Proposed Faculty of Heath Sciences for Lead City University, Ibadan through the Incorporation of Day Lighting and Ventilation Design Principles

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Certification

This is to certify that, Babatunde Oluwafemi MAKANJUOLA with matriculation number LCU/PG/004059 carried out this research work titled 'Incorporation of Day Lighting and Ventilation Principles in a Faculty of Health Sciences' in the department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, Oyo State, for the award of Master Degree (MSc) 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 to any other institution.

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Dedication

This thesis is dedicated to God and my family.

Acknowledgement

I am grateful to the management of Lead city university for the opportunity to learn, providing an enabling environment to learn. I want to sincerely thank God for the success of this Thesis. It has been a rigorous experience, but I am grateful to my supervisor, Arc. Babajide Aseyan, for his mentorship and support in ensuring the successful completion of this program.

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My profound thanks go to my lovely family members both home and abroad. Lastly, even though the above institutions, persons have assisted in the process of this research work, I alone stand responsible for the errors, if any, that may be found in this work.

Abstract

Natural lighting and ventilation are essential components of building design and operation that help to create environments that are favorable for learning, working, and general well-being. However, the inability of many academic buildings to efficiently utilize these natural resources causes a number of problems that have an impact on energy usage and occupant satisfaction. In order to overcome these obstacles, all-encompassing plans that give natural lighting and ventilation system integration top priority in faculty building designs are needed. This research investigated the need for healthier, more comfortable, and energy-efficient environments within faculty buildings through literature and case studies. A science faculty building was designed using natural lighting and ventilation principles and elements to enhance human activity and promote energy efficiency. The study concludes that natural systems of lighting and ventilation are essential aspects of any building and should be prioritized in design and construction.

Keywords: Natural Lighting, Daylighting, Faculty building, Health Sciences, Ventilation

Word Count: 144 words

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Chapter One

Introduction

1.1 Background of the Study

Natural lighting and ventilation are essential components of building design and operation that help to create environments that are favorable for learning, working, and general well-being. While natural ventilation refers to the movement of air between a building's interior and exterior without the use of mechanical systems, natural lighting is the use of sunlight to illuminate interior spaces (Iqbal, Munir, Sari, 2021). Effective integration of these components improves energy efficiency while also fostering occupant productivity, comfort, and health (Zhang et al, 2022).

Assessing the amount of natural light and airflow in academic buildings is an important task for sustainable building practices and architectural design. In order to create environments that are favorable for learning and working in educational institutions, natural elements like light and airflow are essential. The evaluation of natural lighting and ventilation systems' effectiveness becomes critical in today's architectural discourse (Waheeb & Hemeida 2022) due to the growing emphasis on energy efficiency, occupant comfort, and overall well-being.

Natural lighting and ventilation work together to create healthier and more productive indoor environments while also lowering energy use and lessening environmental impact (Pan, Zhong, Zheng, Xu & Zhang, 2024). Optimizing building performance and raising the general standard of educational spaces require an understanding of the interactions between architectural design, environmental elements, and human behavior. By means of thorough assessment techniques and empirical investigation, we aim to clarify optimal approaches and suggestions for architects, building designers, and educational stakeholders.

The process of effectively letting natural light inside a building involves using outside glazing, such as windows and skylights. Daylighting has been defined as the controlled entry of natural light (such as direct sunlight and diffused skylight) into a building with the goal of reducing the need for electric lighting and saving energy.

Natural lighting was important to the earliest clave residents' lives because it allowed them to distinguish between day and night. On the other hand, window openings were incorporated because of improved building designs. As a result, windows have long been used in architecture to provide natural lighting by letting in light, air, and temperature. Therefore, it is possible to think of the window as the means by which daylighting was introduced, leading to the sophisticated building designs of the twenty-first century (Zoure & Genovese, 2023).

Sunlight is one of the main natural lighting materials that humans have access to. One type of solar energy that can be either absorbed, reflected, or transmitted is sunlight. The sun's latitudes, seasons, times, and elevation angles vary due to the Earth's relative movement around the sun. Nevertheless, other types of daylighting are produced by internal reflection, which is light bouncing off your home's interior walls, ceiling, and floor, and external reflection, which is light bouncing off nearby buildings, light shelves, and wide window sills. Interior reflection was also influenced by highly reflective surfaces, such as glossy or smooth surfaces, light-colored finishes, and mirrors positioned throughout a space (Alkhatib, Lemarchand, Norton & O'Sullivan, 2021).

Moreover, it has been determined that natural lighting is an effective architectural tool for designing buildings (Hassan, Ali & Ahmed 2023). It provides passive support for the uniformity and quality of daylighting throughout a structure by capturing and reflecting natural light into the darker areas of the building. An adequate natural lighting scheme eliminates the need for any specialized mechanical equipment or energy sources in the building. As soon as the sun comes up, the passive daylighting techniques gather and reflect light throughout the building.

In order to achieve sufficient natural lighting in buildings, the science of daylighting highlights the need to maintain equilibrium between heat gains and losses, manage glare, and prevent unfavorable effects from fluctuations in daylight availability. Windows, passive or active skylights, daylight redirection devices, solar shading devices, and tubular daylight devices are a few examples of daylighting fixtures. Natural lighting generally results in energy savings (Garcia-Fernandez & Omar 2023), satisfies human mental and physical needs, maximizes visual comfort (Callejas et al. 2020), enhances psychological and physical well-being, and influences the choice of color and type of decoration. The fact that it has been shown to improve student performance and learning is more significant.

By starting this evaluation process, we hope to find insights that will guide future design choices and open the door to faculty buildings that are human-centered, sustainable, and encourage innovation, learning, and teamwork. With careful research and analysis, we hope to add to the continuing conversation about the relationship between architecture, sustainability, and human welfare in learning environments (Kızılörenli & Maden, 2023).

1.2 Statement of the Problem

Optimizing natural lighting and ventilation in faculty buildings is essential to creating environments that are favorable for learning and working. However, the inability of many academic buildings to efficiently utilize these natural resources causes a number of problems that have an impact on energy usage and occupant satisfaction (Ishac & Nadim,2020). The insufficient amount of natural light that enters interior spaces is one major problem. In addition to causing eye strain, poorly lit offices and classrooms can also create a gloomy environment that lowers focus and productivity. Furthermore, the use of artificial lighting to make up for inadequate natural lighting raises operating costs and energy consumption, and this presents problems for sustainability (Zhou & Leng, 2023).

Certain aspects of classroom design are important to maximize student achievement (Dai, An, Huang & Chen 2024), it was discovered that one of the things impeding students' performance was insufficient natural lighting. Additionally, working in classrooms without natural light can change students' hormone patterns, impairing their ability to focus and collaborate and potentially resulting in health problems.

The impact of natural lighting on academic performance and the well-being of lecturers and students in buildings meant for academic purposes in Nigerian institutions is another area where scientific data is lacking (Elghamry & Hassan, 2020).

In order to overcome these obstacles, all-encompassing plans that give natural lighting and ventilation system integration top priority in faculty building designs are needed. Therefore, this research seeks to create healthier, more comfortable, and energy-efficient environments for faculty, staff, and students alike, via solutions that seek to maximize daylight penetration, improve airflow and ventilation efficiency, and promote sustainable practices.

1.3 Aim and Objectives

This study aims at appraising the natural lighting and ventilation of selected National and international faculty buildings to assess the adequacy of natural illumination and ventilation with a view to garner sufficient theoretical information useful for the proposed design of a new Faculty of health sciences building, Leads City University, Ibadan, thus enhancing students' academic performance. The objectives of this study are to:

1. Assess the adequacy of natural lighting in the case studies of selected local and international faculty buildings.
2. Identify design and construction strategies that can encourage the use of natural lighting and ventilation in a faculty building.
3. Propose a naturally reliable faculty building for Lead City University incorporating the design strategies investigated.

1.4 Research Questions

1. To what extent was natural lighting and ventilation principles adhering in the planning and building of the chosen case studies?
2. What design strategies are needed to achieve natural lighting and ventilation in a faculty building?
3. What strategies can be incorporated in the design of a new faculty building for Lead City University.

1.5 Significance of the study

This research project is aimed at creating a sustainable building that has incorporated excellent lighting and ventilation strategies, maximizing nature. The researcher will also gain more knowledge on sustainable design strategies, its advantages in building design, and how it can be incorporated into building structures (Ding & Kareem, 2020).

1.6 Scope of the study

- This research is only focused on Ibadan city.
- The concepts and approaches that will be used in this design will be suited to the Nigerian tropical climate.

1.7 Definition of Terms

Daylighting: The illumination of buildings by natural light.

Faculty Building: a public building within a university used by specific departments where a particular subject is taught and administered.

Health Sciences: The study of the wellbeing, health or medical care for human beings.

Natural Lighting: the visible part of global solar radiation emitted from the sun and received on the earth's surface after diffusion, attenuation and polarisation by the composition of the atmosphere.

Natural Ventilation: a way of providing new air to a space using the natural force of wind.

Ventilation: the movement of fresh air around a closed space.

Chapter Two
Literature Review

2.1 Conceptual review

This chapter provides an in-depth review of a natural lighting and natural ventilation, highlighting its definitions, characteristics, classification, types, and other relevant information regarding natural light and ventilation designs and strategies. It also examines previous studies by many other researchers in this area of study and analyzes some of the existing literature to determine how the studies were conducted conceptually and theoretically.

2.1.1 Definition of Light

The infinite possibilities that light has, have been evident since the beginning of architecture and they will be used in continuity in the future. In the architectural space, light changes and appears and so it defines the form (Radevski, Karanakov & Papasterevski, 2022). Throughout the centuries, light has inspired people as a natural gift that sustains life on Earth. It is a key element of expression, without which it would be impossible to perceive architectural space and its components(Chęć-małyszek, 2019).

In the realm of architecture, form is defined by the ever-changing and appearing light (Radevski, Karanakov & Papasterevski, 2022). The versatility of light and its close connection to human perception bestows a distinctive character upon objects. It goes beyond mere visibility, shaping an environment, atmosphere, monumentality, intimacy, and tranquility that strongly impact the emotions and sensations of individuals. Light constructs a three-dimensional space, accentuating the building's atmosphere and aesthetic values (Chęć-małyszek, 2019).

2.1.2 Sources of Light

Light comes from many sources, the main one being the sun, providing people with the energy needed for life, this is known as natural light or daylighting (Gui, Yan, Hong, Xiao, Guo & Tao, 2021). The other source of light evolved to augment the main light source, and it is known as artificial light. Without light, life as we know it would not exist.

2.1.2.1 Natural Light

Daylight or natural light is defined as the visible part of global solar radiation emitted from the sun and received on the earth's surface after diffusion, attenuation and polarisation by the composition of the atmosphere (Mahian, Javidmehr, Kasaeian, Mohasseb & Panahi, 2020). Daylight serves the building interior with light received from direct sunlight, clear sky, clouds, and reflections from the ground causing interior variability in intensity and direction of the light admitted using exterior glazing(Skvorc & Kozmar, 2021).

In architecture, daylighting is the utilization of natural light, whether it's intense sunlight or gentle overcast light, to meet the visual needs of people in a building (Hoseinzadeh, Assadi, Heidari, Khalatbari, Saidur & Sangin, 2021). Day lighting is focused on designing buildings to utilize natural light to its fullest, and it involves fundamental architectural considerations that must be incorporated from the design phase (Nitu, Gocer, Wijesooriya, Vijapur, Candido, 2022).It is an excellent light source for almost all interior spaces, and it is highly desirable as a light source because people respond positively to it. The amount of available daylight varies according to time of day, time of year, weather, pollution levels, and so on. For energy efficiency in buildings, however, only about 5% of the daylight, should be allowed into a building; more will generate so much heat that energy will be wasted in air conditioning (Nitu, Gocer, Wijesooriya, Vijapur, Candido, 2022).

Daylight design in architecture has always been important because it symbolizes cultural traditions and human needs. The requirements of daylight and ventilation became an essential aspect of the architecture, taking the ideas from the Renaissance architecture, by its E- and H-shaped floor plans (Aboulnaga & Maryam, 2022).

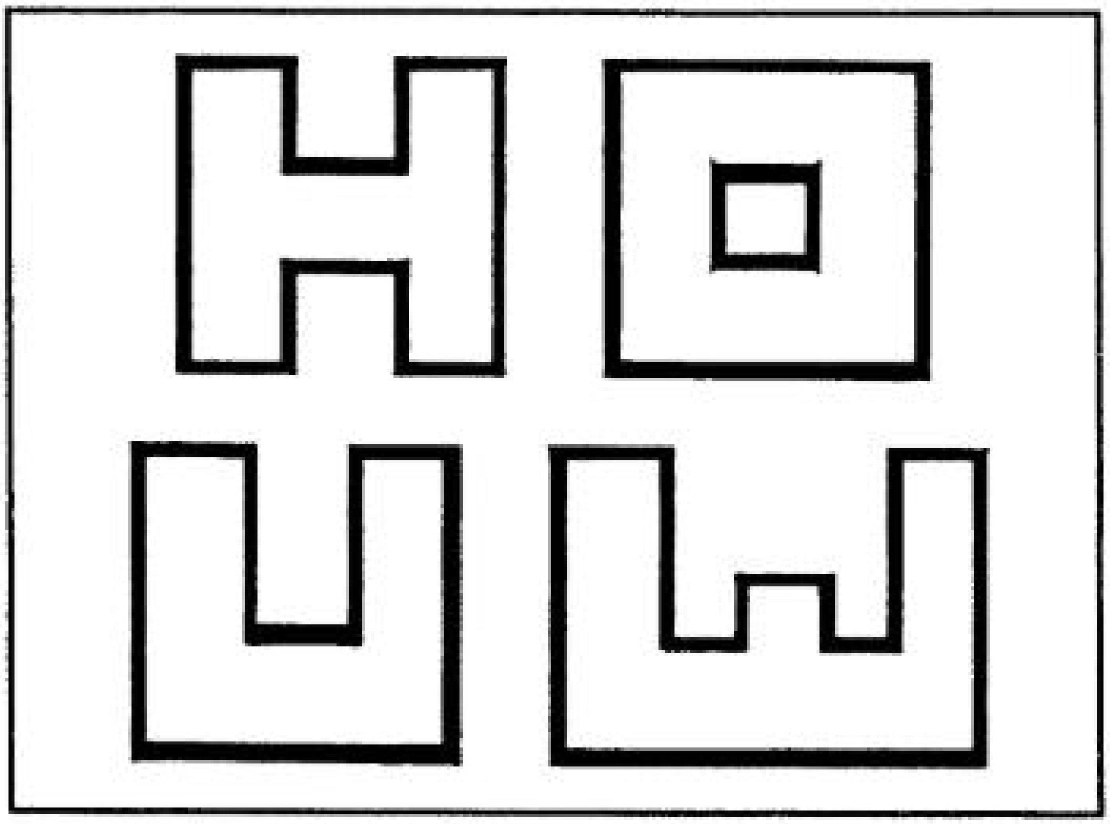

Figure 2.1 Showing E- and H- Shaped Floor Plans
Source: (Aboulnaga & Maryam, 2022).

The room depths in these multi-storey buildings were often limited to about twice the floor to ceiling height in order to permit adequate penetration of natural light. Natural light in deep floor-plan multi-storey buildings was solved by piercing sections with light wells (or atria). Until the second half of the 20th century, when fluorescent lighting and cheap electricity became available, daylight and architecture were interpreted as being the same (Aboulnaga & Maryam, 2022).

2.1.2.2 Strategies of Daylighting

The use of natural light and architectural design go hand in hand. Natural light not only reduces the need for artificial lighting, thus lowering energy consumption, but also impacts heating and cooling requirements. Therefore, incorporating natural light into the design process requires collaboration among different disciplines and professionals. The planning for natural light begins with choosing a building location and extends throughout the building's occupancy.

Daylighting planning has different objectives at each stage of building design (Aboulnaga & Maryam, 2022):

Conceptual Phase: During the conceptual design phase of a building project, a variety of critical decisions are made that significantly shape its overall form and functionality. These decisions encompass the building's geometric configuration, including its shape, proportions, and the placement and dimensions of openings such as windows and doors. Additionally, the integration of essential building systems such as heating, ventilation, and air conditioning (HVAC), electrical systems, and structural components must be thoughtfully considered.

A key aspect of this design phase is the consideration of daylighting design, which refers to the strategical incorporation of natural light into the building's interior spaces. The design choices made regarding the building's structure and its openings can greatly influence how effectively natural light penetrates the space. Conversely, the principles of daylighting can also guide decisions about the arrangement and scale of openings, the orientation of the building, and the selection of materials that can help control light and heat. By establishing a harmonious relationship between the building's design and daylighting strategies, architects and designers can enhance the overall aesthetic appeal, energy efficiency, and occupant comfort of the building.

Design Phase: As the design of the building evolves, various elements of the structure necessitate the formulation of effective daylighting strategies. This includes a thoughtful approach to the design of facades, which play a crucial role in maximizing natural light while minimizing glare and heat gain. Interior finishes must also be carefully chosen to enhance reflectivity and optimize the distribution of daylight throughout the spaces. Additionally, the integration of systems and services such as artificial lighting, shading devices, and HVAC must be harmonized with the overall daylighting plan (Ashraf & Abdin, 2024). Each of these components not only contributes to the aesthetic appeal of the building but also impacts energy efficiency, occupant comfort, and well-being. In the consideration of these factors as a whole, the design team can create a cohesive and sustainable environment that leverages natural light effectively.

Final/Construction Planning: The strategy for daylighting within the building plays a crucial role in guiding the choice of materials and products during the final stages of construction planning. As the construction plans are developed, it is essential to thoroughly address the specific details of the daylighting scheme. This includes considering factors such as the orientation of windows, the use of transparent or translucent materials, and the integration of shading devices. Each of these elements not only influences the aesthetic appeal and functionality of the spaces within the building but also impacts energy efficiency and occupant comfort. Therefore, a well-thought-out daylighting strategy must be carefully considered and incorporated into the construction documentation to ensure that all aspects align harmoniously as the project moves forward.

Commissioning and Post-Occupancy: Once the construction of the building is complete, it is essential to calibrate the lighting controls to ensure optimal performance. This process is crucial for fine-tuning the system to meet specific needs and preferences (Ashraf & Abdin, 2024). Following this calibration, the ongoing operation and maintenance of the lighting system will begin, which takes place during both the commissioning phase and the post-occupancy period. During these phases, regular monitoring and adjustments will be made to maintain efficiency and functionality, ensuring that the lighting continuously supports the occupants' comfort and the building's overall design objectives.

2.1.2.3 Principles of Daylighting

The following are some rules of thumb and methods to consider when designing daylighting systems (Ashraf & Abdin, 2024):

- Light will penetrate a room to a depth roughly equivalent to twice the height of the window head.
- Use light-colored walls to enhance brightness. Steer clear of dark paint colors and avoid dark window frames in a sunny window to reduce contrast without spending much.
- Avoid incorporating small windows in large walls.
- Opt for placing windows on the long wall rather than the short wall of a narrow room to achieve better light distribution.
- Refrain from positioning whiteboards or blackboards in direct view of a window or roof light to avoid glare.
- Consider implementing plantings or screens to provide cost-effective shading.
- Steer clear of undesirable veiling reflections.
- Maintain a 35-degree cutoff line for top-lighting to prevent glare.

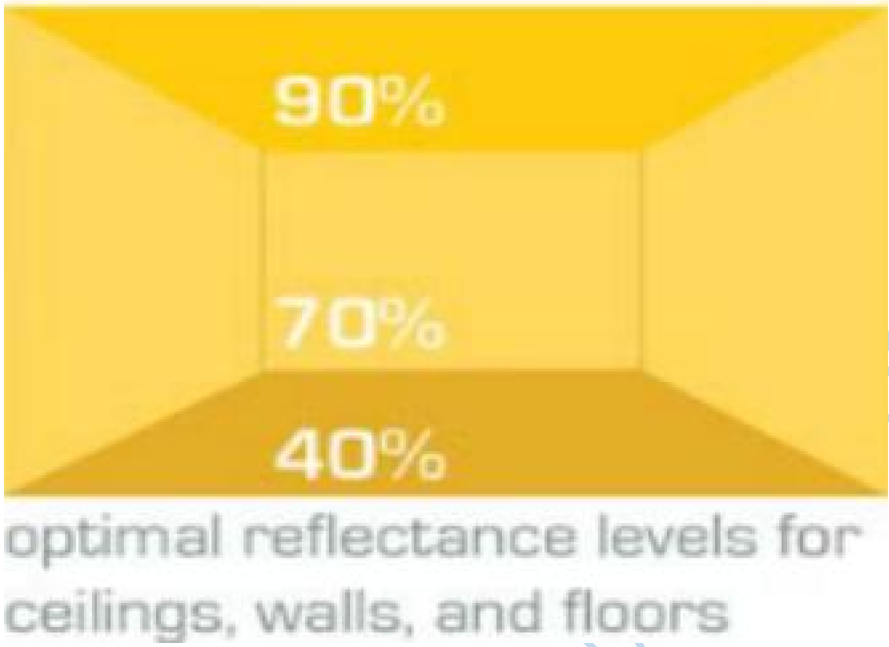

Figure 2.2 Showing Daylighting Principles
Source: (Ashraf & Abdin, 2024).

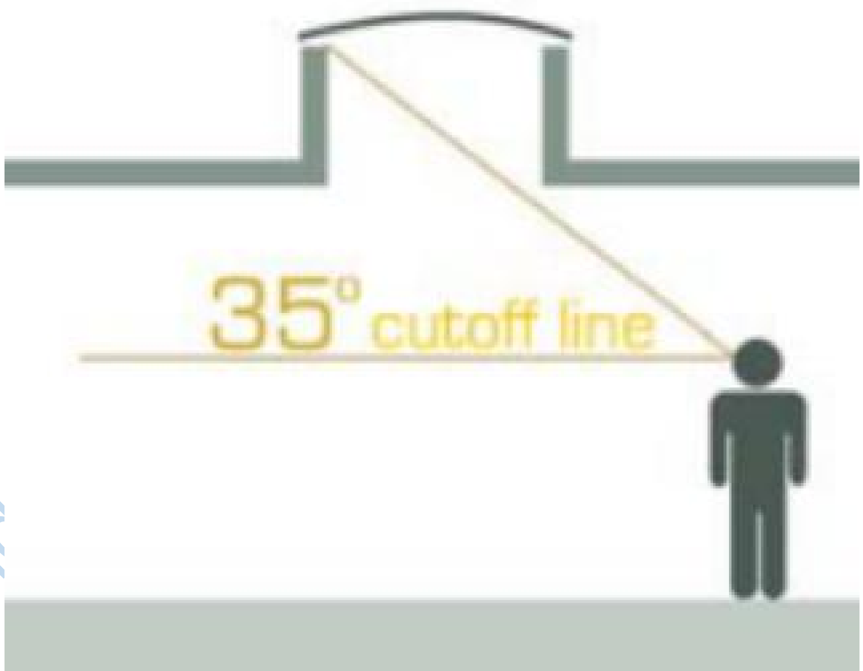

Figure 2.3 Showing Daylighting Principles
Source: (Ashraf & Abdin, 2024).

Apart from these guidelines, it is crucial to have a well-integrated lighting system that combines natural and electric lighting in order to achieve energy savings from daylighting.

This integration allows for the utilization of natural light without experiencing insufficient lighting during periods of poor natural light quality. Integrated systems typically include sensors that automatically adjust the levels of electric light, along with manual controls that can be used to override the system when necessary.

2.1.2.4 Benefits of Natural Light

As human beings, we spend most of our time indoors and yet the indoor environment is discussed much less than the outdoor environment. It is generally known that daylighting improves occupant comfort, health and workability (Ashraf & Abdin, 2024)., and so it must be remembered that even though we have adjusted to indoor living, humans are fundamentally creatures of the outdoors. As a result, a natural environment rather than an artificial one is preferable and necessary. This necessity, combined with the aim of enhancing the energy efficiency of structures, necessitates a shift in mindset to promote and guarantee the incorporation of ample daylight in the future architectural designs (Tharim, Abdullah, Ismail & Ahmad, 2022).

Benefits of natural daylighting therefore include energy savings, improvement of health and well-being, and natural color rendering. With these benefits, daylighting has the potential to diminish costs by downsizing mechanical systems, reducing electricity used for lighting, and increasing productivity by improving both physical and mental health designs (Tharim, Abdullah, Ismail & Ahmad, 2022).

The observations of human behavior and office space layout both provide evidence that daylight is beneficial. The presence of windows in buildings allowing daylight is essential for the connection with the outdoors and the view they offer. Daylight is valued for its quality, spectrum, and variability. Studies on people's responses to indoor environments indicate that daylight is desired because it satisfies two fundamental human needs: the ability to see tasks and the space clearly and to have some environmental stimulation. Prolonged exposure to artificial lighting is considered harmful to health while working in daylight is believed to reduce stress and discomfort designs (Tharim, Abdullah, Ismail & Ahmad, 2022).

Office workers performs 10% to 25% better on tests of mental function and memory recall when they had the best possible view versus those with no view. Also, reports of increased fatigue were most strongly associated with a lack of view. It is also noteworthy that students in classrooms with the most window area or daylighting achieve 7% to 18% higher scores on standardized tests than those with the least window area or daylighting designs (Tharim, Abdullah, Ismail & Ahmad, 2022).

The chances that natural views will efficiently reduce stress and anxiety are high because it produces positive responses and as such improves the mood of its user. Studies in 1979, 1981, and 1986 by Ulrich (Heerwagen, 1986) proves the efficiency of natural views. Vegetation and water views was found effective for making psycho-physiological come back from stress. Similarly, people have recovered completely and faster from a stressful occasion when exposed to scenes of natural settlements rather than urban films.

2.1.2.5 Challenges of Natural Light in Buildings

The common barriers that have hindered the integration of daylight in buildings in the past are (Matheou, Couvelas & Phocas, 2020):

- Limited understanding of modern daylighting systems and lighting control strategies
- Lack of access to user-friendly daylighting design tools
- Insufficient evidence to support daylighting's benefits in buildings

2.1.3 Definition of Natural Ventilation

Natural ventilation uses the natural forces of wind and buoyancy to introduce fresh air and distribute it effectively in buildings for the benefit of the occupants (Yang & Clements-croome, 2020). It is used to maintain indoor air quality and thermal comfort in buildings (Roulet, 2017). Ventilation, particularly, natural ventilation is further defined as a way of providing new air to a space using passive forces, normally by wind velocity or pressure externally and internally differences. Natural ventilation is induced by two natural forces: pressure changes caused by the wind blowing around the building (wind-driven ventilation), and temperature fluctuations ('stack effect ventilation').

Natural ventilation is the procedure of entering fresh air into a home from outside provided by thermal, wind or diffusion effects through doors, windows, or other intentional openings in the building. This new air, forces the dirty, warm air in the rooms out by the building openings, and is one of the most practical techniques to decrease energy usage in buildings. It takes advantage of the natural force of wind and buoyancy to bring in fresh air and distribute it throughout buildings for the benefit of people. Natural ventilation can offer a sufficient supply of breathing air, appropriate ventilation of pollutants, suitable thermal conditioning, and humidity waste through a well-connected to the dynamics of the environment (Matheou, Couvelas & Phocas, 2020).

2.1.4 Natural Ventilation Strategies

According to the National Institute of Standards and Technology(Matheou, Couvelas & Phocas, 2020), there are three major approaches to natural ventilation:

1. Wind-driven cross ventilation
2. Buoyancy-driven stack ventilation, and
3. Single-sided ventilation

Wind-driven cross ventilation: Ventilation occurs through openings on opposite sides of an enclosed space. The depth of the building floorplan in the direction of the ventilation flow must be restricted to effectively expel heat and pollutants from the space using normal driving forces. To guarantee adequate ventilation flow, it is necessary to have a significant contrast in wind pressure between the inlet and outlet openings and minimal internal resistance to flow. Typically, the ventilation openings consist of windows.

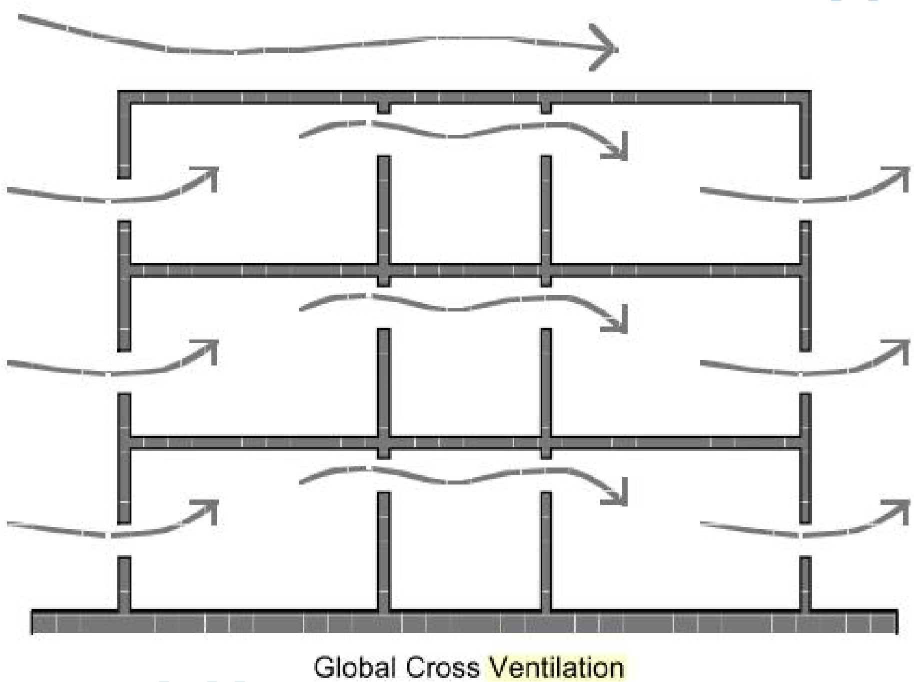

Figure 2.4 Showing Schematic of Cross Ventilation Serving a Multi-Room Building
Source: (Matheou, Couvelas & Phocas, 2020

Buoyancy-driven stack ventilation: This method uses the difference in density to bring in cool, outdoor air through lower ventilation openings and expel warm, indoor air through higher ventilation openings. Chimneys or atriums are often used to create enough upward forces to achieve the necessary airflow. However, even a slight breeze will create pressure variations on the building's exterior that will also contribute to the airflow. In fact, the effects of wind may be more significant than the effects of buoyancy in stack ventilation systems, so successful designs will look for ways to take full advantage of both.

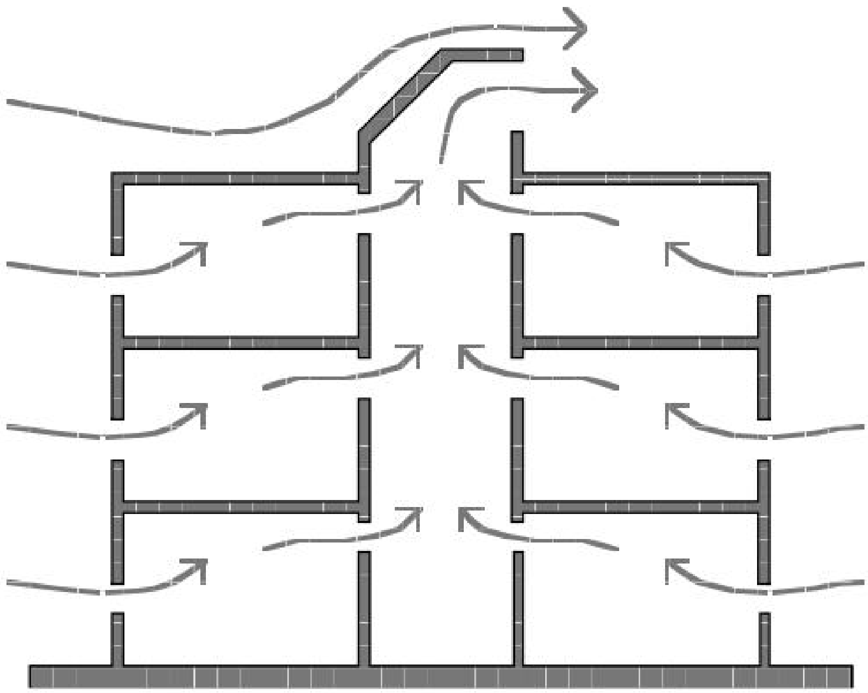

Figure 2.5 Showing Schematic of Stack Ventilation for A Multi-Room Building
Source: (Matheou, Couvelas & Phocas, 2020

Single-sided ventilation: This method usually works for individual rooms and provides a local ventilation option. In this scenario, airflow for ventilation is caused by the natural rising of air in the room, slight variations in wind pressure on the building, and/or turbulence. As a result, the driving forces for single-sided ventilation are generally small and highly unpredictable. When compared to other options, single-sided ventilation is the least appealing natural ventilation choice. However, it still can be a suitable option for separate offices.

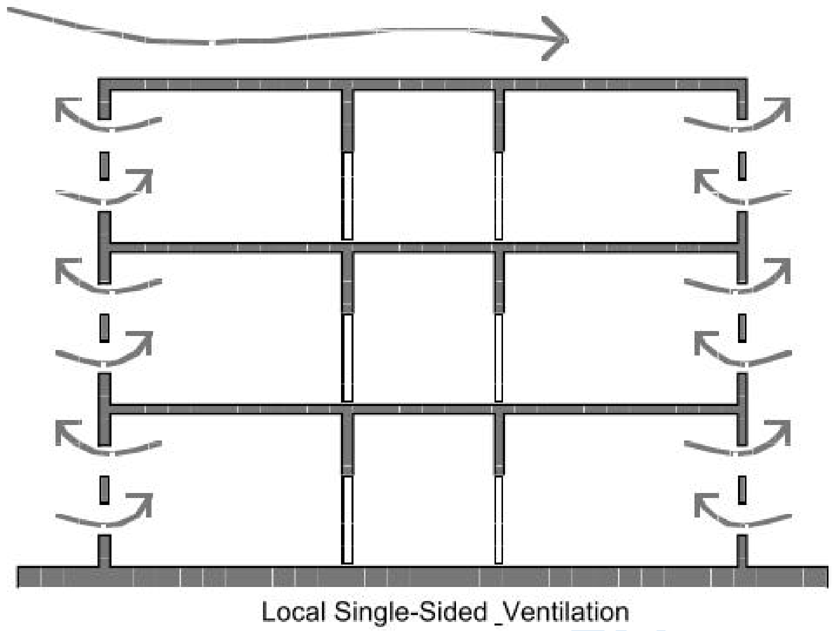

Figure 2.6 Showing Schematic of Single-Sided Ventilation in A Multi-Room Building
Source: (Matheou, Couvelas & Phocas, 2020

Many examples employ incorporate variations of these fundamental designs. In certain cases, these three designs have been combined within individual buildings to address various ventilation requirements.

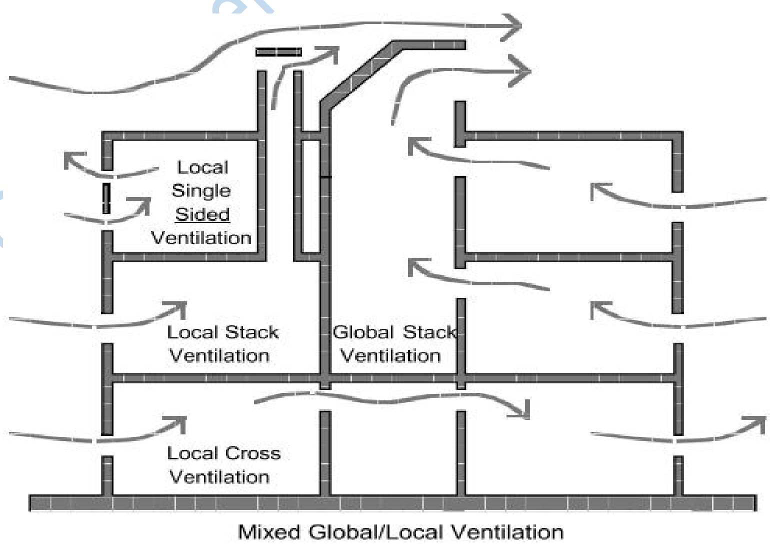

Figure 2.7 Showing Schematic of Mixed Local/Global and Stack/Wind Ventilation Strategy
Source: (Matheou, Couvelas & Phocas, 2020

In other instances, the elaboration resides in the details of inlet, exhaust, and distribution tactics. One common approach involves the use of in-slab or access-floor distribution of fresh air to provide greater control of air distribution across the building section.

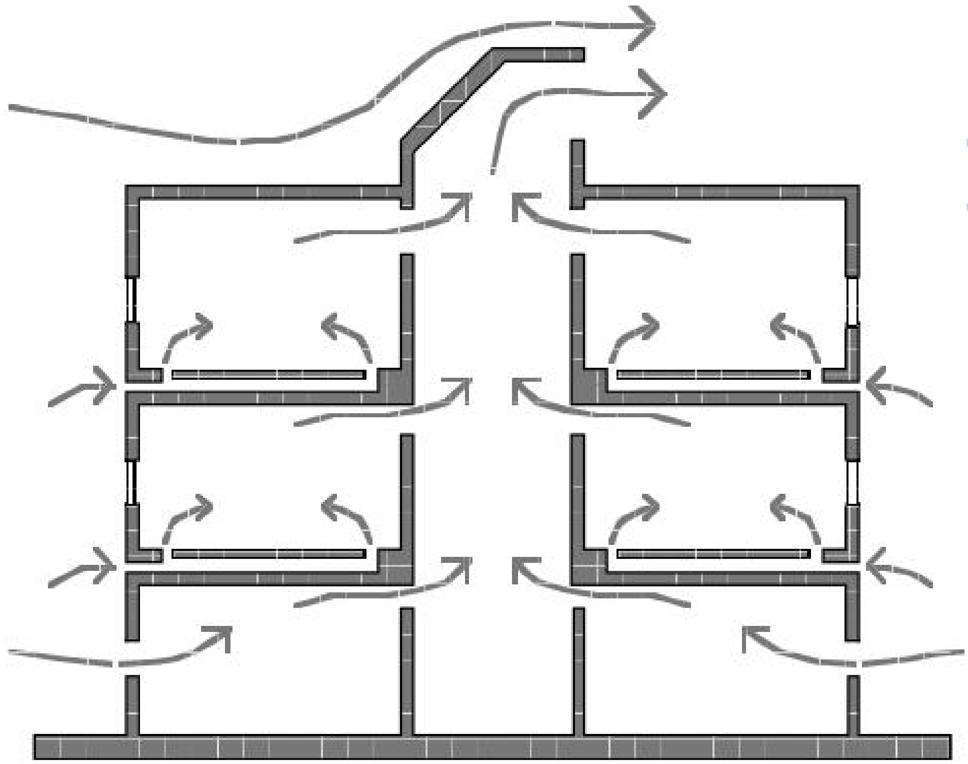

Figure 2.8 Showing Schematic of Stack Ventilation with A Sub-Slab Distribution System
Source: (Matheou, Couvelas & Phocas, 2020).

2.1.5 Elements of Natural Ventilation in a Building

There are numerous subtle and advanced methods to utilize natural driving forces for promoting natural ventilation principles. These architectural characteristics are often incorporated into building designs to improve and support natural ventilation performance. Key components include openings in the facade, windows, wind towers, wind scoops, chimneys, double facades, atria, embedded ducts, and more (Matheou, Couvelas & Phocas, 2020).

Table 2.1 below provides an overview of these various elements and the associated ventilation principles.

Table 2.1 Showing Ventilation Principles and Their Characteristic Element

Characteristic element	Ventilation principle	Supply or exhaust
Wind scoop	Cross and stack	Supply
Wind tower	Cross and stack	Extract
Chimney	Cross and stack	Extract
Double facade	Cross, stack and single-sided	Supply and extract
Atrium	Cross, stack and single-sided	Supply and extract
Ventilation chamber	Cross and stack	Supply and extract
Embedded duct	Cross and stack	Supply
Ventilation opening in the facade	Cross, stack and single-sided	Supply and extract

Source: (Matheou, Couvelas & Phocas, 2020).

According to Yang & Clements-Croome, (2020), well-designed natural ventilation systems need to address the following aspects comprehensively:

- Design of the site, including the location of the building, its orientation, layout, and landscaping.
- Design of the building, including its type, function, form, orientation, outer covering, ability to retain heat, strategy for natural ventilation, internal layout and functions, internal heat generation, shading from the sun, availability of daylight, and potential for passive night cooling.
- Design of ventilation openings, including their placement, ensuring unobstructed airflow, types of openings, size, and selection of window opening design, the effective area of multiple openings, provision of secure and operable openings, and control strategy.

Additionally, to aid in the decision making process for selecting whether to use natural ventilation, mechanical systems, or air-conditioning, the CIBSE AM 10 1997(Yang & Clements-croome, 2020) gives the following monograph as a guide.

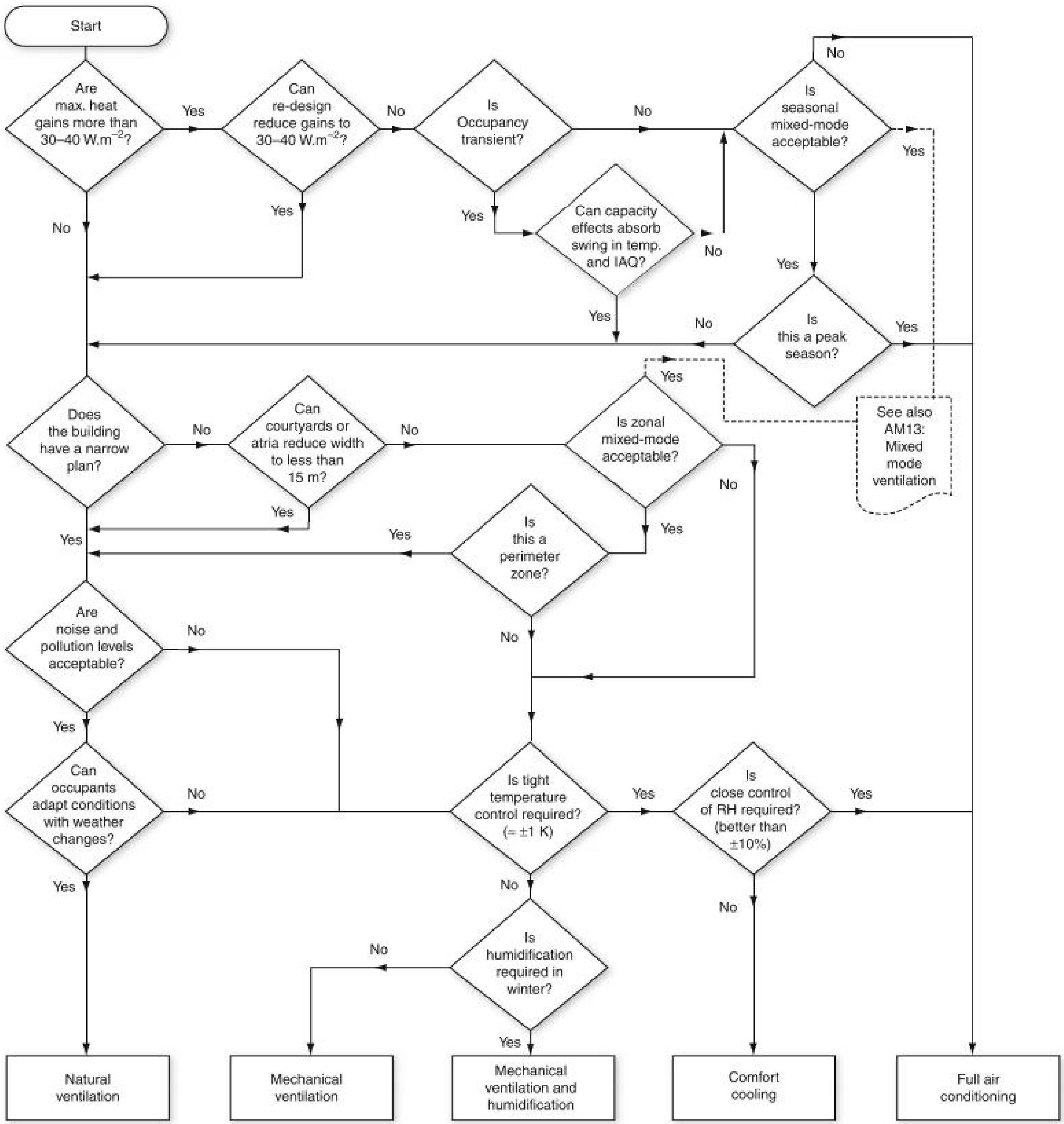

Figure 2.9 Showing Natural Ventilation Decision Making Process
Source: (Yang & Clements-croome, 2020)

2.1.6 Benefits of Natural Ventilation

Natural ventilation provides various advantages, including cheap operating costs, zero energy use, little maintenance, and maybe reduced startup costs. It is perceived as healthier, and the way it communicates with the outside world is viewed as psychologically beneficial. Natural ventilation's efficacy is governed by the prevailing exterior conditions: microclimate (wind speed, temperature, humidity and surrounding topography) and the structure itself (direction, number of windows or openings, size and position) (Yang & Clements-croome, 2020).

2.1.7 Challenges of Natural Ventilation in Buildings

Natural ventilation systems currently lack proven ventilation heat recovery capabilities, while several solutions are in development, they are also often difficult to regulate and unreliable when natural driving forces are low. Furthermore, natural ventilation systems currently lack established filtering capacities and may be jeopardized by surroundings, particularly urban, with high outside particle and gaseous pollutant concentrations.

The potential of natural ventilation systems relies, in part, on the adaptability of a particular environment, in part, on the design of the natural ventilation system utilized, and in part, on the benefits offered by mechanical system alternatives. Recent advancements in natural ventilation system design have been mirrored by parallel advances in mechanical ventilation design. Thus, while the development of natural ventilation systems provides a way to ventilate without using fans, research into low pressure ventilation systems provides mechanical systems with lower fan power needs. These and other scientific discoveries have inevitably led to the establishment of so-called hybrid ventilation systems that try to maximize the benefits of both natural and artificial ventilation (Matheou, Couvelas, & Phocas, 2020).

2.2 Empirical Review

2.2.1 Design Considerations for a Faculty Building

A wide range of unique traits that must be clear in the building's planning are required for a setting to be successful for learning. School buildings, such as faculty buildings, are thought of as locations where children can study and work and play and communicate and mature. As a result, when designing a faculty building, the factors required to promote human growth must be carefully taken into account.

In addition, spatial organization has been pointed as one of the basic requirements in faculty buildings for effective teaching and learning in creative discipline. Different basic spatial requirements were found in different parts of the world. In Europe and America, the minimum acceptable standard studio space per person is 5 - 7sqm, and a maximum of 10 - 12 students per academic staff. Meanwhile, 4sqm per person and 12 students per academic staff is acceptable in Nigeria (NUC, 2023).

Additionally, according to Uzuegbunam (2011), the size and shape of each unit within a building affects a project's viability. In order to keep party wall costs to a minimum, repetitive or standardized units have simple shapes. In another view, the success of a faculty building design was hinged on climatic conditions (Akubue, 2006). The effect of the nature of climate changes on human comfort is inevitable, but climate integrated design elements such as humidity, temperature, wind patterns, and rainfall takes advantage of this climate changes to produce a positive effect and reflection on the architectural building designs. (Akubue, 2006).

(Uzuegbunam, 2011) suggested some structural properties to be considered for effective building design as;

1. Provision of adequate drainage system to avoid flooding.
2. The roof design should be given a proper attention to aid effective discharge and rain water harvesting for use.

3. The use canopies, verandas, logia, eves, hoods can be employed to protect the openings on the external walls from the driving rains, as well as other architectural elements.
4. Trees should be planted during the coolest months are (January and December) to provide outdoor shade.
5. Heat gain reduction by minimizing the areas of concrete pavements should be minimized to reduce heat gain.
6. Air movement is essential, and therefore adequate ventilation should be ensured through the building.
7. Wind utilization can be optimized for effective ventilation through the choice of the building design. Consideration should therefore be given to the location and Size of openings. The type and level of the window should be in such a way to admit and maximize the flow of wind in the building.
8. Importance should be given to shading of the building from direct sunshine

A designed Faculty of Environmental Studies building with four departments, offices, classrooms and studios, the Dean's office, faculty library and ICT, and a conference hall of about five hundred sitting capacity for the University of Nigeria was done by Uzuegbunam (2011a). For adequate spacing, he proposed an allocation of floor spaces for each department, including the dean's office, thus, having a total of five floors. While the link between physical spaces and technology systems and learning remains vital, even more important is how and if the surroundings encourage healthy human interactions that key to learning (Matheou, Couvelas & Phocas, 2020).

Chapter Three

Methodology: Case Study

3.1 Introduction

This study focused on the incorporation of daylighting and ventilation design methods and principles in the creation of a faculty of science building for Lead City University that promotes an effective learning process and performs all its functions. A review of the literature on daylighting techniques and how they may be used in design was conducted via the use of journals, papers, books, and other materials. Already existing science faculty buildings of prestigious universities were also investigated and assessed to have a better understanding of the design requirements and techniques that may inform the design of a proposed faculty building.

3.2 Case Study Selection Criteria

The case studies were chosen with care based on the following criteria:

1. Faculty of Science buildings designed with daylighting principles.
2. Faculty of Science buildings that incorporated ventilation principles in their architecture.
3. The project's scope (national/international).

3.3 Aspects of Case Study Analysis

Following selection, the case studies were evaluated on four criteria:

1. Overview/general information
2. Design concept and building materials
3. Building's architectural description/features
4. Study observations and conclusions

3.4 Case Studies

3.4.1 Case Study 1: College of Medicine and Health Sciences

Name: College of Medicine and Health Sciences, Afe Babalola University
Location: Afe Babalola University, Ado Ekiti

Project year: 2015

3.4.1.1. Overview

Plate 3.1 Showing the Faculty Entrance
Source: Author’s survey

3.4.1.2 Design Concept and Building Materials

In contrast to the lively atrium, the lecture rooms are precisely positioned along the building's façade, with a basic and logical design. In addition to creating a remarkable visual impact, the diverse arrangement of windows allows ample light into the structure and affords a breathtaking view of the river.

The design made use of various building materials like hollow blocks, reinforced concrete, mass concrete, glass, combination of wooden and steel roof truss, aluminum roofing sheet, wooden frames and doors, metal doors.

Plate 3.2 Showing the Faculty's Entrance
Source: Author's Survey

Plate 3.3: Showing Courtyard of the Faculty Building
Source: Author's Survey

Plate 3.4: Showing Courtyard of the Faculty Building
Source: Author's Survey

3.4.1.3 Description and Features

The College of Medicine and Health Sciences building houses four blocks and is also one of the largest buildings in the University. It houses several departments, some of which are: Nursing, Medical Laboratory Science, Medicine and Surgery (MBBS), Anatomy, and Physiology amongst others.

3.4.1.4 Observations

- Good use of natural lighting
- Good incorporation of natural ventilation
- Easy accessibility
- Adequate spatial allocation
- Use of shading devices is apparent
- There is a presence of green spaces, courtyards and open areas
- Adequate parking spaces

- Lack of proper drainage system
- Design execution is poor

3.4.2 Case Study 2: Faculty of Basic Medical Sciences, University of Medical Sciences, Ondo state, Nigeria

Name: Faculty of Basic Medical Sciences

Location: Ondo state, Nigeria

Project year: 2015

3.4.2.1 Overview

The Faculty of Basic Medical Sciences at UNIMED was founded on April 22, 2015, with a vision to teach students medical and basic medical science courses at undergraduate and postgraduate levels.

Plate 3.5 The Faculty Building, UNIMED
Source: Author's Fieldwork

3.4.2.2 Design Concept and Building Materials

From the outside, the building has a combination of rectilinear facades with square windows arranged on all sides in a colorful, rhythmic pattern. The building's internal area is conceived as a dynamic succession of staircases and divided, open floor levels where abstract, white boxes swing freely from the ceiling and filter the light streaming in via the high skylights.

Plate 3.6 Side View of the Faculty Building at UNIMED
Source: Author's Fieldwork

3.4.2.3 Description and Features

The construction of a spacious, open learning atmosphere in which everyone is a part of the same room and is only divided by the split floors and glass walls of the teaching rooms was one of the main goals that guided the building's design. The layout encourages the students to share knowledge and ideas and makes it easier for them to be inspired by one another.

The building houses administrative offices, lecture halls, and multiple laboratories to serve

3.4.2.4 Observations

- Easy accessibility
- Adequate spatial allocation

- Use of shading devices is apparent
- There is a presence of green spaces, courtyards and open areas
- Adequate parking spaces
- There are plenty of parking places available.
- Good use of passive design concepts, including the use of natural ventilation and lighting in all spaces.
- The structure is made of sandcrete blocks, reinforced concrete and glass

3.4.3 Case Study 3: Kuwait University College of Life Sciences, Ardiya, Kuwait

Name: College of Life Sciences

Architect: Cambridge Seven Gulf Consult

Location: Ardiya, Kuwait

Year: 2020

Area:74322 m^2

3.4.3.1 Overview

The College of Life Sciences blends programmatic requirements and responses to specific site and environmental conditions resulting in a distinctive and suitable college for the art and environmental studies.

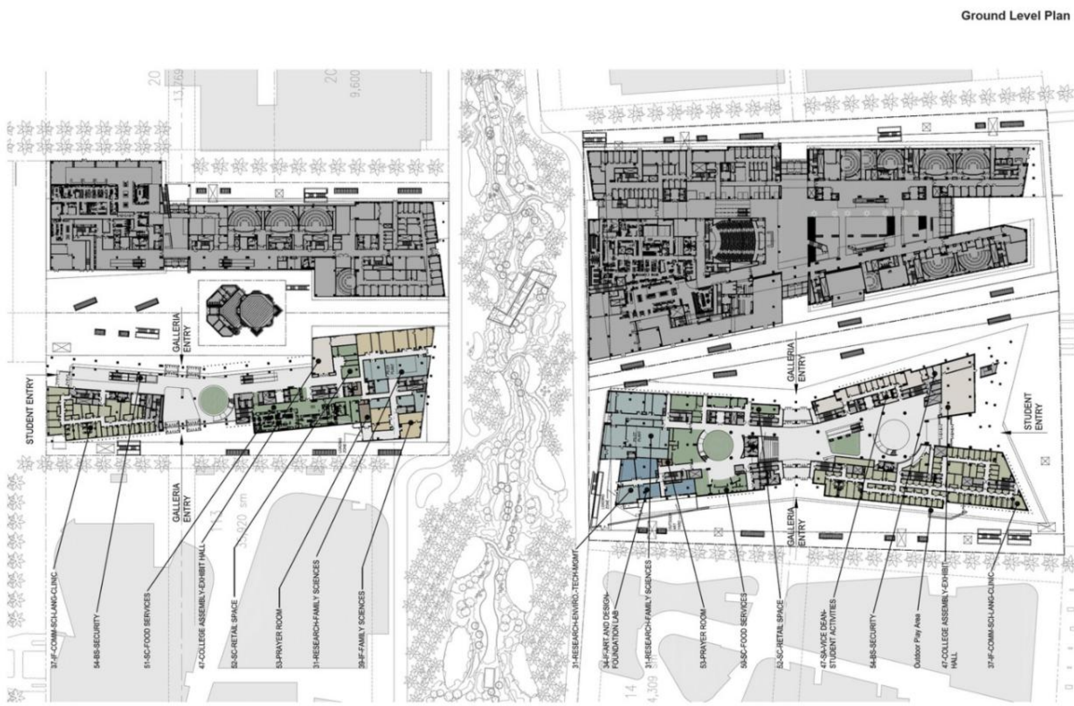

Figure 3.1: Ground floor Plan of College of Life Sciences
Source: Author's field work

3.4.3.2 Design Concept and Building Materials

The building is sophisticated and exceptionally site-responsive. It utilized a dramatic form with a visible combination of, an angular sloped façade and its striking cladding system of shading, mimicking a desert-colored in textured material. The use of a continuous array of perforated metal panels in a diamond-shaped form helps in the filtering of natural daylight and shades the interior from the strong sun. The color intensity of the structure changes with the passage of the sun throughout the day, similar to the surrounding desert. The angular geometry of the panel array is reflected in the building footprint and surrounding landscape elements.

Plate 3.7 Exterior View of College of Life Sciences
Source: Author's Field work

3.4.3.3 Description and Features

There is a screen shading system of perforated metal panels that mitigate solar glare while maintaining direct views out. Louvers are positioned on each building's face to manage light that comes in. The college is organized around vibrant, multi-level atria which includes a food court and informal meeting areas, demonstration labs and practicum clinics, fostering student/faculty interaction.

Plate 3.8 Atrium of the College of Life Sciences
Source: Author's Fieldwork

Plate 3.9 Exterior View of the College of Life Sciences
Source: Author's Fieldwork

3.4.3.4 Observations

- Easy accessibility
- Adequate spatial allocation

- Use of shading devices is apparent
- Use of natural and energy saving materials and methods
- There is a presence of atria and open areas
- Good use of passive design concepts, including the use of natural ventilation and lighting in all spaces.

3.4.4 Case Study 4: University of Cincinnati Health Sciences Building, Cincinnati, United States.

Name: University of Cincinnati Health Sciences

Location: Cincinnati, United States

Project year: 2019

Architects: Perkins & Will

Area: 110000 ft²

3.4.4.1 Overview

The aim was to have a facility with lots of light and a healthy environment to stimulate collaboration across the Academic Health Center colleges. Integrating education with practice as well as designing for inter-professional, problem based learning, with innovative spatial solutions and technological applications.

Plate 3.10 Cincinnati Health Sciences Building
Source: Author's Fieldwork

3.4.4.2 Design Concept and Building Materials

The building is crescent shaped, curving around a 1.5-acre forecourt. The classrooms overlook a four-story atrium. The central atrium serves as a hub for collaboration and movement, with bridge-like ramps and monumental stairs distributed around the atrium, providing sculptural visual interest and allowing views into the classrooms and labs, putting learning on display.

The design incorporated the use of insulated precast wall panels, structural thermal isolators, and double layer slabs. These materials helped meet energy goals while maintaining the exposed concrete appearance of the building.

A major goal for this building was to create a true sense of place: a permanent yet flexible home for programs to help the department navigate a rapidly changing industry.

Plate 3.11: Interior View Showing the Atrium of Cincinnati Health Sciences Building
Source: Author's Fieldwork

3.4.4.3.Description and Features

In order to achieve interdisciplinary collaboration and have a hands-on clinical training space, the building features glass-walled classrooms and labs, with large airy breakout areas, adjacent balconies, providing opportunities for project work and informal discussions.

3.4.4.4 Observations

- Easy accessibility
- Adequate spatial allocation
- Use of shading devices is apparent
- There is a presence of green spaces, courtyards and open areas
- Good use of passive design concepts, including the use of natural ventilation and lighting in all spaces.

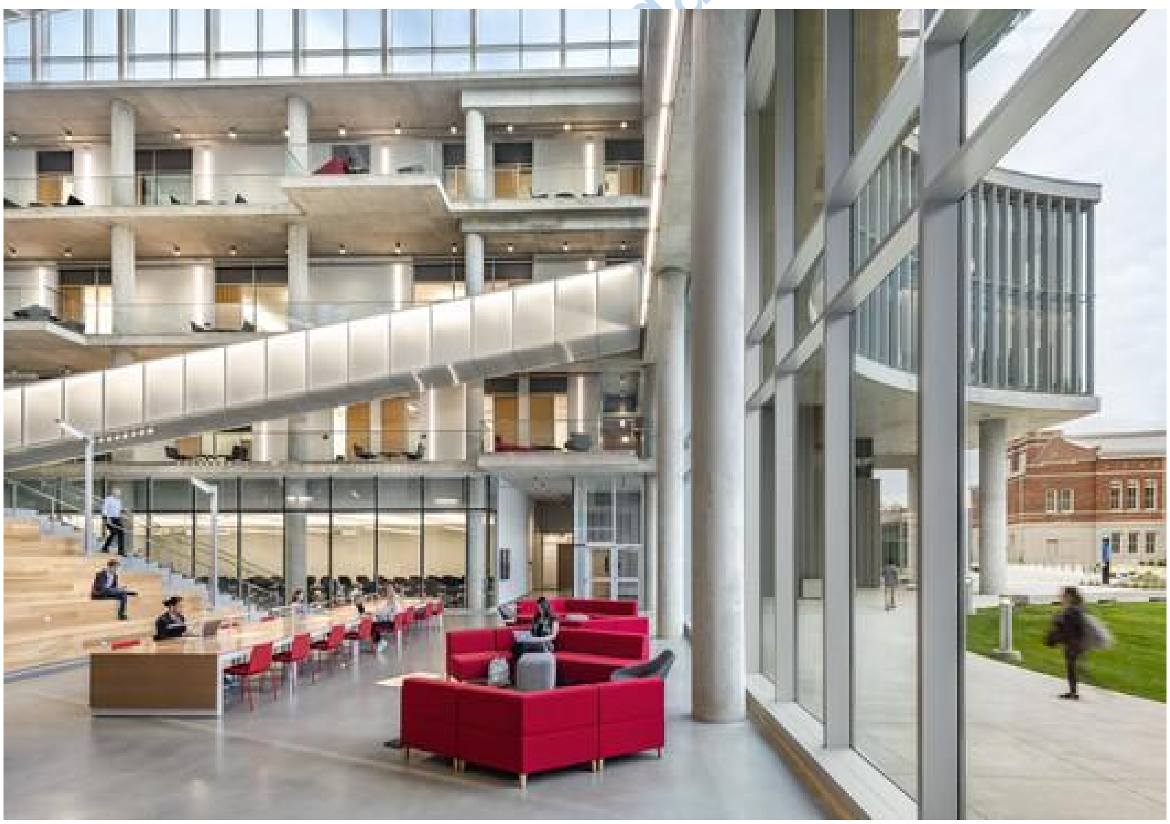

Plate 3.12: Interior View of the Cincinnati Health Sciences Building
Source: Author’s Fieldwork

Chapter Four

Site, Project Analysis and Design Synthesis

4.1 Study Area

This section discusses the preliminary design proposal and the design decisions taken to arrive at the proposed faculty of health sciences. The solution for the proposed design is based on the space requirements, case studies, site location characteristics and the application of ventilation design principles in Architecture to ensure user wellness and building effectiveness (Sun, Luo & Bai, 2023).

4.1.1 Site Location and Description

Figure 4.1 Showing Earth View of Proposed Site
Source: Author's Fieldwork

The site is located in the Lead City University premises, Ibadan, Oyo state. It is bounded by the school chapel, the sports complex and an ongoing construction site. The school is situated in the Ibadan North East local government area, along the Ibadan-Lagos expressway.

4.1.2 Site Selection Criteria

A thorough evaluation was conducted across multiple sites on the university campus to identify the most suitable location for the proposed Faculty of Health Science building. This assessment involved a comprehensive analysis of various criteria to ensure an informed decision could be reached. Key factors considered included accessibility for students and faculty, proximity to existing health facilities, potential for future expansion, environmental impact, and the availability of essential infrastructure such as utilities and parking. By systematically examining each site against these criteria, the assessment aimed to pinpoint the ideal location that would support the needs of both the academic community and the broader university objectives.

4.1.2.1 Accessibility

When selecting a location for the new faculty building on the university campus, prioritizing accessibility is crucial. The proposed site benefits from a strategic position, as it is flanked by major roads on one side and well-maintained walkways on the other. This configuration ensures that both vehicles and pedestrians can reach the building without encountering any significant obstacles. Ample parking options and clear pathways will facilitate easy access, encouraging higher foot traffic and fostering a welcoming environment for students, faculty, and visitors alike. Overall, this thoughtful consideration of location will enhance connectivity within the campus and promote engagement within the university community (Djabborovich & Sevara, 2023).

4.1.2.2 Visibility

The chosen site at Lead City University offers a strategic advantage due to its positioning at the intersection of two key roads. The right-side road leads to the student residential area and a faculty building, while the front road leads to significant university buildings such as the school chapel, senate building, faculty of law, and faculty of environmental design and management. The proposed building will enjoy high visibility from this location, becoming a prominent campus feature. In addition, the architectural excellence of the structure will enhance the overall streetscape of the university, creating a visually appealing and cohesive environment.

4.1.2.3 Site Area and Future Expansion Potential.

The selected location underwent a thorough assessment, taking into account not only its current suitability but also the potential for future expansion. Factors such as geographical advantages, accessibility, available infrastructure, and proximity to key markets were meticulously analyzed to ensure that the site could accommodate growth and evolving needs in the years to come (Dastoum, Guevara & Arranz, 2024).

4.1.2.4 Proximity to Academic Buildings and Student Hostels.

This approach significantly enhances accessibility for both students and staff, allowing them to conveniently engage from various locations, including the hostels and other areas of the school. By fostering a culture of academic engagement and encouraging intellectual exploration within the university community, this strategy not only supports individual learning but also plays a crucial role in building a cohesive and interconnected community. As members of the university interact more readily with one another, they develop a stronger sense of belonging and shared purpose, ultimately enriching the overall educational experience (Xiao, Zhong, Wu & Zhang, 2023).

4.2. Project Analysis and Design Synthesis

4.2.1 Brief Analysis

Lead City University is a renowned institution situated in Ibadan, Oyo State, Nigeria. It has affiliated primary and secondary schools nearby. There is a need for expansion in the university to accommodate new departments, faculties, and ultimately new students.

The proposed faculty of Health Science building will serve as a vibrant space that nurtures learning, collaboration, and experimentation, enhancing academic access. Ultimately, this architectural design project aims to elevate the educational experience for students, staff, and parents within the school community. As a result, this design is expected to satisfy architectural, sustainability, services, and structural functions by incorporating good circulation, accessibility, natural lighting, and ventilation (Gunasagaran, Saw, Mari, Srirangam & Ng, 2023).

4.2.2 Brief Development `

After conducting a comprehensive examination of five diverse case studies, encompassing both local and international examples, it became clear that there were significant similarities in their spatial functionalities. Each study was meticulously designed to uncover the necessary planning standards that contribute to the effectiveness of these environments. Furthermore, the analysis highlighted the distinct roles that various spaces within faculty buildings fulfill, ranging from collaborative areas to individual study zones. By comparing these case studies, we gained valuable insights into how thoughtful spatial design can enhance academic interactions, promote community engagement, and support the overall learning experience within educational institutions.

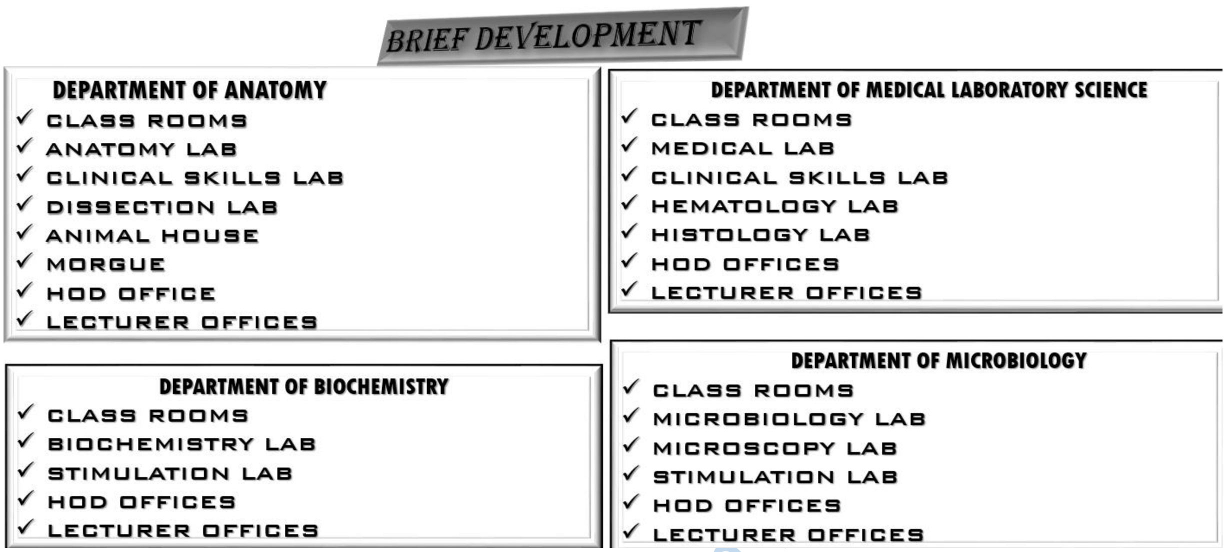

Figure 4.2 Showing Spaces to be Included in Each Department
Source: Author’s Research Survey

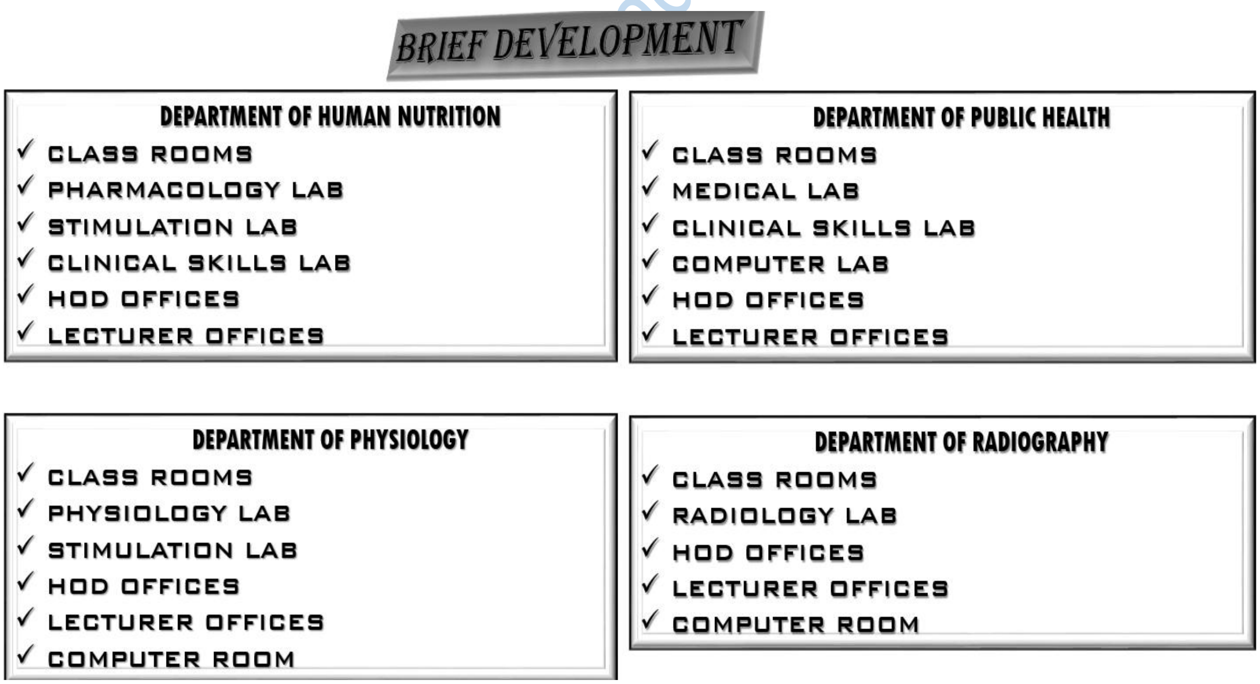

Figure 4.3 Showing Spaces to be Included in Each Department
Source: Author’s Research Survey

Figure 4.4 showing Spatial Analysis
Source: Author's Research Survey

4.2.3. Design Criteria

Criteria considered in the design of the faculty building include:

4.2.3.1 Accessibility

The entrances and exits of the building will be strategically positioned along the proposed roadway to ensure seamless access to the site. This thoughtful placement is aimed at facilitating smooth traffic flow and enhancing the convenience for all visitors. To further enhance accessibility to essential amenities, a coordinated design approach will be implemented, ensuring that necessary services and facilities are within easy reach for everyone. Additionally, measures will be put in place to create a welcoming environment for individuals with disabilities, including features such as ramps, designated parking spaces, and wider doorways, ensuring that all areas of the building can be easily navigated.

4.2.3.2 Passive Design Elements

The faculty building will incorporate a range of passive design strategies aimed at maximizing energy efficiency. By emphasizing daylighting, the design will feature large windows and strategically placed skylights to enhance natural light within the spaces, reducing the need for artificial lighting during the day. Additionally, the structure will be oriented to take advantage of prevailing winds for natural ventilation, allowing fresh air to flow through the building and minimizing reliance on mechanical cooling systems. Together, these elements will not only foster a comfortable indoor environment but also contribute significantly to energy conservation efforts.

4.2.3.3 Aesthetics

The design of the building will focus on captivating users through a thoughtfully curated blend of architectural form, vibrant colors, high-quality materials, and intricate patterns. Each element will be strategically chosen to create an inviting and harmonious atmosphere that resonates with the building's purpose and the community it serves. The use of dynamic shapes will enhance the overall aesthetic, while a nuanced color palette will evoke emotions and set a welcoming tone. Additionally, carefully selected materials will not only ensure durability but also contribute to a sense of warmth and comfort. The incorporation of patterns, whether through textures or motifs, will add depth and visual interest, making the building an engaging space for all who interact with it.

4.2.3.4 Rainwater and Storm Water Collection

Rainwater and storm water collection systems will be integrated into the design to promote sustainable water management and resource conservation. These systems will capture and store runoff from precipitation events, minimizing the risk of flooding while effectively utilizing this water for irrigation and other non-potable uses. By implementing features such as permeable surfaces, retention basins, and dedicated cisterns, we aim to enhance groundwater recharge and reduce the burden on municipal drainage systems, ensuring a more resilient and environmentally friendly approach to water management.

4.2.3.5 Site Zoning

The site is divided into several distinct zones, each offering a variety of unique activities tailored to enhance the visitor experience. Each zone is designed to cater to different interests and age groups, providing engaging options such as interactive exhibits, recreational areas, and specialized workshops. This thoughtful organization ensures that every guest can find something enjoyable and memorable to participate in during their visit.

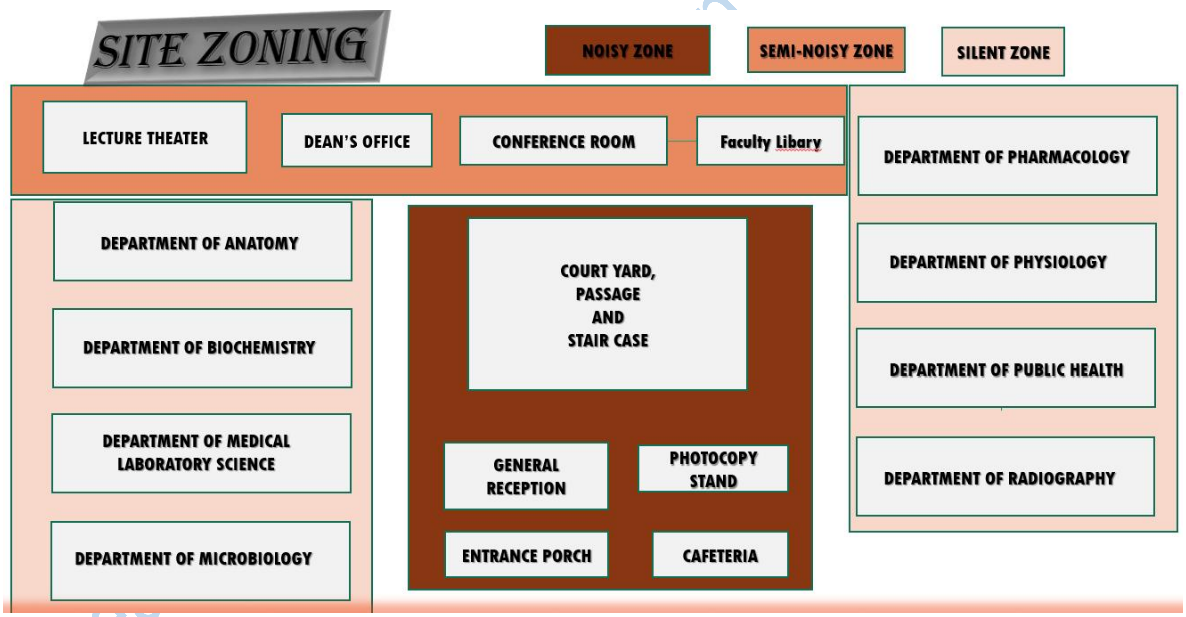

Figure 4.5 showing Site Zoning
Source: Author's field work

4.2.4. Conceptual Development

In architecture, the concept serves as the foundational guiding principle that influences and directs the design of a structure. This overarching idea encompasses the integration of various design elements such as form, function, materials, and aesthetics—into a cohesive and harmonious whole. By carefully considering how these elements interact and support the overarching vision, architects can create spaces that not only fulfill practical needs but also evoke emotional responses and enhance the overall experience of the environment. This approach requires a thoughtful balance between creativity and functionality, ensuring that each aspect of the design contributes to the intended narrative and purpose of the structure.

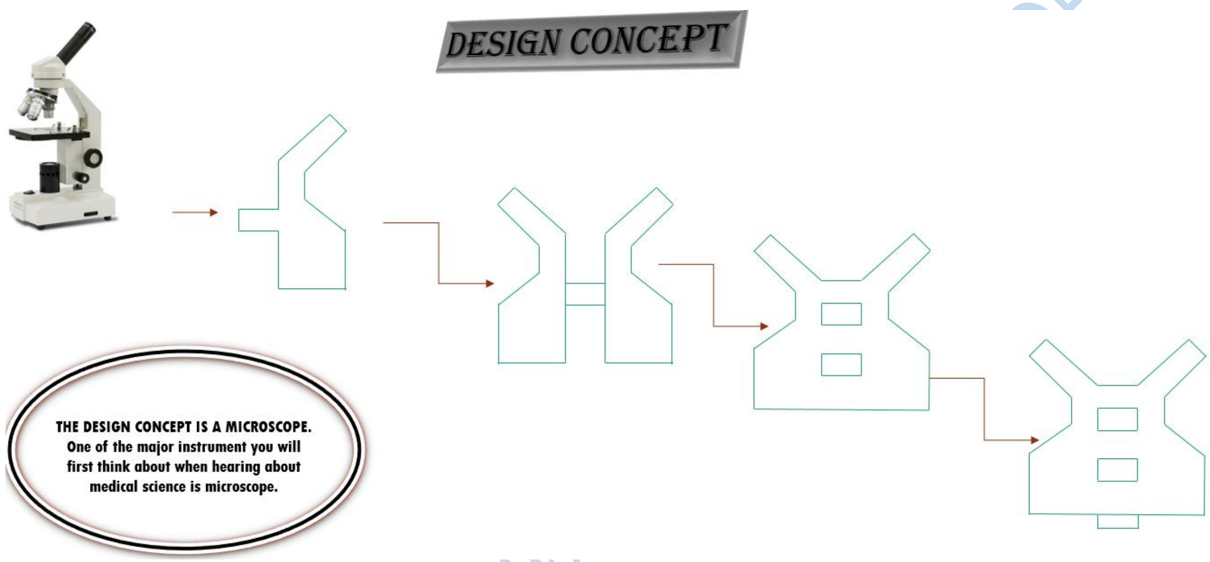

Figure 4.6: Showing Design Concept
Source: Author's Fieldwork

4.2.5. Space Allocation/ Schedule of Accommodation

SPATIAL REQUIREMENTS

DEPARTMENT OF ANATOMY

S/n	Space	Number required	Area (m²)
1	Class Room	6	55.0
2	Anatomy Lab	2	112.5
3	Dissection Lab	1	112.5
4	Medical Lab	2	112.5
5	HOD Office	1	42.5
6	Lecturer Offices	15	17.6

DEPARTMENT OF BIOCHEMISTRY

S/n	Space	Number required	Area (m²)
1	Class Rooms	6	55.0
2	Biochemistry Lab	2	112.5
3	Stimulation Lab	1	112.5
4	HOD Offices	1	42.5
5	Lecturer Offices	15	17.6

DEPARTMENT OF MEDICAL LABORATORY SCIENCES

S/n	Space	Number required	Area (m²)
1	Class Rooms	6	55.0
2	Medical Lab	2	112.5
3	Stimulation Lab	1	112.5
4	Microscopy Lab	1	112.5
5	HOD Offices	1	42.5
6	Lecturer Offices	15	17.6

DEPARTMENT OF MEDICAL LABORATORY SCIENCES

S/n	Space	Number required	Area (m²)
1	Class Rooms	6	55.0
2	Microbiology Lab	2	112.5
3	Stimulation Lab	1	112.5
4	Microscopy Lab	1	112.5
5	HOD Offices	1	42.5
6	Lecturer Offices	15	17.6

Figure 4.7: Showing Schedule of Accommodation

Source; Author's fieldwork

DEPARTMENT OF PHARMACOLOGY			
S/n	Space	Number required	Area (m^2)
1	Class Rooms	6	55.0
2	Pharmacology Lab	2	112.5
3	Stimulation Lab	1	112.5
4	Clinical Skill Lab	1	112.5
5	HOD Offices	1	42.5
6	Lecturer Offices	15	17.6

DEPARTMENT OF PUBLIC HEALTH			
S/n	Space	Number required	Area (m^2)
1	Class Rooms	6	55.0
2	Medical Lab	2	112.5
3	Clinical Skill Lab	1	112.5
4	Computer Lab	1	112.5
5	HOD Offices	1	42.5
6	Lecturer Offices	15	17.6

DEPARTMENT OF PHYSIOLOGY			
S/n	Space	Number required	Area (m^2)
1	Class Rooms	6	55.0
2	Physiology Lab	2	112.5
3	Stimulation Lab	1	112.5
4	Computer Lab	1	112.5
5	HOD Offices	1	42.5
6	Lecturer Offices	15	17.6

DEPARTMENT OF RADIOGRAPHY			
S/n	Space	Number required	Area (m^2)
1	Class Rooms	6	55.0
2	Radiology Lab	3	112.5
3	Computer Lab	1	112.5
4	HOD Offices	1	42.5
5	Lecturer Offices	15	17.6

Figure 4.8: Showing Schedule of Accommodation
Source; Authoer's fieldwork

OTHERS			
S/n	Space	Number required	Area (m^2)
1	DEANs Office	1	52.5
2	Lecture Theatre	1	324.0
3	Conference Room	1	31.6
4	ICT Equipment Room	1	36.0
5	Entrance Porch	1	9.0
6	Resting Room	5	12.96
7	Changing room	22	12.96
8	Toilet		2.16
6	General Reception	1	18.0
6	Outdoor Seating area		
7	Photocopy Stand	6	9.0
8	Cafeteria	1	18.0
13	General Store	8	12.96
14	Faculty Library	1	36.0

Figure 4.9: Showing Schedule of Accommodation
Source; Author's fieldwork

4.2.6. Construction Methods and Materials

In the design of this project, a comprehensive range of factors was meticulously evaluated when selecting the appropriate materials. Key considerations included aesthetics to ensure visual appeal, durability to withstand the test of time, local climate conditions that would affect material performance, availability within the region, functionality to meet the specific needs of the project, and strict adherence to relevant regulations and bylaws.

Substructure: The substructure is constructed using high-quality reinforced concrete, which not only provides a solid and stable foundation but also enhances the overall structural integrity of the building. This choice of material is critical for ensuring the long-term stability and safety of the structure, particularly in varying environmental conditions.

Shading Device: An innovative shading device has been incorporated as an effective strategy to significantly reduce heat gain within the building. This feature not only enhances energy efficiency but also contributes to the overall comfort of the interior space by minimizing reliance on artificial cooling systems.

Walls: The walls of the building are designed with a strategic combination of concrete blocks and structural columns, complemented by advanced glazed curtain wall systems. This design facilitates the optimal flow of natural light while maintaining sound insulation and energy efficiency. The use of glazed elements also adds a modern aesthetic to the exterior, creating an inviting atmosphere for occupants and visitors alike.

Window: To optimize internal daylight illumination and ensure effective ventilation throughout the building, strategically placed windows were incorporated into both the upper and lower sections of the glass curtain walls. This design feature enhances airflow, utilizing the stack effect to allow warmer air to rise and exit through the upper windows while drawing cooler air in through the lower openings. This thoughtful integration not only improves indoor air quality but also reduces the reliance on artificial lighting, fostering a more comfortable environment.

Floor Finishes: When selecting flooring materials for the store area, sustainability emerged as a pivotal consideration. A meticulous evaluation process led to the selection of laminate flooring, PVC tiles, and polished concrete. Each of these materials was chosen not only for their aesthetic appeal but also for their outstanding durability, making them ideal for high-traffic environments. Laminate provides warmth and a welcoming atmosphere, while PVC tiles offer versatility in design and ease of maintenance. Polished concrete, known for its strength and longevity, adds a modern touch and serves as an eco-friendly choice, reflecting the commitment to sustainable practices.

Ceiling: Within the faculty, the choice of ceiling materials was thoughtfully tailored to enhance the functionality and aesthetics of each area. The offices feature a POP (Plaster of Paris) false ceiling, providing a clean look while allowing for the installation of lighting and HVAC systems without compromising the overall design. In contrast, the open spaces will utilize 600mm x 600mm gypsum ceiling boards, offering excellent acoustical properties and a seamless finish. This variety in ceiling treatments not only serves practical purposes but also enriches the overall ambiance of the environment, catering to both student comfort and experience.

4.2.7. Building Services

The design of the Faculty of Health Science building will thoughtfully integrate mechanical, electrical, and plumbing services, with a strong emphasis on functionality, efficiency, and safety. These systems will be specifically tailored to meet the diverse needs of both students and staff, ensuring optimal performance and safeguarding valuable assets, such as electronic equipment and educational resources.

Power to the facility will be sourced from the existing IBEDC connection, which the university currently utilizes, ensuring a reliable and consistent power supply for all operational needs.

To enhance space utilization and facilitate maintenance, a generously sized duct measuring 900mm will be incorporated into the design. This duct will not only optimize airflow and climate control within the building but also simplify access for routine maintenance and service interventions across various systems. Additionally, a discreet 1200mm duct will be implemented to effectively conceal water supply lines, sewage pipes, and inspection chambers, maintaining the aesthetic appeal of the facility while ensuring necessary infrastructure is easily accessible when required.

Natural lighting has been prioritized in the overall design of the faculty building. Strategically placed windows and openings will allow ample daylight to penetrate the interiors, significantly enhancing the atmosphere and reducing reliance on artificial lighting. Complementing this natural light, carefully selected artificial lighting fixtures will be installed on false ceiling soffits, suspended floor slab soffits, and in external areas. These fixtures will not only provide adequate illumination during darker hours but will also harmonize with the incoming natural light, creating a warm and inviting ambiance throughout the building, both inside and out.

This integrated approach to design aims to foster a conducive learning environment, promote well-being, and enhance the overall experience for all users of the facility.

Fire hydrants will be provided at recommended distance within the building and at the car park area to cater for all forms of fire accidents.

Chapter Five

Conclusion

5.1 Project Appraisal

The thesis centered on the innovative design of a faculty of health sciences building, emphasizing the critical importance of daylighting and natural ventilation. This approach was pursued through a comprehensive set of strategies aimed at creating a conducive learning environment.

In-depth case study analyses coupled with an extensive literature review allowed for the identification of various effective design strategies, which were then integrated into the overall architectural plan. Key elements included the implementation of curtain walls that maximize natural light entry while minimizing energy consumption, and the incorporation of atriums that facilitate airflow and enhance the building's aesthetic appeal.

Building orientation played a pivotal role in optimizing sunlight exposure and reducing glare, ensuring that interior spaces remain luminous and inviting. Various shading devices were thoughtfully integrated to control light levels and prevent overheating, further contributing to the building's energy efficiency.

Additionally, the use of plants and natural materials was deemed essential not only for improving air quality but also for fostering a connection to nature, which is vital in a health-focused educational setting. Overall, these strategies combine to create an environment that supports both the educational and well-being needs of students and faculty alike, setting a new standard in university building design.

5.2 Conclusion

In conclusion, the thoughtful integration of daylighting and natural ventilation strategies is essential for significantly enhancing spatial comfort across a variety of settings. By leveraging natural light, we can not only improve the aesthetic appeal of an environment but also positively influence the well-being and productivity of individuals. Studies have shown that access to daylight is linked to improved mood, alertness, and overall health, making it a fundamental aspect of design.

Moreover, incorporating natural ventilation facilitates the circulation of fresh air, which can reduce indoor air pollution and create a more pleasant atmosphere. This dual approach not only fosters a healthier environment but also encourages social interaction and engagement among occupants.

The success of these strategies in existing faculty buildings serves as a persuasive testament to their effectiveness. Observations from these sites reveal that spaces designed with ample natural light and effective ventilation contribute to higher levels of comfort, satisfaction, and productivity for individuals. Therefore, it becomes increasingly clear that incorporating these elements into building design is not merely an option but a necessity for enhancing overall occupant comfort in various environments.

5.3 Recommendations

Daylighting and natural ventilation are vital components in establishing a focused and productive work environment. To enhance the design process, stakeholders in the industry should consider the following detailed recommendations:

1. Embrace Technological Advancements: As technology continues to evolve, there are increasingly innovative solutions available for lighting design, particularly in the realm of smart controls. These advancements enable greater customization and efficiency in lighting systems. It is essential for designers to engage in further research into the integration of natural daylighting strategies alongside these technological solutions. By combining traditional design principles with modern technology, we can create more adaptable and sustainable environments.
2. Prioritize User Experience through Lighting: The quality and arrangement of lighting significantly impact how users perceive and interact with a space. Careful consideration should be given to various lighting techniques—such as task lighting, ambient lighting, and accent lighting—to enhance the overall experience. A well-lit space not only boosts morale but can also increase creativity and concentration among users. Therefore, lighting should be a fundamental aspect of the design process rather than an afterthought.
3. Ensure Optimal Ventilation and Lighting: The interplay between ventilation and lighting is crucial in any setting. Poor ventilation can lead to stuffiness and discomfort, while inadequate lighting may cause strain and hinder focus. Together, they can drastically affect productivity levels. Designers must create spaces that allow for natural airflow and ample access to natural light. By doing so, we can cultivate

environments that promote well-being and efficiency, ultimately enabling users to work more effectively.

Incorporating these recommendations, design stakeholders have the opportunity to create spaces that are not only functional but also conducive to the health and productivity of users.

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Appendix 1

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The University Compliance Certificate

This is to certify that the thesis by Babatunde Oluwafemi MAKANJUOLA with matriculation number LCU/PG/004059 in the department of the Department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, Oyo State, Nigeria, is in full compliance with the University format and style of thesis.

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Signature   Date