. Fundamental materialization of this building is handmade brick chips surface prepared with pebble wash technique. Red textured brick chips mosaic is used as floor finish.

Aesthetics

The brick walls of the building had a very thin layer of shell lime plaster coat which worked as a weather protection and retained the ornamentation of the exterior facade. This crafted ornamentation was an inseparable part of the ancient history and culture of Bangladesh.

Appraisal of Building

Merits

-Wide open-able glass windows are introduced to ensure plenty of daylight and air circulation which minimize energy consumption.

- To cut down the startup cost, pre-owned furniture was arranged in this building space. - Workstations and cabins were planned to encourage interactions and collaborative working.

Variables	**Adequate (*)**	**Inadequate (X)**	**Not Available (0)**
Architectural form	*		
Scope of Facility	*		
Construction Technology	*		
Building Material	*		
Sustainability of building	*		

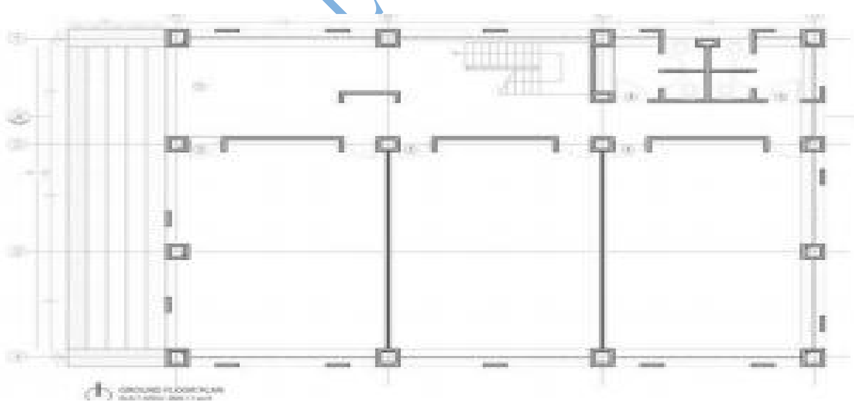


Plate 26: Floor Plan of Dhaka International University Administrative Building (Google Search)

Plate 27: Rear View of Dhaka International University Administrative Building (Google Search)

Plate 28: 3D Building Plan of Dhaka International University Administrative *Building (Google Search)*

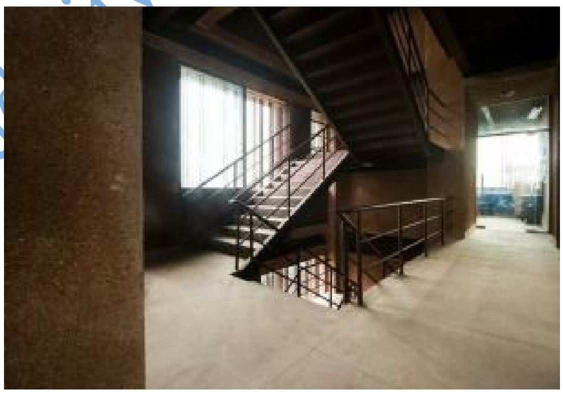


PLATE 27: a. Roof Top for student activities b. Main stair hall of Dhaka International University Administrative Building (Google Search)

S/N	Variables	Checklist	Level of application					Remark
			1	2	3	4	5	

1	Building envelope	Suitability of the materials to the climate					●	High efficiency glazing and external thermal envelope
		Use of external Insulation					●	
		Use of smooth surface Finishes					●	
		Use of light colours					●	
2	Natural lighting	Wall to window ratio (40%)					●	The interior naturally lit with large glazed panel
		Use of spectrally selected glass					●	
3	Natural ventilation	Use of openable Windows			●			The use of openable casement windows,
4	Site and external spaces	Use of interwoven Landscape		●				Not enough landscaping.
		Use of impervious Surfaces			●			
5	Building form	Large building surface Area					●	Appropriate building form based on climate
6	Building orientation	Sun orientation; E-W					●	The optimum orientation is NW-SE
		Wind orientation; SW-NE					●	

7	Wall/Window shading	Use of horizontal and vertical shading devices				●		There is outdoor area for green area and presence of overhang
		Use of interior blinds				●		
		Use of recessed walls		●				
		Use of overhangs			●			
		Use of plants		●				
8	Existing energy	Use of PV cells			●			Automatic presence detectors/sensors and high efficiency lighting

		Use of natural gas			●			

Chapter Four

Site Analysis and Design Synthesis

4.1. Study Area

4.1.1. Site Location

4.1.2 Site Selection Criteria

Site selection for this project is very important, has it greatly affects the functional use of the facility, for the effective site selection, certain criteria were considered in selecting the site;

I. Land use:

II. Accessibility

III. Services.

IV. Proximity To another administrative Area.

V. Topography

VI. Expansion Possibilities

4.1.3 Site Analysis

Site Accessibility

The site has easy and convenient access for both vehicular Water Way and pedestrian. The site is accessable from the major road that runs through Lagos.

Nearness to Public Utilities

There are basic infrastructures in place e.g., Good Roads, Electricity, Water, Telecommunications, Security etc.

Drainage and Topography

The site has a gentle slope spread evenly throughout. Drainages are also in place for water collection.

Vegetation

He site enjoys two distinct season which are the cold and dry seasons. This enables a wide range of vegetation ranging from thick undergrowth, short grasses to evergreen trees in the site's immediate vicinity. Soil is sandy, and it is low bearing capacity.

Soil Condition

It has a Loose Sandy soil with good sub-surface condition for construction and landscaping. It gives satisfactory geological and soil condition with no rock crops.

Wind Direction

The north-east trade wind brings cold, dust, harmattan and these cause discomfort. The south west trade wind brings cold humidity which gives comforting effect to the people. Proper ventilation is considered as part of the building effective arrangement. The building´s long sides (east and west) elevations are positioned such that they receive the maximum amount of air. The shorter sides of the proposed mall face the direction of the north-east trade wind

4.2 Project Analysis and Design Synthesis

4.2.1 Brief Analysis

4.2.2. Brief Development

Some spaces were found to be common to all the five case studies examined in this study.

These spaces were studied critically to determine the standard required, the number of units per people, their capacity and exact function they perform in an Office design. These spaces are;

- Indoor parking
- Outdoor parking
- Convenience

- Reception
- Waiting Area
- Mechanical Room
- Electrical Room
- Circulation Area
- Restaurant
- Offices
- Senate board rooms
- Senate chamber
- Outdoor Sitting Area
- Service circulation
- Security post
- Maintenance, electrical and IT department

4.2.3. Design Consideration

4.2.3.1 Site planning and landscaping

The site planning was carefully planned to accommodate the outdoor activities in relationtotheindoorfacilitiesfor easier use of both facilities simultaneously, vehicular movement and pedestrian movement were clearly separated. Longer Side of the building was positioned to Face North -South Direction to minimize solar gain into the Building. Enough greens are also introduced to cool and also provide fresh air For the Office Complex.

4.2.3.2 Spatial Organization

Most of the spaces were allocated based on standards for the offices and the anthropometry of the human being in relation to the activity within the spaces.

4.2.3.3 Energy Efficiency Strategies

Energy Efficiency strategies are used in the design of the office complex to a large ex

4.2.4 Conceptual Development

4.2.6 Space Allocation / Schedule of Accommodation

SPACES	AREA (m^2)	CAPACITY
INTERNAL SPACES		
Toilets & Urinals	364.26m2	51 toilets & 18 urinals
This is the account of all toilets & urinals across all floors		
Relaxation & Eating Areas	780.38m2	156 Seats
This is an account of all sit-outs, open terraces & restaurants		
Office Spaces	2182.43m2	62 Offices
Accumulation of offices across all floors		
Conferences & Halls	861.58m2	4 conferences & 2 Halls
All meeting rooms, chambers & conference hall		
Disability Considerations	160.2m2	Interior Ramp
Ramp @ 9 degrees inclination from ground floor to the second floor, the provision of three elevators eases disability access beyond the second floor.		
Stairs & Elevators	606.45m2	3 staircases & 3 elevators
This include Main elevators / staircase, service staircase / freight elevator, and emergency staircase. This analysis include the staircase landings and elevator waiting areas.		

SPACES	AREA (m^2)	CAPACITY
EXTERNAL SPACES		
Parking Lot	2,454.69m2	147 Vehicle capacity
Green Areas	12,115.34m2	Grasses, flowers & Trees
Drive ways	3,036.66m2	All drivable routes within the site
Pedestrian Areas	1361.37m2	All spaces where driving is prohibited
Relaxation Area	1114.46m2	56 Umbrella Canopy 224 Seats
Disability Considerations	64.82m2	All ramps outside the building

4.2.7 Construction Methods and materials

The method of construction to be adopted is the frame framing system for the civil work, most other component should be fabricated on site and placed in the right position. The steel work will be prefabricated and placed in position, while the aluminums works will be done by tower aluminums Nigeria and brought to site completed with proper specification. Due to the nature of the site soil, pile Foundation its deep pile columns will be used to support the building. All wiring and piping should be by conduit and the water supply pipe should be ppr pipes with less joints and thus reducing leakages.

The external work will be properly completed, with trees planted and well-guarded for it to nurture, walk ways will be put in place with concrete paving stone.

The material for construction will be predominantly concrete, steel and glass will be used in some areas.

- **Reinforced Concrete**

The high structural strength of concrete (especially when reinforced with steel) make sit the perfect‘material for the structural. The fluidity of reinforced concrete make sit a good construction material for curved, slanted wall.

Steel

Steel offers many advantages, primarily high strength hanductility. It is also durable if protected from corrosion. Relatively, the higher yield stress of steel allows for smaller sections and its lower weight reduces foundation requirement.

4.2.8 Building Services

4.2.8.1 Water supply

The site has access to water supply from Eko Atlantic water Board, however there will be provision for ground water tank and overhead water tank for the purpose of storage. Duct are located close to the wet areas of the building. The ducts are wide enough to be accessible from the back for easy maintenance.

4.2.8.2 Power supply

Power shall be tapped from the Power Holding Company of Nigeria (PHCN)‘s national grid. However, the design shall also cater for its own power needs. There is provision for building integrated photo voltaic panel for alternative power source. Transformer will also be installed on the site because of the amount of power needed by the facility.

4.2.8.3 Refuse disposal

The building has as hoot for refuse disposal from each floor, this is an enclosed place where there fuse will be thrown form each floor and collected on the ground floor to avoid littering of all the space. From here it‘s going to be taking to site waste disposal prior to when the disposal agency will come for the final disposal

4.2.8.4 Waste water and sewage disposal

Waste water from water closets should be drain through the central sewer line to the sewage treatment plant for treatment and subsequently disposed environmental board

4.2.8.5 Firefighting system

Fire hydrants for easy water collection by firefighters, fire extinguisher should be strategically located on the corridors, smoked etectors water sprinklers should be provide din each space and corridors

Chapter 5

Conclusion and recommendation

Project Appraisal

The research work is built on the subject of sustainability efficiency in office Building, the problem definition being that architectural design elements can offer a better methodology towards achieving **Energy** efficiency within the Building. The argument draws its background to the study of Office Complex within and outside Nigeria.

Review of relevant literature on the issue of sustainable principles of architectural design in having a conceptual framework in which architectural design elements can be applicable. Certain key Strategies such as Site planning and landscaping, Building envelope and material types, Building Orientation, Form and ventilation among others were highlighted and discussed in the research to achieve Energy efficient office complex. Case studies were analyzed using specific variables directly related to the subject of the research as well as the use of structured questionnaire to user and maintenance staffs to aid in acquiring more information about the Study. Findings from the literature review, questionnaire as well as the five areas studied were thus used in generating a design and planning concepts for the proposed Office complex.

Conclusion

The problems associated with Energy efficiency in office Buildings has overtime not been addressed properly, thus architects and designers are beck on to address the issue from the design stage, as this will make the facility to consume less energy. This is first done by applying Energy efficiency strategies During design and Construction, there is possibility of achieving about 70% lesser drop in energy consumption within the facility.

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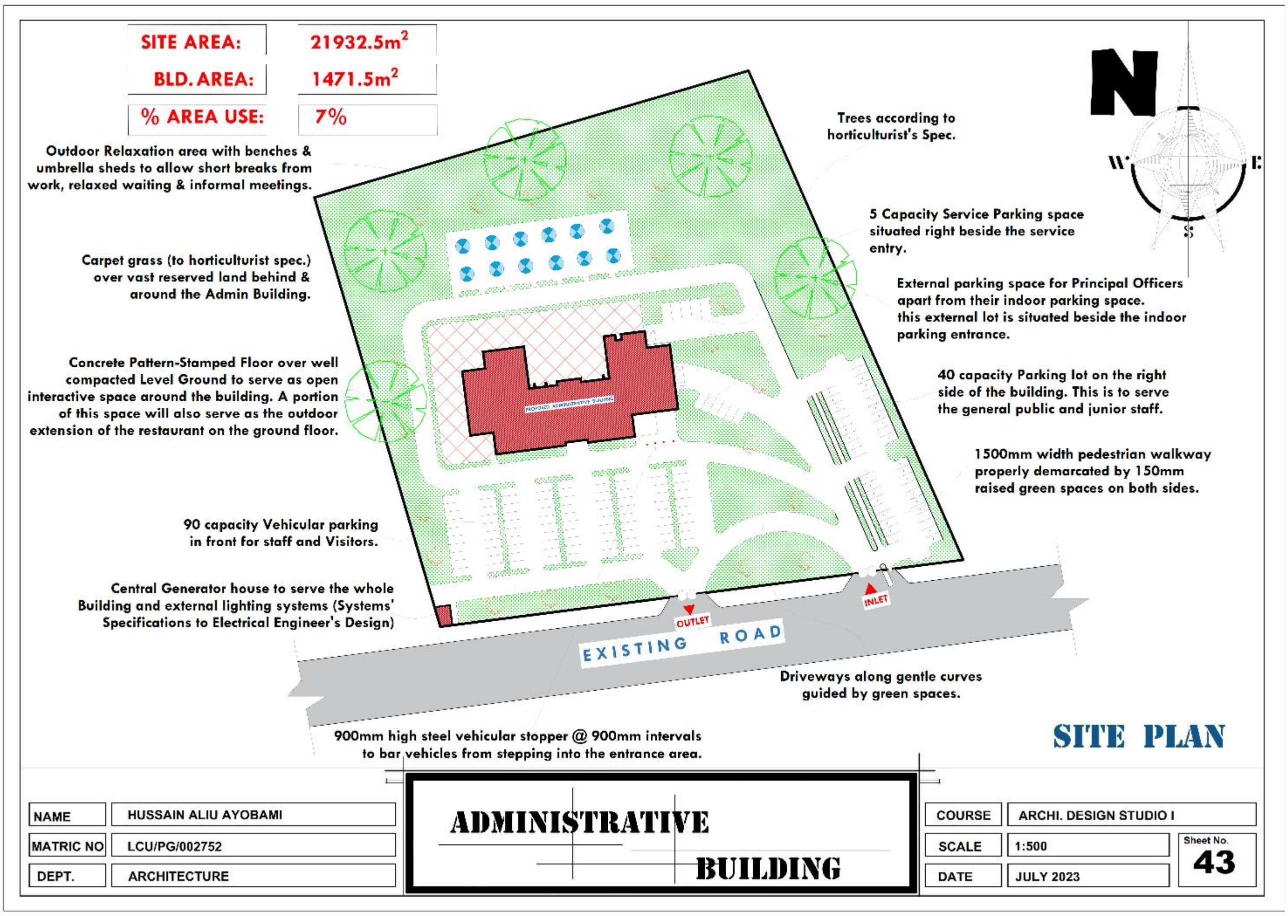
Appendix

APPENDIX 1: Showing the site Location map

Appendixes

AppendixI: Presentation Drawings



SITE AREA: 21932.5m²
BLD. AREA: 1471.5m²
% AREA USE: 7%
Outdoor Relaxation area with benches & umbrella sheds to allow short breaks from work, relaxed waiting & informal meetings.
Carpet grass (to horticulturist spec.) over vast reserved land behind & around the Admin Building.
Concrete Pattern-Stamped Floor over well compacted Level Ground to serve as open interactive space around the building. A portion of this space will also serve as the outdoor extension of the restaurant on the ground floor.
90 capacity Vehicular parking in front for staff and Visitors.
Central Generator house to serve the whole Building and external lighting systems (Systems' Specifications to Electrical Engineer's Design)
Trees according to horticulturist's Spec.
5 Capacity Service Parking space situated right beside the service entry.
External parking space for Principal Officers apart from their indoor parking space. this external lot is situated beside the indoor parking entrance.
40 capacity Parking lot on the right side of the building. This is to serve the general public and junior staff.
1500mm width pedestrian walkway properly demarcated by 150mm raised green spaces on both sides.
OUTLET
INLET
EXISTING ROAD
Driveways along gentle curves guided by green spaces.
900mm high steel vehicular stopper @ 900mm intervals to bar vehicles from stepping into the entrance area.
SITE PLAN
NAME
HUSSAIN ALIU AYOBAMI
MATRIC NO
LCU/PG/002752
DEPT.
ARCHITECTURE
ADMINISTRATIVE BUILDING
COURSE
ARCHI. DESIGN STUDIO I
SCALE
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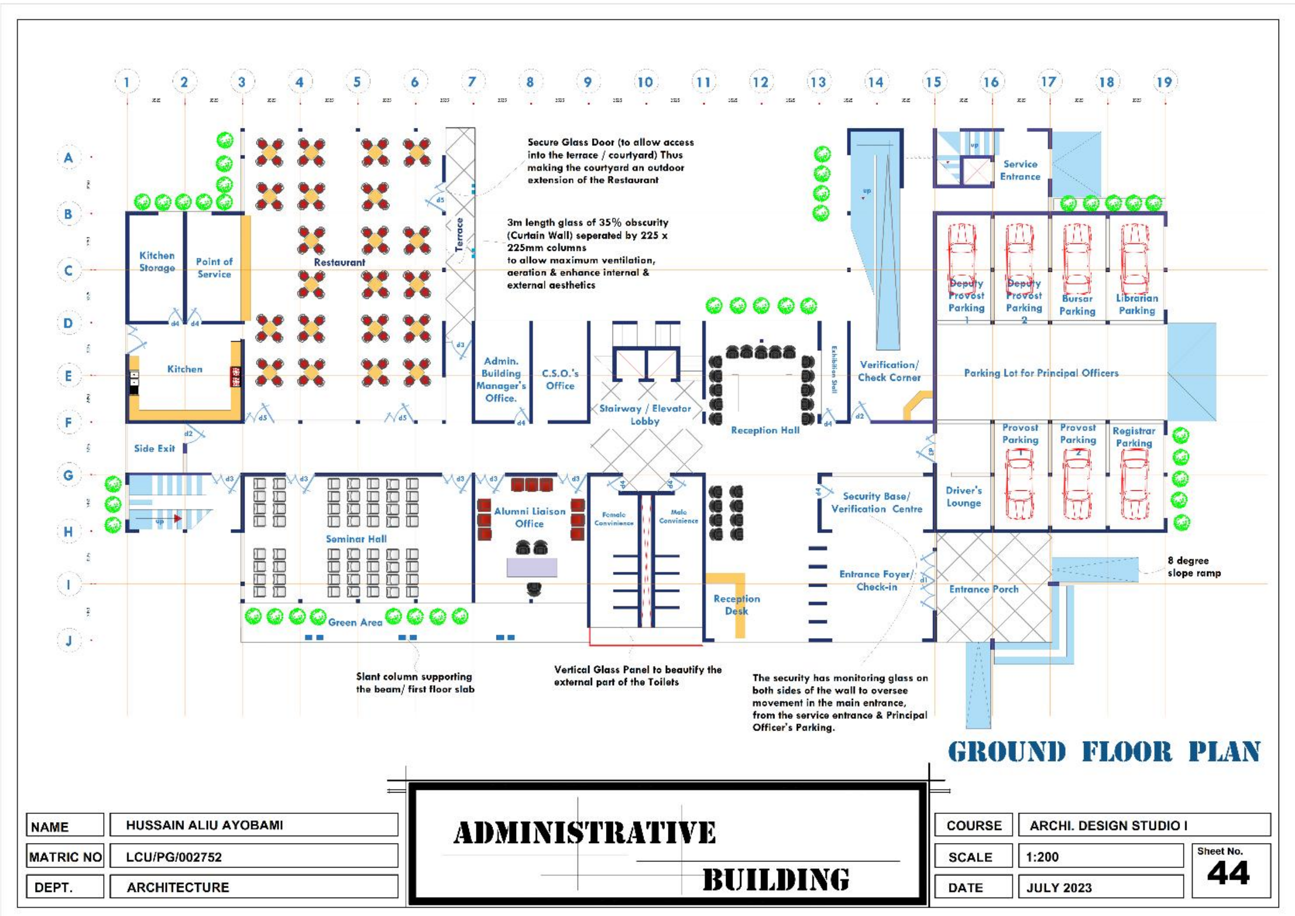
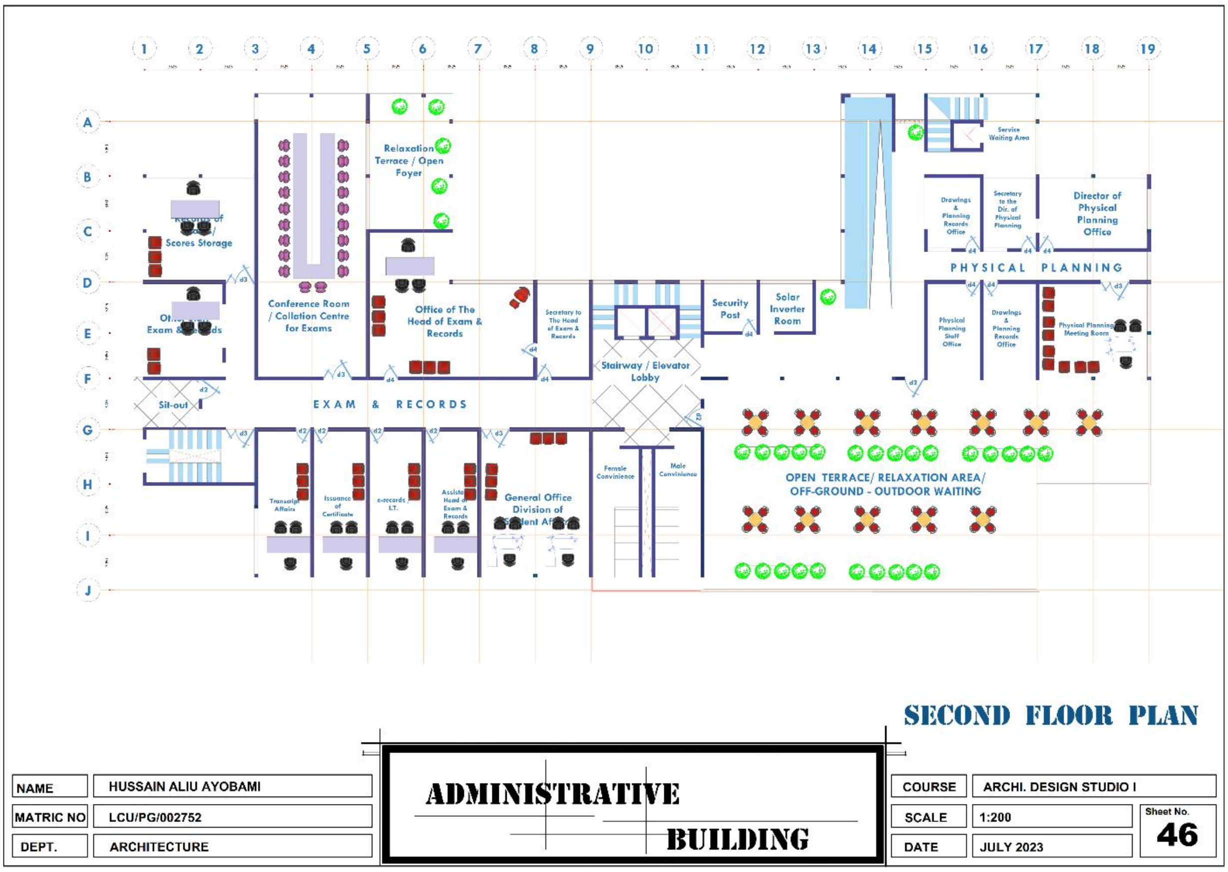
DATE
JULY 2023
Sheet No.
43



Secure Glass Door (to allow access into the terrace / courtyard) Thus making the courtyard an outdoor extension of the Restaurant
3m length glass of 35% obscurity (Curtain Wall) seperated by 225 x 225mm columns to allow maximum ventilation, aeration & enhance internal & external aesthetics
Kitchen Storage
Point of Service
Restaurant
Terrace
Kitchen
Side Exit
Seminar Hall
Green Area
Admin. Building Manager's Office.
C.S.O.'s Office
Stairway / Elevator Lobby
Reception Hall
Exhibition Stall
Alumni Liaison Office
Female Convinience
Male Convinience
Reception Desk
Verification/ Check Corner
Security Base/ Verification Centre
Entrance Foyer/ Check-in
Entrance Porch
Service Entrance
Deputy Provost Parking 1
Deputy Provost Parking 2
Bursar Parking
Librarian Parking
Parking Lot for Principal Officers
Provost Parking
Provost Parking
Registrar Parking
Driver's Lounge
8 degree slope ramp
Slant column supporting the beam/ first floor slab
Vertical Glass Panel to beautify the external part of the Toilets
The security has monitoring glass on both sides of the wall to oversee movement in the main entrance, from the service entrance & Principal Officer's Parking.
GROUND FLOOR PLAN
NAME
HUSSAIN ALIU AYOBAMI
MATRIC NO
LCU/PG/002752
DEPT.
ARCHITECTURE
ADMINISTRATIVE BUILDING
COURSE
ARCHI. DESIGN STUDIO I
SCALE
1:200
DATE
JULY 2023
Sheet No.
44



Conference Room / Collation Centre for Exams
Relaxation Terrace / Open Foyer
Scores Storage
Office of The Head of Exam & Records
Stairway / Elevator Lobby
Security Post
Solar Inverter Room
Director of Physical Planning Office
PHYSICAL PLANNING
Sit-out
EXAM & RECORDS
General Office Division of Student Affairs
OPEN TERRACE/ RELAXATION AREA/ OFF-GROUND - OUTDOOR WAITING
SECOND FLOOR PLAN
NAME
HUSSAIN ALIU AYOBAMI
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ARCHITECTURE
ADMINISTRATIVE BUILDING
COURSE
ARCHI. DESIGN STUDIO I
SCALE
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Sheet No.
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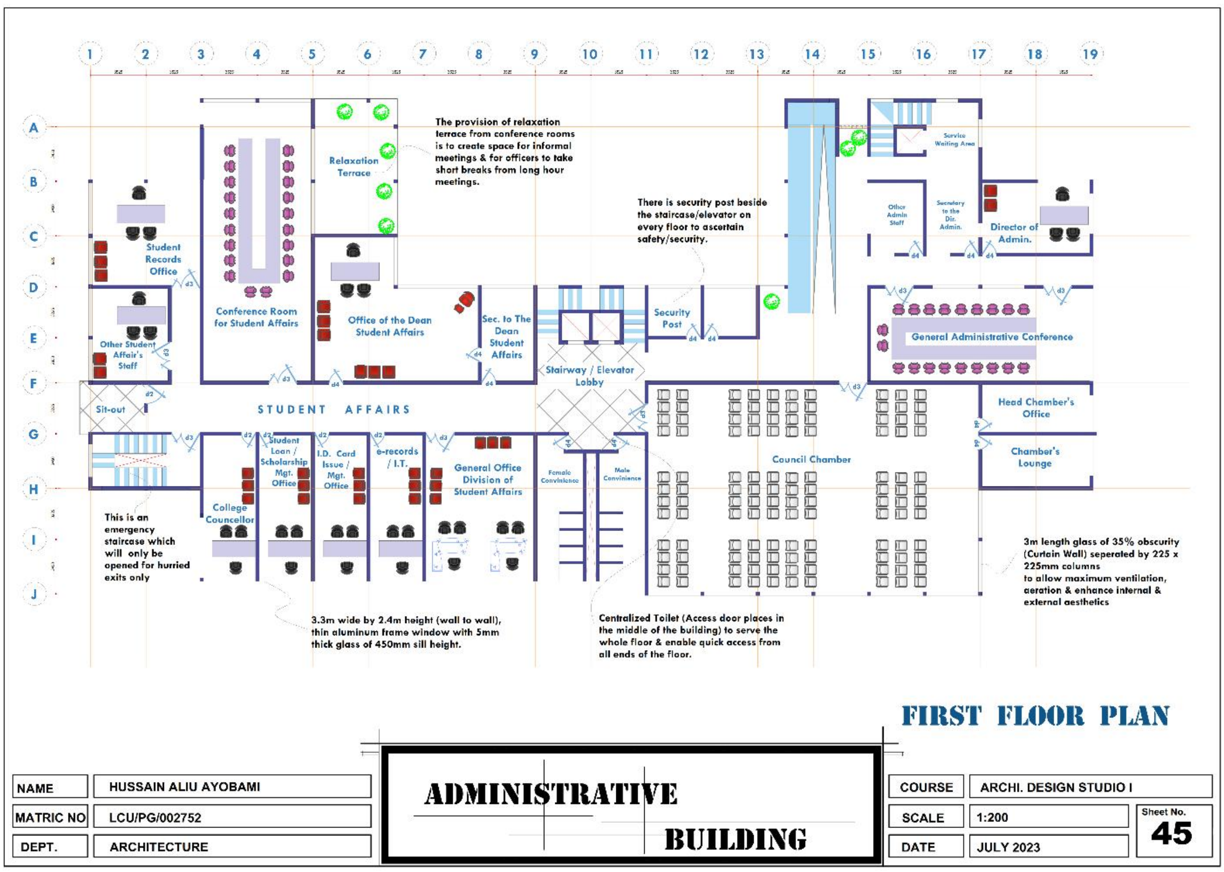

Relaxation Terrace
The provision of relaxation terrace from conference rooms is to create space for informal meetings & for officers to take short breaks from long hour meetings.
There is security post beside the staircase/elevator on every floor to ascertain safety/security.
Student Records Office
Conference Room for Student Affairs
Office of the Dean Student Affairs
Sec. to The Dean Student Affairs
Stairway / Elevator Lobby
Security Post
Director of Admin.
General Administrative Conference
Other Student Affair's Staff
Sit-out
STUDENT AFFAIRS
Head Chamber's Office
Chamber's Lounge
Council Chamber
I.D. Card Issue / Mgt. Office
e-records / I.T.
General Office Division of Student Affairs
College Councellor
This is an emergency staircase which will only be opened for hurried exits only
3.3m wide by 2.4m height (wall to wall), thin aluminum frame window with 5mm thick glass of 450mm sill height.
Centralized Toilet (Access door places in the middle of the building) to serve the whole floor & enable quick access from all ends of the floor.
3m length glass of 35% obscurity (Curtain Wall) seperated by 225 x 225mm columns to allow maximum ventilation, aeration & enhance internal & external aesthetics
FIRST FLOOR PLAN
NAME
HUSSAIN ALIU AYOBAMI
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ADMINISTRATIVE BUILDING
COURSE
ARCHI. DESIGN STUDIO I
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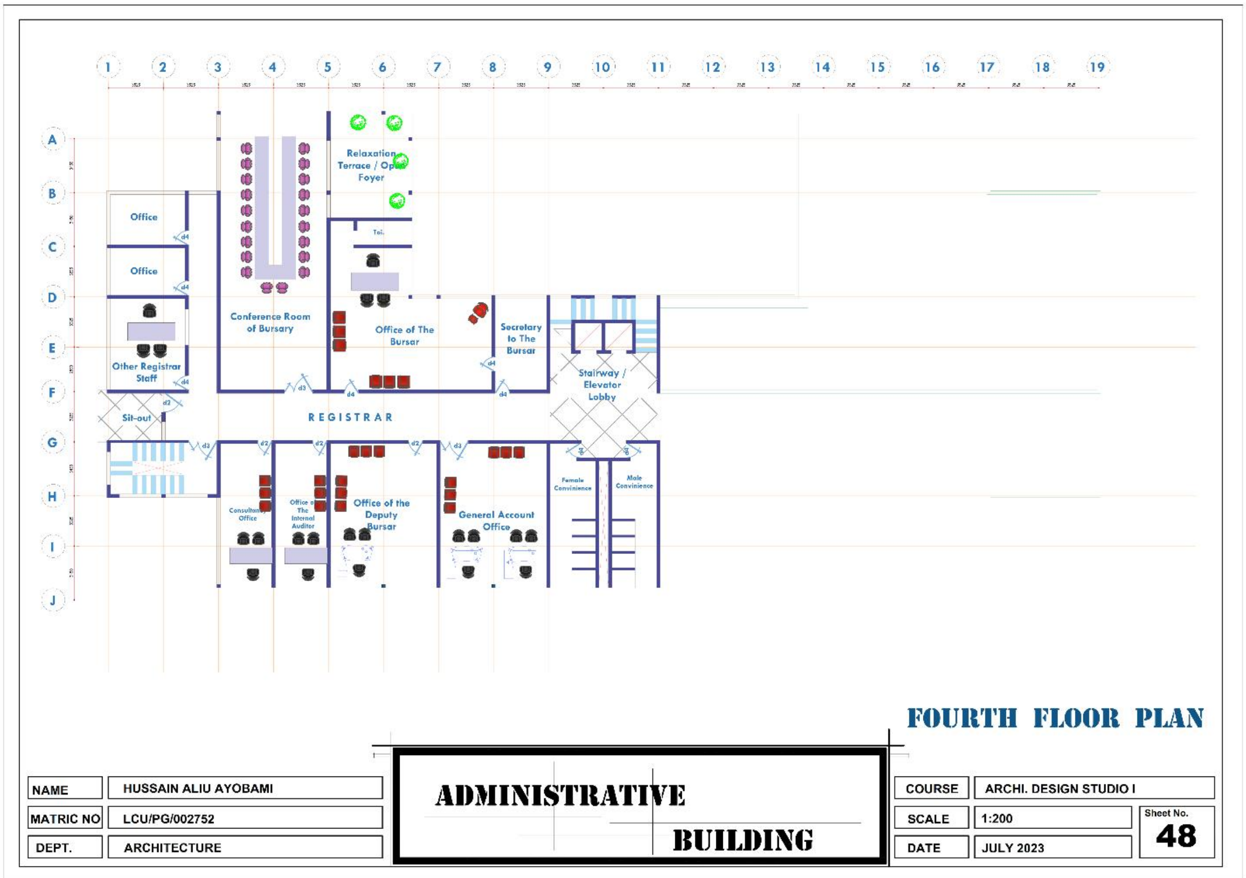
Office
Office
Other Registrar Staff
Sit-out
Conference Room of Bursary
Relaxation Terrace / Open Foyer
Toi.
Office of The Bursar
Secretary to The Bursar
Stairway / Elevator Lobby
REGISTRAR
Consultant Office
Office of The Internal Auditor
Office of the Deputy Bursar
General Account Office
Female Convinience
Male Convinience
FOURTH FLOOR PLAN
NAME
HUSSAIN ALIU AYOBAMI
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ARCHI. DESIGN STUDIO I
SCALE
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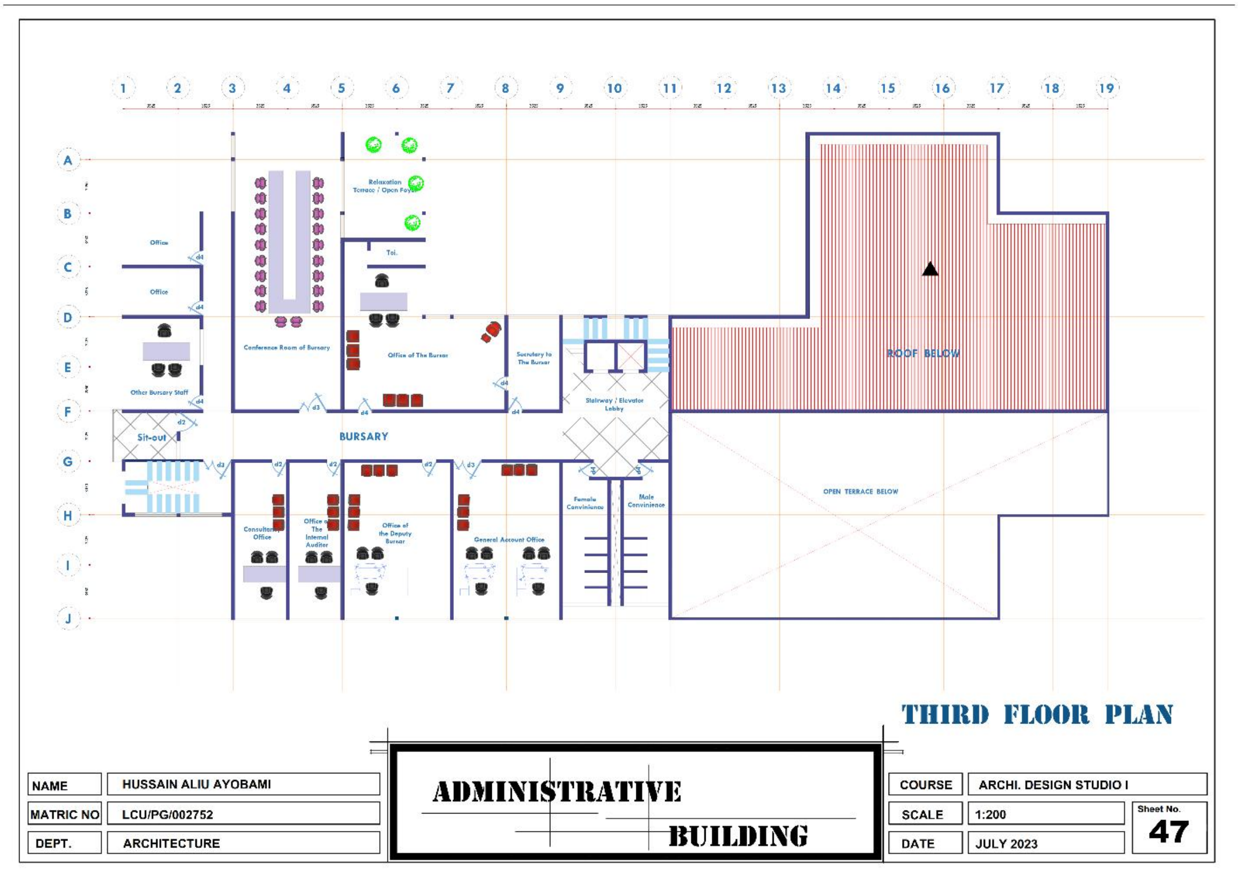
JULY 2023
Sheet No.
48


Office
Office
Other Bursary Staff
Sit-out
Conference Room of Bursary
Relaxation Terrace / Open Foyer
Toi.
Office of The Bursar
Secretary to The Bursar
Stairway / Elevator Lobby
BURSARY
Consultant Office
Office of The Internal Auditor
Office of the Deputy Bursar
General Account Office
Female Convinience
Male Convinience
ROOF BELOW
OPEN TERRACE BELOW
THIRD FLOOR PLAN
NAME
HUSSAIN ALIU AYOBAMI
MATRIC NO
LCU/PG/002752
DEPT.
ARCHITECTURE
ADMINISTRATIVE BUILDING
COURSE
ARCHI. DESIGN STUDIO I
SCALE
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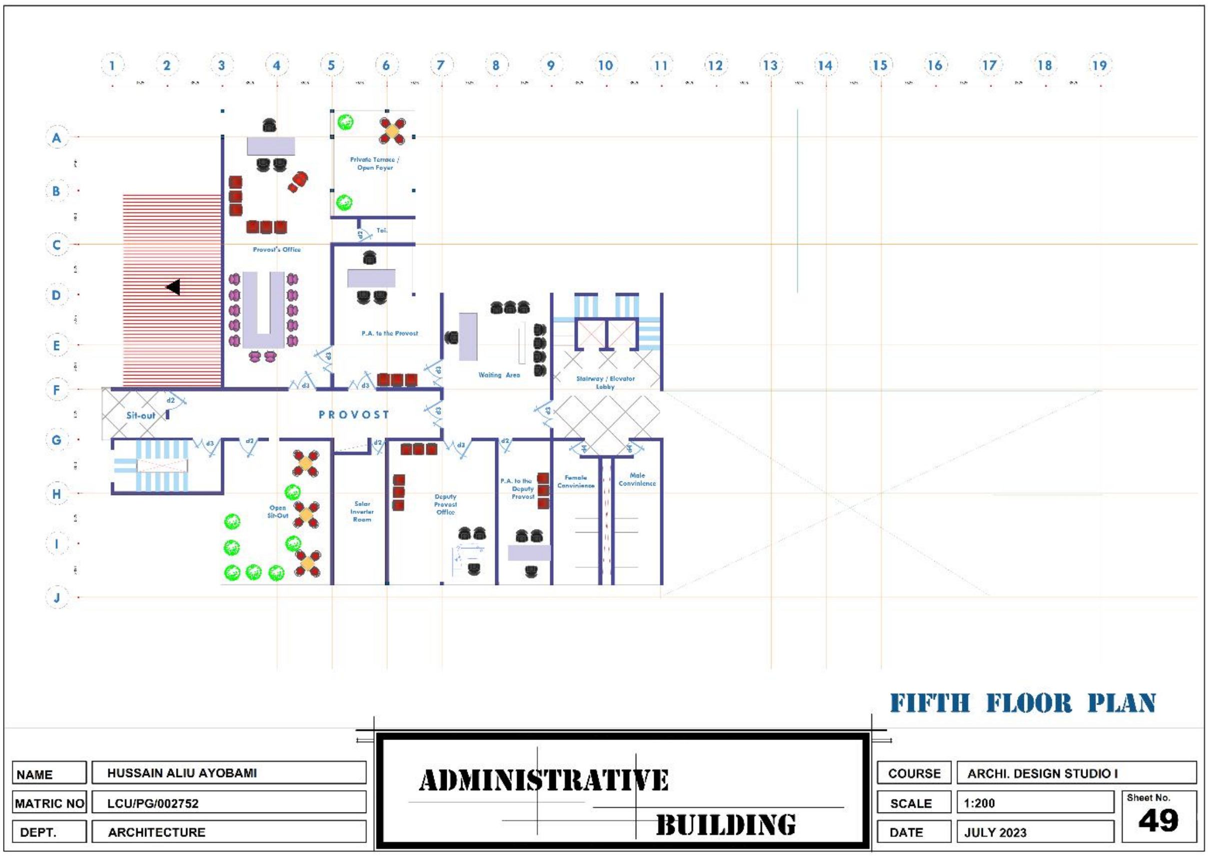
DATE
JULY 2023
Sheet No.
47


FIFTH FLOOR PLAN
PROVOST
NAME
HUSSAIN ALIU AYOBAMI
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DEPT.
ARCHITECTURE
ADMINISTRATIVE BUILDING
COURSE
ARCHI. DESIGN STUDIO I
SCALE
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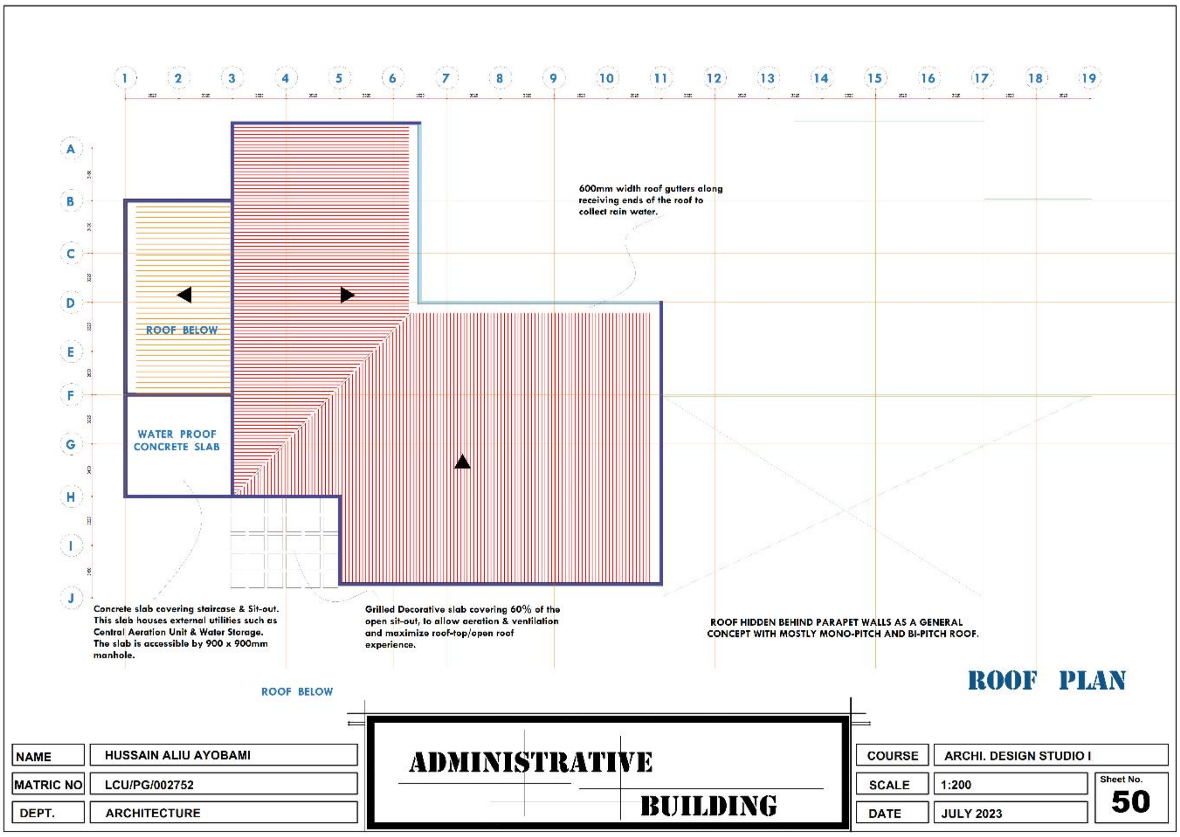
DATE
JULY 2023
Sheet No.
49


600mm width roof gutters along receiving ends of the roof to collect rain water.
ROOF BELOW
WATER PROOF CONCRETE SLAB
Concrete slab covering staircase & Sit-out. This slab houses external utilities such as Central Aeration Unit & Water Storage. The slab is accessible by 900 x 900mm manhole.
Grilled Decorative slab covering 60% of the open sit-out, to allow aeration & ventilation and maximize roof-top/open roof experience.
ROOF HIDDEN BEHIND PARAPET WALLS AS A GENERAL CONCEPT WITH MOSTLY MONO-PITCH AND BI-PITCH ROOF.
ROOF BELOW
ROOF PLAN
NAME
HUSSAIN ALIU AYOBAMI
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Sheet No.
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3D DRAWING 2

3D Image showing the Front / Right Sides perspective of the Building

Aliu Hussain Ayobami | Matric No: LCU/PG/002752

76

3D DRAWING 1

3D Image showing the Left / Front Sides of the Proposed Administrative Building

Aliu Hussain Ayobami | Matric No: LCU/PG/002752

75

3D DRAWING 3

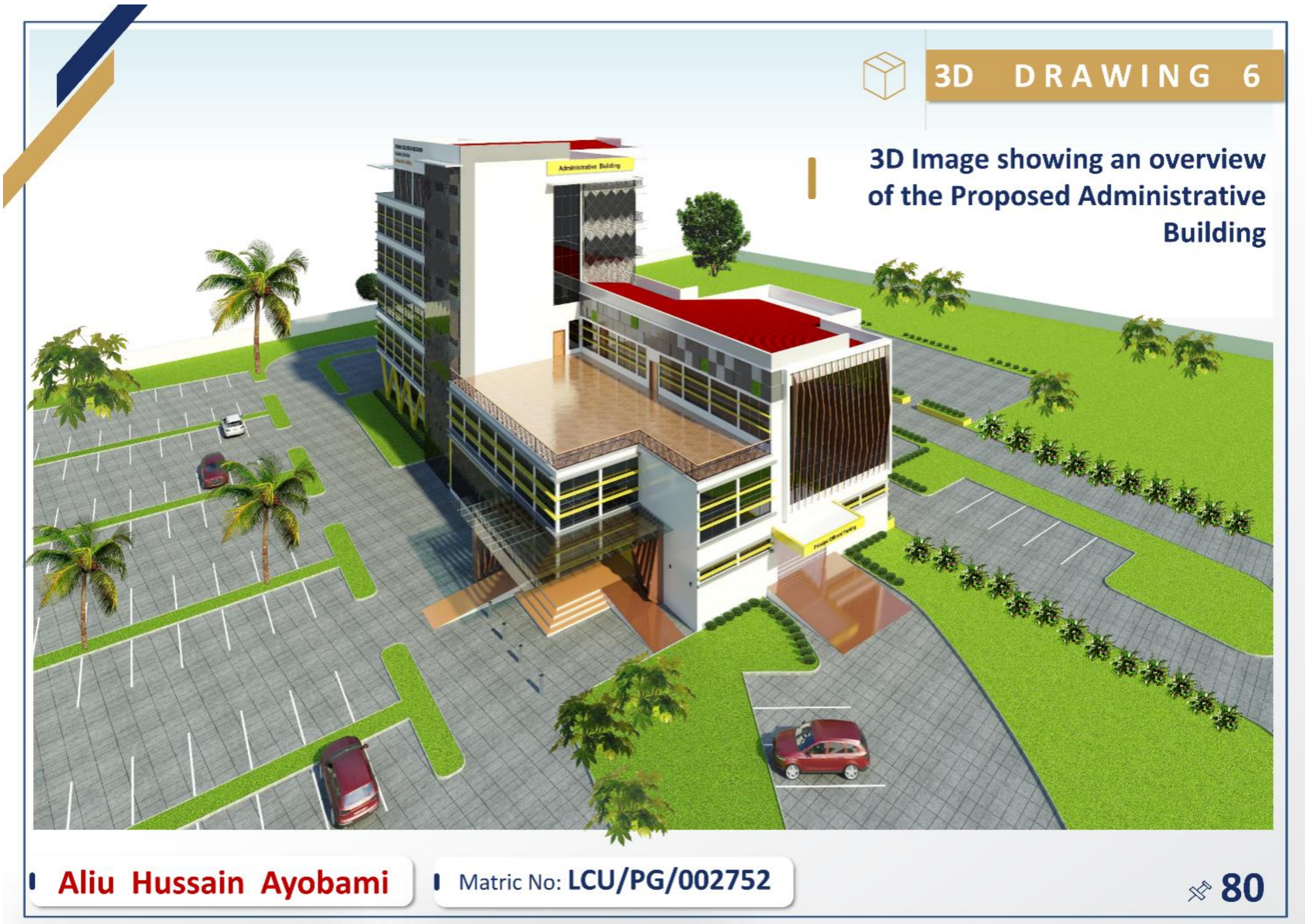
3D Image showing the Rear end of the building from the Right side

Aliu Hussain Ayobami | Matric No: LCU/PG/002752 | 77

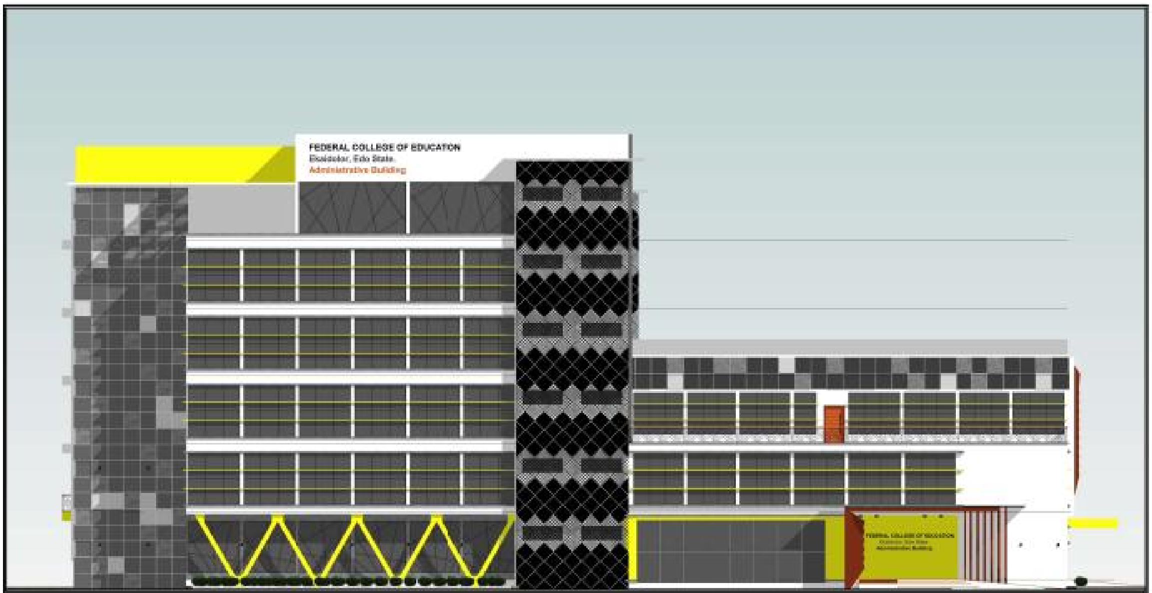
3D DRAWING 4

3D Image showing the Rear end of the Building from the Right Side

Aliu Hussain Ayobami | Matric No: LCU/PG/002752 | 78


3D DRAWING 6
3D Image showing an overview of the Proposed Administrative Building
Aliu Hussain Ayobami
Matric No: LCU/PG/002752
80


3D DRAWING 5
FEDERAL COLLEGE OF EDUCATION
Ekaidolor, Edo State.
Administrative Building
3D Image showing the Rear end of the Building from the Right Side
Aliu Hussain Ayobami
Matric No: LCU/PG/002752
79



FRONT ELEVATION

NAME	HUSSAIN ALIU AYOBAMI	**ADMINISTRATIVE BUILDING**	COURSE	ARCHI. DESIGN STUDIO I
MATRIC NO	LCU/PG/002752		SCALE	1:200
DEPT.	ARCHITECTURE		DATE	JULY, 2023
			Sheet No	**51**

LEFT ELEVATION

NAME	HUSSAIN ALIU AYOBAMI	**ADMINISTRATIVE BUILDING**	COURSE	ARCHI. DESIGN STUDIO I
MATRIC NO	LCU/PG/002752		SCALE	1:200
DEPT.	ARCHITECTURE		DATE	JULY, 2023
			Sheet No	**54**

BACK ELEVATION

NAME	HUSSAIN ALIU AYOBAMI	ADMINISTRATIVE BUILDING	COURSE	ARCHI. DESIGN STUDIO I	
MATRIC NO	LCU/PG/002752		SCALE	1:200	Sheet No 52
DEPT.	ARCHITECTURE		DATE	JULY, 2023	

RIGHT ELEVATION

NAME	HUSSAIN ALIU AYOBAMI	ADMINISTRATIVE BUILDING	COURSE	ARCHI. DESIGN STUDIO I	
MATRIC NO	LCU/PG/002752		SCALE	1:200	Sheet No 53
DEPT.	ARCHITECTURE		DATE	JULY, 2023	

SECTION A-A

NAME	HUSSAIN ALIU AYOBAMI	administrative building	COURSE	ARCHI. DESIGN STUDIO I		
MATRIC NO	LCU/PG/002752		SCALE	1:200	Sheet No	57
DEPT.	ARCHITECTURE		DATE	JULY, 2023		

SECTION B-B

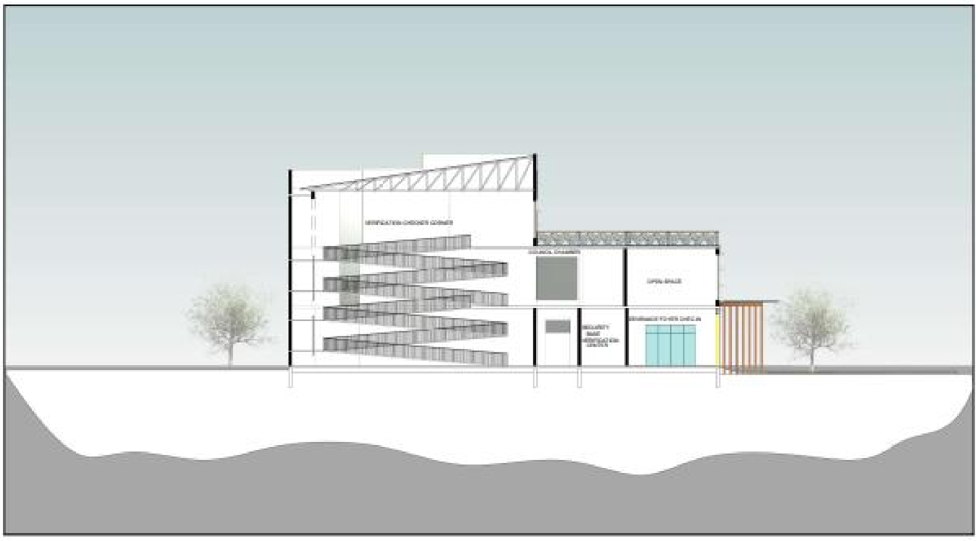
NAME	HUSSAIN ALIU AYOBAMI	administrative building	COURSE	ARCHI. DESIGN STUDIO I		
MATRIC NO	LCU/PG/002752		SCALE	1:200	Sheet No	55
DEPT.	ARCHITECTURE		DATE	JULY, 2023		

SECTION C-C

NAME	HUSSAIN ALIU AYOBAMI	administrative building	COURSE	ARCHI. DESIGN STUDIO I		
MATRIC NO	LCU/PG/002752		SCALE	1:200	Sheet No	
DEPT.	ARCHITECTURE		DATE	JULY, 2023	57	

SECTION D-D

NAME	HUSSAIN ALIU AYOBAMI	administrative building	COURSE	ARCHI. DESIGN STUDIO I		
MATRIC NO	LCU/PG/002752		SCALE	1:200	Sheet No	
DEPT.	ARCHITECTURE		DATE	JULY, 2023	58	



SECTION B-B

NAME	HUSSAIN ALIU AYOBAMI	administrative building	COURSE	ARCHI. DESIGN STUDIO I
MATRIC NO	LCU/PG/002752		SCALE	1:200
DEPT.	ARCHITECTURE		DATE	JULY, 2023
			Sheet No	56

SECTION A-A

NAME	HUSSAIN ALIU AYOBAMI	administrative building	COURSE	ARCHI. DESIGN STUDIO I
MATRIC NO	LCU/PG/002752		SCALE	1:200
DEPT.	ARCHITECTURE		DATE	JULY, 2023
			Sheet No	55

Biodata

A. Personal Data

Full Name: Aliu Ayobami HUSSAIN

Address: No 3, Odekunle Street, Agbowo, UI, Ibadan

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Place of Birth: Ibadan, Oyo State

Nationality: Nigerian

Marital Status: Single

Name and Address of Next of Kin:

B. Educational background

Educational Institutions Attended with Dates

a. Primary Education
   - Ad-din International School — 1996 - 2002

b. Secondary Education
   - i. Muslim International School — 2002 - 2008

c. Higher Education
   - i. Lead City University — 2019 - 2021

C. Academic and Professional Qualifications with Dates

i. Bachelor of Science (B.Sc) Architecture — 2021
ii. West Africa School Certificate — 2008
iii. Primary School Leaving Certificate — 2002

D. Work Experience with Dates

Architect, Masad Consult — 2009 - 2015

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Date　　　　　　　　　　　　　　　　　　　　　Signature

University Compliance Certificate

This is to certify that the Thesis by Aliu Ayobami HUSSAIN with matriculation number LCU/PG/002752 in the department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, is in full compliance with the University format and style of Thesis.

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Date   Signature