Proposed 5 Star Hotel for Dangote Group of Companies
(Evaluating Passive design strategies for minimizing energy Consumption in Luxury Hotels through Sustainable practices)

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Being a MSc Thesis Submitted to the Department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, Oyo State, Nigeria

In partial fulfillment of the Requirements for the Award of Master Degree (MSc) in Architecture

2024

Certification

This is to certify that Farouq Ayomide LAWAL, with matriculation number LG/PG/004098 carried out this research work titled 'Evaluating Passive design strategies for minimizing energy Consumption in Luxury Hotels through Sustainable practices' in the Department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, for the award of Master Degree (M.Sc) in Architecture and this has not been previously submitted.

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Dedication

This project is dedicated to Al-Mighty Allah for sparing my life and giving me the opportunity to complete this task. I also dedicate this to my parents Alhaji and Alhaja Lawal for their parental care, moral advice and financial assistances throughout the entire research, words alone cannot suffix my gratitude. I also dedicate this project to my Fiancée, Siblings and friends for their care and support academically.

Acknowledgement

My profound gratitude goes to Almighty Allah for the grace and mercy endowed on me throughout my journey in life and for His help over me in achieving this important phase of my academic pursuit.

My sincere gratitude goes to my supervisor, and design coordinator, Arc. Adedamola Adeola, who despite his incredibly tight schedule coupled with his multifarious commitments, still carved out time to go through my work and guide me diligently all through this project work; for these I say a big thank to you Sir. Special appreciation to Dr. (Arc) Funmilayo. M. Adedire and Arc. Ajilola. S. Oluwakemi for the efforts they have put in to ensure the smooth running of the Masters programme. May God reward you abundantly.

Also, worthy of acknowledgement are all the members of staff of the Department of Architecture who directly or indirectly contributed to the success of this project, including: Dr. (Arc) Obaleye Oludare; Arc. Afolabi Adedeji; Arc. Olamide Martins; Arc Olugbesan A. Abiodun; Arc. Babafemi Gegelesho, and all the technologists. May God bless you all abundantly. I also wish to appreciate my family, friends, course mates and every person that, in one way or the other, has contributed to the success of this project. I wish every one of us a very fruitful future (Aameen)

Abstract

The hospitality industry is a significant consumer of energy, particularly in luxury hotels where high levels of comfort and amenities are expected. This thesis explores the potential of passive design strategies to minimize energy consumption in luxury hotels while maintaining or enhancing guest experience. Passive design strategies, which leverage natural elements and architectural features to regulate building temperature and lighting, offer a sustainable approach to energy efficiency. The research investigates various passive design techniques, including building orientation, natural ventilation, thermal mass, daylighting, and shading devices. Case studies of existing luxury hotels Including the Burj Al Arab, Rosewood Abudhabi for international and Three local case studies, such as the Transcorp Hilton Abuja, Lagos continental Hotel and The Art hotel, Lagos; that have implemented these strategies provide real-world insights into their effectiveness. The study also examines the integration of green roofs and facades, the use of high-performance building materials, and the role of landscaping in energy conservation. By evaluating the performance and benefits of these strategies, the thesis aims to demonstrate that sustainable practices can significantly reduce the energy footprint of luxury hotels without compromising their quality and appeal. The findings are expected to provide valuable guidelines for architects, developers, and hotel operators aiming to enhance sustainability in the hospitality sector.

Keywords: Energy Consumption, Luxury Hotels, Passive design, Sustainability.
Word Count: 209

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Chapter One

Introduction

1.1 Background to the Study

In Nigeria today, the hospitality industry, particularly luxury hotels, plays a pivotal role in catering to the diverse needs of travelers. However, the unprecedented growth in this sector has led to a substantial increase in energy consumption, posing environmental challenges. Lagos is among the fastest growing cities in Africa. Thus, an architect should be a catalyst for positive change in the nature of buildings, cities and if possible our lives. In order to achieve this it is important to consider the entire context of architecture and to foster innovation. Environmental concerns and global economic difficulties require innovations that are created with ever diminishing resources (Abdulmajid K et al., 2015). Many factors need to be taken into consideration in architectural designs, such as user comfort, efficiency, deliverability, and sustainability. High performance systems can be achieved through the automated responses that dynamic architecture can provide to external data sources.

Luxury hotels, known for their opulence and high-end services, are also significant consumers of energy, contributing to environmental impact and operational costs. Energy consumption in luxury hotels is a multifaceted issue influenced by factors such as guest comfort requirements, operational demands, and environmental considerations. (Smith et al. 2018) luxury hotels often exhibit higher energy consumption levels compared to their non-luxury counterparts due to the luxurious amenities and services they offer. This heightened consumption not only contributes to environmental degradation but also poses financial challenges for hotel operators in the face of rising energy costs (Su, Peng, & Zhang, 2019). Thus, there is a pressing need for innovative and sustainable approaches to mitigate energy consumption without compromising guest satisfaction.

A variety of sustainable approaches have been implemented in luxury hotels to minimize energy consumption. These include investments in energy-efficient technologies, such as LED lighting, smart HVAC systems, and renewable energy sources (Di Lascio et al., 2020). Additionally, operational adjustments, such as optimizing laundry practices and implementing guest room energy management systems, have been shown to yield significant energy savings (Chung & Rainer, 2017). These approaches not only reduce the ecological footprint of luxury hotels but also enhance their competitiveness in an increasingly environmentally conscious market.

This study aims to delve into the intricate dynamics of energy consumption within luxury hotels and explore sustainable approaches to mitigate environmental impact. The research recognizes that implementing green technologies, such as energy-efficient lighting, heating, ventilation, and air conditioning (HVAC) systems, can significantly reduce energy use. Additionally, the study will investigate the integration of renewable energy sources, such as solar panels and geothermal systems, to further minimize the carbon footprint of luxury hotels. Despite the potential benefits, the adoption of sustainable energy practices in luxury hotels is not without challenges. One significant barrier identified in the literature is the perceived conflict between sustainability goals and maintaining the luxury image and guest experience (Lai & Wong, 2021). Hoteliers may be hesitant to implement energy-saving measures that could be perceived as compromising the opulence and comfort expected by their affluent clientele. Additionally, upfront investment costs and a lack of awareness or understanding of sustainable technologies may impede adoption (Park & Yoon, 2018). Overcoming these challenges requires a holistic approach that considers the interconnectedness of environmental, economic, and social factors.

This Study addresses the pressing need for luxury hotels to adopt sustainable approaches in minimizing energy consumption. By examining technological advancements, renewable energy integration, and guest involvement. The study aims to provide comprehensive insights that can guide luxury hotels toward a more environmentally conscious and economically efficient future.

1.2 Statement of the Research Problem

It is evident that in developing countries like Nigeria, with poor energy infrastructure development leading to epileptic power supply, high electricity tariff and harsh climatic condition (notably excessive heat from solar radiation mostly in the tropical hot and dry region) designing a luxury hotel for hospitality activities will require special design considerations, being that the building will be generating heat internally as well as gaining heat externally too.

The need for a luxury hotel to effectively minimize energy consumption while maintaining a high standard of service through the implementation of sustainable practices, considering factors such as guest comfort, operational efficiency, and overall environmental impact. This design therefore seeks to incorporate sustainable design strategies as a tool for energy efficiency in the design of a Hotel and the possibilities of reducing energy consumption by exploring passive architectural strategies

1.3 Aim and Objectives of the Study

The aim of this study is to evaluate passive design strategies and examine sustainable practices which can be integrated in the design of luxury hotels to effectively minimize energy consumption while maintaining and enhancing overall guest experience and operational efficiency.

The specific objectives of this study are to;

i. Examine the passive design strategies of Hotels and the Hospitality sector
ii. Understand the concept of Sustainability and its underlining principles
iii. Identify the spatial requirements of a 5 star luxury Hotel
iv. Assess Sustainable building Technologies and practices applicable to luxury hotels that can significantly reduce energy consumption.
v. Propose an energy efficient and sustainable 5 star Luxury Hotel design for Dangote Group of Companies.

1.4 Research Questions

i. What are the likely causes of high energy consumption in Luxury Hotels?

ii. How do luxury hotels integrate sustainability into their operations and management practices?

iii. What are the typical spatial requirements for different facilities within a 5-star luxury hotel, such as guest rooms, restaurants, and recreational areas?

iv. What are the benefits of adopting sustainable building practices that can be effectively implemented in luxury hotel construction?

v. What are the specific energy-efficient and sustainability principles be integrated into the overall architectural design of the hotel

1.5 Significance of the Study

This study will serve as a case study for those coming behind who will need to write similar project as part of the requirement for the fulfillment of their degree program. It could also serve as a case study for architects in the design of a 5-Star Luxury Hotel. To serve as a reference in creating Energy efficient buildings and as a means to reduce the environmental and social problem.

1.6 Scope of the Study

This study focuses on investigating strategies for implementing green and sustainable approaches to minimize energy consumption in luxury hotels. it encompasses various dimensions, including technological, operational, and guest-related aspects, with the aim of creating a comprehensive framework for sustainable practices within the hospitality industry.

The outcome of this study is to highlight the strategies that can be adopted to enhance energy efficiency in any hospitality building project, causes of high energy consumption and how it can be reduced substantially. Also, the roles of staff and guests in the awareness and skills in implementing energy-efficient practices fostering a culture of sustainability, and how various building components, configuration of the building, building materials and landscape can be used to achieve a Sustainable Building.

1.7 Limitation of the Study

The project is limited to the designing of the 5-Star Hotel and incorporating sustainable approaches to aid in minimizing the consumption of energy in Hospitality Building. General limitations of the study are as follows;

i. Time constraint.
ii. Non-availability of the instruments to conduct test.
iii. Lack of access to some relevant literatures and books.
iv. In Nigeria most information were kept secret. This was a major constraint for data collection by me notwithstanding the whole exercise has been very stimulated in identification of customer needs and seeking to satisfy ones' need.

1.8 Operational Definition of Terms

i. **Passive Design Strategies:** Passive design strategies are a set of design approaches that rely on the natural environment to provide heating, cooling, ventilation, and lighting for a building. Passive design strategies, as opposed to active design strategies, are based on natural laws rather than mechanical systems and processes. Passive design strategies seek to create a comfortable and energy-efficient indoor environment while minimizing the use of mechanical systems and lowering building energy consumption. They make use of the climate, site conditions, and materials to design a building that works in tandem with the environment.

ii. **Minimizing Energy Consumption:** For the purpose of this study, "minimizing energy consumption" refers to the deliberate reduction of energy usage within luxury hotels through various sustainable strategies and practices, aimed at decreasing overall energy consumption levels while maintaining or enhancing service quality and guest satisfaction.

iii. **Sustainable Approaches:** "Sustainable approaches" in the context of this study denote strategies and practices implemented within luxury hotels to promote environmental sustainability and reduce energy consumption. These approaches encompass the adoption of energy-efficient technologies, renewable energy sources, operational adjustments, and conservation measures that contribute to long-term environmental stewardship.

iv. **Luxury Hotels:** Luxury hotels refer to high-end hospitality establishments characterized by premium amenities, services, and accommodations catering to affluent clientele. These hotels typically offer upscale facilities, personalized services, and luxurious experiences, distinguishing them from standard or budget accommodations.

Chapter Two

Literature Review

2.1 Conceptual Review

This part of the study consists of information from previous literature related to Energy Consumption, Conservation and Efficiency. It also examines sustainable approaches that could be implemented during the design and construction of Luxury Hotels to maximize energy efficiency, Extensive discussion is done on the strategies that can be adopted to minimize the consumption of energy in Luxury Hotels and the Hospitality sector in general. The sources of literature reviewed include published and unpublished works.

2.1.1 Concept of Passive Design

Passive design is a systematic approach to building design that is primarily determined by the climate and site conditions of a location, with the goal of maximizing building users' comfort and health while minimizing energy consumption. The primary goal of passive design is to minimize and potentially eliminate the use of any active mechanical systems to maintain occupant comfort. Passive design solutions are typically less expensive. Passive design is one of the earliest and most active methods of energy conservation (International Journal of Engineering Research and Reviews, 2019). This all goes back to the man in the cave. Shearer (2010) mentioned that cave dwellings in the northern hemisphere often had openings facing south. This allowed the sun to warm the rock inside during the day, releasing heat into the cave at night. This theory has been around for years but has been enhanced by modern technology and building materials, making it more efficient. Passive design involves various strategies that harness natural energy flow to enhance building design, construction, and management. It has remained constant but has become more effective with advancements in technology and materials. Passive architecture encompasses principles that promote energy flow from the natural environment to building elements.

The beauty of passive design is that it doesn't transport solar energy; instead, it utilizes it where it's collected (Shearer, 2010). Collection points must be strategically placed to serve specific functions within buildings. For instance, a sunlit window can naturally warm a room using solar energy collected passively.

Improvements can be made through various methods such as window placement, building orientation, and landscaping elements like solar-powered lights. Effective passive design relies on optimizing local climate conditions (Shearer, 2010). Factors like window positioning, insulation, thermal mass, and shading play vital roles in designing efficient buildings.

By integrating passive design techniques, buildings can save significant costs over their lifespan. Solar cooling systems are utilized for building cooling and ventilation purposes. Minimizing excessive heating is key to reducing cooling loads associated with sunlight exposure or hot air infiltration from outside sources (Shearer, 2010). Friendly-building features such as proper window treatments and insulation help maintain comfortable indoor temperatures while cutting down on energy expenses.

Passive methods for controlling temperature and humidity in buildings date back to ancient times. However, these methods gradually fell out of favor with the rise of electrical energy and artificial climate control systems (Santamouris, 2016). In developed countries with hot climates, there has been a resurgence of interest in cost-effective passive cooling systems for buildings (Pacheco R, 2012). These systems function by creating differences in hot and cold air densities, which rely on natural convection for air movement. Although passive systems mainly depend on natural sources for cooling or heating, mechanical equipment like fans can enhance their effectiveness. A power source is still needed to initiate the process, even though passive systems draw primarily from natural energy sources. Different passive systems would have different effects on different aspects of the design.

2.1.1.1 Advantages of Passive Design

(Tahmina, 2009), provides the following as the advantages of passive design:

- **i.** Cost Savings
- **ii.** Energy Efficiency
- **iii.** Aesthetics
- **iv.** Enhance Comfort.

Cost Savings: Passive design is a cheap way to heat a building. According to the Light House Sustainable Building Centre (2011), it has been proved that passive design and optimal building envelope performance can help reduce utility bills and the need for mechanical systems and their associated costs. The United States Department of Energy (2009) also established that incorporating passive design elements into buildings and homes can reduce heating bills by as much as 50 percent.

Energy Efficiency: Passive design is a clean energy resource that can minimize the demand for fossil fuels. Passive design principles help a building to reduce its demand for lighting, heating and cooling.

Aesthetics: The New Mexico Solar Energy Association (2009) establishes that one advantage of passive design is the aesthetic appeal of the architecture itself.

Enhances Comfort: The major reason for utilizing passive design in a building is to immerse the building with natural light. Passive design buildings are fresher and well lighten and with more spacious feeling than a conventional structure. The placement of windows in a careful manner on the earth sheltered sides ensures that enough daylight enters all sides of the building. The interiors of passive design buildings are warmer in winter, cooler in summer (even during a power failure).

2.1.1.2 Passive Design Strategies.

According to Agboola (2011), passive design focuses on utilizing natural energy flows to achieve thermal comfort, involving thoughtful building orientation, choice of materials, and landscaping. Proper specifications for building materials help reduce and prevent heat gain, and shading is essential to limit solar radiation.

With the increased awareness of global warming and the dependence of buildings on energy for daily activities, the importance of sustainability is being emphasized worldwide. Building occupants are now more conscious of sustainability's role in enhancing quality of life (Sambo, 2012). Energy is essential for building operations, with features like lighting, ventilation, insulation, and controls playing key roles in achieving energy efficiency. Passive design strategies for energy efficiency—such as thermal mass, cross ventilation, external shading, orientation, and insulation—are key elements of sustainable building design (Wimmer, 2013).

Passive design entails measures to create buildings that leverage natural heat and air movement to maintain a comfortable indoor environment (Gokarakonda, 2016). It includes the collection, storage, and distribution of energy naturally. The primary aim of passive design is to minimize or eliminate the need for active mechanical systems while ensuring occupants' comfort (Hyde, 2017).

The enhancement of health and well-being in buildings can be achieved through various techniques and strategies supported by different parameters. These include using technologies (both passive & active), customizable controls, and incorporating biophilic design patterns.

In home design, the building envelope serves as a barrier between natural climate conditions and artificial climate settings to ensure human comfort. Important factors that affect human comfort include visual, thermal, and acoustical aspects. Building envelopes play a crucial role in attaining the desired comfort level, along with the technologies utilized.

These technologies can be classified as active, passive, or hybrid (a combination of both). Passive technologies rely on natural resources to provide comfort without depending on artificial energy sources. The choice of passive design techniques is influenced by the local climate conditions of the project site.

2.1.1.3 Passive Cooling Strategies.

Passive cooling strategies aim to prevent overheating by blocking solar gains and removing internal heat. These strategies are often paired with passive ventilation methods, increasing airflow rates during cooler outdoor temperatures to flush heat from the building. Elements contributing to passive cooling include: Shading devices, Thermal mass, Natural ventilation openings Implementing these passive cooling strategies within building envelopes helps create sustainable living spaces that support human life effectively. (Passive Design Toolkit, 2009).

a) Thermal mass

A material's capacity to absorb and retain heat energy during a hot phase and then release it during a cool phase is referred to as thermal mass. Three noteworthy results are possible during this lag time (Kalogirou, 2002):

i. In hot or cold climates, it uses less energy than an equivalent low-mass building.

ii. Because energy storage is controlled by proper mass size and interaction with the HVAC system, it shifts building energy demand to off-peak hours.

iii. The slower reaction time tends to minimize the indoor temperature changes caused by external temperature oscillations.

b) Thermal Insulation

When thermal insulation is appropriately constructed in the building envelope, energy use may be reduced with the least amount of negative environmental effects. Expanded polystyrene (EPS), phenolic foam, and Rockwool insulation's environmental effects were evaluated and contrasted by (Tingley, 2015). The most environmentally friendly insulation was identified after 30 years of research into 16 different effect areas. According to their claims, of the sixteen impact categories looked at, EPS had the least detrimental environmental impact in 14 of them. This study also analyzed the embodied carbon associated with PIR (polyisocyanurate) and wood fiber boards. As the material with the least amount of embodied carbon, wood fibre board is ideal for usage in settings where lowering CO2 emissions is a top concern.

c) External Surface Color

The rate at which solar radiation is absorbed or blocked may be changed by using the right colors on a building's exterior surfaces. Numerous research looked at the relationship between alterations in building energy use and various types of color coverings for outside surfaces.

d) Glazing Types

Because of its effects on enabling solar radiation to travel through the inner spaces, glazing plays a significant part in building energy management. According to Lee JW, Windows are responsible for 20-40% of a building's lost energy (Lee, 2013). Another way to control the amount of solar radiation that enters the structure is to choose the right glazing. The importance of this method may be better understood in areas where there are high needs for heating and cooling. Also, in a study by (Nejat Payam, 2005), there exists an increasing gap in supply and demand of various materials including the glazing types. As a result, while deciding on the kind of glass, the specific climates of the building's location should be considered.

e) External Shading devices

The primary purpose of a shading system is to protect a building’s transparent elements from the sun’s harmful rays. There are three main types of shading systems: fixed, mobile, and other varieties. Shading devices can reduce a building's energy consumption by blocking incoming sunlight (Bansal N. K., 1988).

According to the Passive Design Toolkit (2009), nocturnal cooling involves using cool night air to ventilate and remove heat stored in a building's mass from the day. Cool air enters through lower windows, creating an upward airflow that pushes warm air out through higher windows. Evaporative cooling works by using the heat within a space to evaporate water, cooling and humidifying the air in the process. To cool a space this way, moisture is added to an airstream, which can be achieved by drawing air over water sources like indoor water features, outdoor bodies of water, or hydroponic living walls. Earth tempering, meanwhile, leverages the stable underground temperature at depths below 1.5 meters to cool ventilation air. This approach involves installing a buried ventilation intake, or "earth tube," to temper the incoming air.

f) Landscaping

Heat capacity of building is a scientific measure of how much heat various materials can hold. For a particular building element, heat capacity is calculated by multiplying the density of its material by its overall thickness, and then by its specific heat. Specific heat is referred to the amount of heat a material can hold per unit of mass. The greater the specific heat, the more energy is required to heat up the material. Thermal mass is basically the ability of a material to store heat (Thani SKSO, 2012). It can be easily incorporated into a building as part of the walls and floor.

According to (Shashua-Bar L, 2009), Thermal mass affects the temperature within a building by:

i. Stabilizing internal temperatures by providing heat source and heat sink surfaces for radiative, conductive and convective heat exchange processes.
ii. Providing a time-lag in the equalization of external and internal temperatures.
iii. Providing a reduction in extreme temperature swings between outside and inside

Both heat capacity and conductivity play a role in the thermal mass effect. Heating large, dense materials requires significant energy, as much of this energy is absorbed and distributed throughout the material's volume. With high energy applied to the surface, the heat gradually travels through the material's entire thickness, eventually causing a temperature increase on the interior surface. This conduction process can be lengthy—taking up to 10-12 hours in thick masonry walls. When the external surface experiences fluctuating energy, it can create "waves" of temperature moving through the material (Shashua-Bar L, 2009).

Landscaping elements are essential in shaping a site's microclimate. Factors such as the extent of hard paving, placement of water bodies, shade trees, and building orientation all influence this. Hard paving increases heat retention around buildings, contributing to the heat island effect, and increases runoff by reducing water absorption. Water bodies can act as natural coolers in hot, dry climates, as the moisture they release cools warm air passing over them. Trees and shrubs impact wind flow and provide shade for buildings and paved areas, especially when planted near building edges. When placed around the site's perimeter, they also serve as sound barriers, reducing noise intrusion. However, the effectiveness of shading depends on the trees' height, limiting benefits to lower building levels.

2.1.1.4 Natural Ventilation (Passive Ventilation) and Daylighting

a) Natural Ventilation.

Passive ventilation systems leverage natural airflow patterns within and around a building to bring in fresh outdoor air. Wind and temperature-driven buoyancy create air pressure variations within inhabited spaces. By designing buildings to enhance these natural airflows, it is possible to optimize ventilation instead of obstructing it.

Because architectural features—such as a building's shape, the layout of walls and floors, and even furniture—affect airflow, passive ventilation should be considered early in the design phase. Design elements need to balance airflow pathways with privacy and noise reduction. Ventilation involves replacing hot air with fresh air to maintain indoor air quality.

In the building sector, ventilation serves three main functions, as outlined by Watson and Labs (1983): it cools the building by exchanging warm indoor air with cooler outdoor air, aids in the body's evaporative and sensible heat loss, and fulfills the need for fresh air among occupants. Additionally, Givoni (1998) notes that cross-ventilation can be used to promote quicker cooling and improved air quality.The two forces listed below can provide natural ventilation:

a) Temperature differential between the outside and the inside of the structure.

b) Wind flow against the building.

Passive ventilation systems harness natural airflow patterns within and around a building to introduce fresh outside air. Variations in air pressure, caused by wind and temperature-driven buoyancy, create airflow throughout occupied spaces. Buildings can be designed to enhance and utilize these natural airflows rather than block them. Since many architectural elements—such as the building's shape, the layout of walls, floors, and even furniture—affect air movement, passive ventilation must be integrated into the design phase. Design considerations must balance airflow direction with needs for privacy and noise reduction, allowing air to move with minimal resistance. Additionally, the predominant wind direction influences ventilation rates (Vladimir Mikler, 2009).

The three most popular methods of passive ventilation are as follows. The simplest type of ventilation is single- sided ventilation with moveable windows, where ventilation air enters via the same window(s) on the same side of the inhabited room and exits through the same window(s). The size of a space that can be properly ventilated in this method is constrained by design; single-sided ventilation does not provide noticeable results unless ceilings are quite high.

Cross-ventilation, where moveable windows on opposite or adjacent walls flow ventilation air across the inhabited room, is more efficient. To allow for cross-ventilation, designs should aim for at least two exposed walls per residential or business unit (Mikler, 2009).

Finally, induced ventilation using high spaces like atria, stacks, and wind towers may be required in larger buildings with significant core spaces in order to provide adequate ventilation using only passive means. Passive ventilation through natural means is optimized by these thoughtful architectural features.

b) Daylighting.

While still promoting bright, functional interior areas, day lighting helps to reduce the need for electric lighting. The kind, size, and position of windows affect how much natural light enters a room or building. The position of the sun and its seasonal variations, the ideal amount of daylight, glare reduction, and the heat gains and losses associated with the selection of windows and frames should all be taken into account. Another way to provide natural light to a building's interior are sunlight tubes. Sunlight tubes use cutting-edge design and technology to collect sunlight from the roof or outside walls, direct it down a highly reflective shaft, and then disperse an abundance of pure day-light throughout the interior space (Wayii Serekara Kennedy, 2022).

Daylight contributes significantly to the lighting and mood of an interior and, in certain businesses, may offer sufficient illumination for extended periods of time without the need of electric lighting. The shape of the structure and its windows, which are established during the design phase, are the main components that affect a building's daylighting characteristics (Jiang, Achieving Energy Efficiency in Office Building, 2010).

The thoughtful design of the building skins and the daylighting demonstrate the comparatively high daylight factor of this structure. This suggests that, provided artificial lighting is not turned on continually, the electrical lighting load within the thermal model might be decreased. As a result, the lighting burden in the office spaces has decreased to 10W/m2. (Jiang, Achieving Energy Efficiency in Office Building, 2010), to complement the daylighting, the building energy conservation features are also enhanced by the use of energy efficient artificial lighting installation. The energy efficiency of an artificial lighting installation depends on:

a) The efficiency of the various components of the system: lamps, ballasts, luminaires,
b) The way in which they are used, often strongly influenced by the control system and the daylight availability

Instead of a 38 mm tube, a fluorescent tube with a 26 mm diameter is employed. While using around 8% less energy, these thinner lamps generate roughly the same amount of light as the bigger diameter bulbs of the same length and color temperature. In addition to the bulb, reflectors and control equipment have been carefully chosen to increase the efficiency of artificial lighting. As task lighting is likely to be employed in some workstations, decreased overhead lighting is applied where it is appropriate.

High frequency low energy fluorescent bulbs are used in the general illumination to increase energy efficiency and reduce maintenance expenses. Pendant lights with direct/indirect light distribution are used for office lighting. In open-plan offices, general lighting that conforms with CIBSE LG7 is employed. In the reception spaces, accent lighting and ornamental effects are created using metal halide and low voltage halogen lamps. The control system makes sure that automated controlled blinds and window coverings are in operation at the right times of day on all sun exposed windows in order to provide a decent daylighting factor while alsopreventing excessive overheating in the summer. When rooms are empty, the management system makes sure that the windows and blinds are closed to block too much direct sunlight.

2.1.1.5 Design for Climate

By utilizing the natural environment to maintain a building's internal temperature range, passive design reduces the need for artificial heating and cooling. Considering the local climate conditions of a region while creating is one of the passive design methods. In order to achieve maximum productivity, a structure constructed using passive design principles must be integrated with the local climate (O A Alagbe et. al., 2019).

Design for climate is a crucial aspect of passive design strategies, which involves tailoring a building's design to harness local climatic conditions in order to maximize comfort and energy efficiency without relying heavily on mechanical systems. The aim is to work with the natural elements and climatic characteristics of a specific location to create a more sustainable and environmentally friendly building. Here are some key considerations and passive design strategies for Hot and Humid climate type:

a) Hot and Humid Climates

Hot and humid climates, common in tropical regions, present challenges related to high temperatures and humidity. Passive design strategies for such climates include:

i. **Building Orientation**: Orient the building to capture prevailing breezes and create effective wind channels for natural ventilation.

ii. **Elevated Floors**: Elevate the building above the ground to reduce the impact of humidity and potential flooding.

iii. **Roof Design**: Use light-colored or reflective roofing materials to minimize heat absorption and reduce the "heat island" effect.

iv. **High Ceilings**: Design higher ceilings to allow for better air circulation and heat dissipation.

v. **Shading and Overhangs**: Employ large overhangs and shading devices to block direct sunlight while maintaining natural light and ventilation

2.1.2 Concept of Energy Consumption

2.1.2.1 Energy

The ability of a physical system to carry out work is called energy. There are different forms of energy, including heat, electrical, mechanical, kinetic, and light energy. Energy is defined as the ability to do work. One could divide energy sources into two categories: renewable and non-renewable.

Everything we do requires energy, even jumping off a building and launching astronauts into space. There are several different types of energy, such as thermal, nuclear, atomic, electrical, chemical, mechanical, and radiant forms. While energy can be transformed into different forms, it cannot be produced or destroyed. Energy can be extracted from a variety of resources that can be categorized as primary and secondary; commercial and non- commercial; conventional and nonconventional; renewable and non-renewable and traditional and non- traditional.

Energy is a vital resource that helps in everything we do; it is one of the most important sources of every country's development. Energy empowers agricultural, commercial, industrial, domestic and official activities in both developing and developed countries of the world. To lessen the problem of poverty of a country, energy has to be provided to its citizens; this is the fundamental step when embarking on its growth and development.

Nigeria is fortunate to have huge energy resources. Nigeria sits astride of over 35 billion barrels of oil, 187 trillion cubic feet of gas, 4 billion metric tons of coal and lignite, as well as huge reserves of tar sands, hydropower and solar radiation, among others (Adenikinju, 2023).

2.1.2.2 Energy Efficiency

The United Nations Environmental Protection (UNEP) and the Environmental Protection Agency (EPA) (1997) describe energy efficiency as achieving the same level of performance from a product or process using less energy, or achieving a higher performance with the same amount of energy. In financial terms, energy efficiency can be understood as delivering the same output in a more cost-effective way (Marloes, 2007).

Energy consumption typically breaks down into lighting systems (29%), heating, ventilation, and air conditioning (HVAC) systems (47%), and other uses like office equipment (27%). With low- to medium-cost technical interventions, energy use can be reduced by 25-30% (Grobler and Singh, 1999). The Department of Minerals and Energy's Energy Efficiency Strategy (2005) aims for a 15% reduction in energy use in commercial and public buildings compared to the projected 2015 energy consumption levels.

2.1.2.3 Energy Conservation

Corky (2003) describes energy conservation as a multifaceted issue that involves being mindful of the building site, choosing suitable construction methods and materials, and carefully designing lighting in buildings. The energy impact of a building is largely influenced by the choice of heating, ventilation, and air conditioning (HVAC) systems.

Energy conservation involves reducing energy consumption by lowering service levels; in other words, conserving energy means reducing usage. Energy is needed for extracting, processing, manufacturing, and transporting construction materials, as well as for the construction process itself. Even more energy is required for the heating, cooling, lighting, and operation of equipment in a completed building, which adds to the overall cost.

2.1.2.4 Instances of Energy Efficiency and Energy Conservation

It is explained also that "Energy conservation" and "energy efficiency" are often used interchangeably, but there are some differences. At the most basic level, energy conservation means using less energy and is usually a behavioral change.

Energy conservation is an effective way to reduce total energy usage and can also enhance energy efficiency. However, these terms differ in meaning. Energy efficiency refers to saving energy while maintaining the same level of service (Gillaspy, 2015).

i. For example, switching off a light when you leave a room is an act of energy conservation. On the other hand, replacing an inefficient incandescent bulb with a more efficient compact fluorescent bulb is an example of energy efficiency.

ii. Adding insulation to a home's attic and walls allows the homeowner to use less energy for heating and cooling while still maintaining a comfortable temperature. Similarly, replacing old, inefficient windows with new, energy-efficient ones also improves energy efficiency.

iii. Upgrading to newer, energy-efficient appliances also exemplifies energy efficiency. These modern appliances provide the same or better performance while using significantly less energy than older models.

iv. Energy conservation can also be achieved by lowering the thermostat by a few degrees, though this may result in feeling colder. To improve energy efficiency, installing a more efficient heater and better insulation allows the thermostat to be set higher while using the same or less energy, maintaining comfort with less energy used.

v. Energy conservation can be seen as “cutting back,” whereas energy efficiency means using energy more “effectively.” Through scientific and technological advancements, energy efficiency provides society’s needs with less energy consumption (Gillaspy, 2015).

2.1.2.5 Benefits of Energy Efficiency and Conservation

A 2012 study on energy efficiency strategies highlights several benefits of energy efficiency as follows:

i. **Economic Growth**: Implementing energy efficiency measures often requires local labor, which can boost employment and foster economic growth. Over time, energy efficiency can lower domestic energy bills, leading to higher disposable incomes that can stimulate other areas of the economy. Additionally, businesses may experience reduced operating costs, improving productivity.

ii. **Innovation in Energy-Efficient Technology**: Investing in energy-efficient technologies creates a long-term cycle of innovation, leading to cost reductions. This, in turn, makes future investments in energy efficiency more affordable and accessible. By developing innovative technologies, materials, and business models for energy efficiency, Nigeria can open up significant export opportunities as global efforts to combat climate change intensify.

iii. **Increased Productivity**: Economic studies suggest that improving energy efficiency can boost productivity, spur economic growth, and reduce inflation. This, in turn, generates additional job opportunities through the broader economic growth.

iv. **Savings for Domestic and Business Consumers**: Energy efficiency measures, such as improved heating efficiency and insulation, already benefit most buildings. Without these measures, energy consumption could be nearly double the current level. Ongoing energy efficiency improvements will continue to help lower energy bills, enhancing overall well-being. The financial savings from reduced energy costs may allow consumers to allocate more funds to other needs, improving health and quality of life.

v. **Emission Reductions**: Energy efficiency is essential for reducing greenhouse gas emissions in the most cost-effective manner. Improving energy efficiency across all sectors will help meet emission reduction targets while providing a cost-effective solution to tackling climate change.

vi. **Sustainable and Secure Energy System**: Reducing energy consumption enhances energy security and reduces the need for significant investments in additional infrastructure. This can lower the long-term costs associated with energy generation, making the energy system more sustainable and secure for the future.

2.1.2.6 Energy in Buildings

In the context of buildings, energy refers to the power or capacity required to sustain various activities, functions, and operations within the built environment. It encompasses the energy needed for heating, cooling, lighting, ventilation, and powering appliances and equipment within residential, commercial, and industrial structures. Energy in buildings is measured in terms of consumption and efficiency, with a focus on optimizing energy usage to minimize environmental impact, reduce costs, and enhance occupant comfort and well-being. This includes efforts to improve insulation, adopt energy-efficient appliances and lighting systems, utilize renewable energy sources, and implement smart building technologies to optimize energy management and conservation.

Building energy can be divided into two categories: operational energy and embodied energy. Operational energy is needed to keep the building running throughout its life, from commissioning to demolition, whereas embodied energy is needed for material manufacturing, construction, and transportation to the site.

2.1.2.7 Energy Efficient Buildings

United Nations (1991) defines energy efficient buildings as buildings that have minimum levels of energy inputs. Power-efficient buildings that are well-designed offer optimal human comfort levels at a lower cost of energy use. The Development and Land Use Policy Manual for Australia (DLUPM) (2000) states that the goals of energy-efficient buildings are to decrease energy consumption (natural gas, electricity, etc.) and increase occupant comfort for heating, cooling and lighting. Chowdhury (2006) asserts that increased energy efficiency in buildings can provide financial benefits through reduced electricity bills and have a role in reducing total societal energy use.

Energy efficient buildings are designed in a way that ensures that energy is used at a reduced cost, and in a sustainable and conserved manner. Energy efficient building is a panacea to attaining a "sustainable city or eco-city". Eco-cities are designed to achieve maximum comfort by occupants with emphasis on reduced energy inputs, water and food, waste output of heat, and reduced air, noise and water pollution (Devuyst, 2011., Eco- city, 2011.) Energy efficient building is relatively unknown in Nigeria due to certain factors which include: ignorance/illiteracy, poverty, lack of awareness and/or poor Government policies toward achieving such concepts in buildings.

i. Ignorance/illiteracy:

Most developing countries are known for high illiteracy rate. According to the report of the Minister of State for Education in Nigeria, adult illiterates rose from 25 million in 1997 to 35 million in 2013 (Vanguard, 2014). Specifically adult literacy rate is about 56.9% of the total population (National Bureau of Statistics, 2010. Murtala et. al., 2013). This makes the focus of most citizens on buildings to be more on quick gains without consideration on sustainability of the environment and climate. Also with such high degree of illiteracy, majority of the citizens need to be educated on the need for energy efficiency in buildings to enable them understand the merits.

ii. **Poverty**

According to the 2006 census (National Population Commission, 2006, National Bureau of Statistics, 2010), there are 2,176,947 people living in Nigeria. Nigeria's poverty rate is still worrisome. Ninety percent of the poorest people reside in the north of Nigeria, where an estimated 54% of the population (43 percent in urban areas and 64 percent in rural areas) live below the poverty line (Nigeria Country Programme document, 2014-2017, Unicef). Poverty is a major barrier to the construction of energy- efficient buildings because it costs money to acquire the labor and materials required to complete such projects.

iii. Lack of awareness:

The majority of Nigerians are unaware of how buildings affect our climate and surroundings. Without being aware of the drawbacks, they are more focused on the visual appeal and quantity of contemporary technology equipment in buildings. Certain rural areas attribute weather variations and seasonal variations—which may be caused by climate change—to archaic religious beliefs. Thus the need for awareness on the influence of energy efficient buildings on the environment to be created in the minds of the citizenry cannot be overstressed.

iv. Lack of Government policies:

Lack of Government policies on achieving energy efficient buildings for sustainable environment and development are another contributing factor. The Government (Federal. State and Local) are yet to come up with strong policy that will ensure that buildings are regulated to ensure that energy efficiency is achieved. Currently, the Nigerian government has set a target to increase electricity generation by 40,000MW of power by the year 2020 (Nnaji, 2012) and subsequently, many gas-powered stations have been commissioned to increase generation and many more are expected to be commissioned to meet up with energy demand. These are non-renewable energy source and will result in the emission of GHGs, leading to global warming to consequently increase climate change. Increased urbanization in most States especially in the housing.

2.1.3 Concept of sustainability

Sustainability is a complex and crucial issue for the survival of humanity and nearly all life on Earth. The development of sustainable, eco-friendly architecture has become a key objective for those aiming to improve quality of life and provide a model for future endeavors. As a result, the transition to greener architecture has become a central focus in modern architectural practice (Mahdavinejad, 2014). The rapid depletion of Earth's limited resources to meet increasing global demands signals that, without a significant shift in human attitudes and behaviors, the future of civilization is uncertain.

Achieving sustainability is a difficult challenge, as it requires continuous collective effort. Green architecture offers environmental, social, and economic benefits. Environmentally, it reduces pollution, conserves resources, and prevents environmental degradation. Economically, it lowers costs for water and energy usage in buildings, while improving occupant productivity (Thomas, 2009). From a societal perspective, green buildings are designed to be aesthetically pleasing and exert less strain on local infrastructure.

Buildings protect us from nature's extremes, but they also affect our health and the environment. As the impact of these effects becomes more apparent, the practice of "green building" is gaining traction. Green or sustainable building involves designing, constructing, and maintaining structures that are healthier and more resource-efficient (Roy, 2008).

2.1.3.1 Sustainable Design

Sustainable design in architecture takes a holistic approach aimed at reducing environmental impact while creating healthy and efficient spaces for occupants. This approach encompasses energy conservation, resource preservation, biodiversity promotion, and quality enhancement within built environments. Sustainable design aligns environmental, social, and economic goals throughout a building's entire lifecycle, from planning and operation to eventual deconstruction. The rapid depletion of Earth's resources to meet global development needs underscores the need to change human attitudes in order to secure the future of civilization. While sustainability is complex, it remains a common goal. Sustainable architecture delivers environmental, social, and economic benefits by reducing energy consumption and improving productivity (Thomas, 2009). Socially, these buildings aim to be visually appealing and reduce pressure on local infrastructure. Although buildings shield us from extreme weather conditions, they also affect health and the environment. As awareness of these impacts grows, the field of sustainable building continues to expand. Sustainable construction emphasizes the use of healthier, more efficient materials and methods (Roy, 2008).

2.1.3.2 Principles of Sustainable Design

a. **Energy Efficiency:** Design buildings to minimize energy consumption through passive design strategies, high-performance building envelopes, efficient HVAC systems, and renewable energy integration. Incorporate daylighting, natural ventilation, and shading to reduce reliance on artificial lighting and mechanical cooling.

b. **Resource Conservation:** Optimize resource use by selecting sustainable materials with low embodied energy, recycled content, and minimal environmental impact. Implement construction waste management plans to reduce waste generation and promote material reuse, recycling, and recovery.

c. **Water Conservation:** Incorporate water-saving technologies and practices, such as low-flow fixtures, greywater recycling systems, and rainwater harvesting, to reduce water consumption and promote water efficiency in building operations.

d. **Site Planning and Biodiversity:** Design buildings and landscapes to minimize site disturbance, preserve natural habitats, and promote biodiversity. Integrate green spaces, native vegetation, and wildlife habitats to support ecosystem health and enhance the quality of the outdoor environment.

e. **Health and Well-being:** Prioritize indoor air quality, thermal comfort, and daylighting to create healthy and comfortable indoor environments for occupants. Use non-toxic building materials, low-VOC finishes, and natural ventilation to improve indoor air quality and occupant satisfaction.

f. **Adaptability and Resilience:** Design buildings to adapt to changing environmental conditions, future needs, and evolving user preferences. Incorporate resilient construction methods, flexible layouts, and modular systems to enhance building longevity and adaptability over time..

2.1.3.3 Examples of Sustainable Design Strategies:

a. Passive Solar Design: Orient buildings to maximize solar exposure, optimize natural daylighting, and minimize solar heat gain in summer and heat loss in winter. Use thermal mass, shading devices, and high-performance glazing to enhance energy efficiency and occupant comfort.

b. Green Roofs and Living Walls: Install green roofs and living walls to reduce stormwater runoff, mitigate urban heat island effects, improve air quality, and provide habitat for wildlife. Green roofs also offer insulation benefits, energy savings, and aesthetic enhancements to buildings.

c. Biophilic Design: Incorporate biophilic design elements, such as natural materials, vegetation, water features, and views of nature, to foster connections with the natural environment and improve human health and well-being. Biophilic design enhances occupant productivity, creativity, and satisfaction while reducing stress and fatigue.

2.1.3.4 Sustainable Construction

The concept of sustainable construction has emerged in the construction industry as a response to increasing concerns about the environmental and social impacts of construction activities. Sustainable construction is defined as "the creation and responsible management of a healthy built environment based on resource efficiency and ecological principles" (Khalfan, M.M.A, 2002: 15). In essence, it refers to applying sustainable development principles within the context of the built environment. Discussions and practices related to sustainable construction often emphasize efficient construction processes, the use of materials, available technologies, and other technical considerations that prioritize environmental health, as well as the well-being of building occupants, builders, the general public, and future generations (Rhydin, Y. & Vandergert, P, 2006: 5).

2.1.3.5 The Triple Bottom Line for Sustainable Construction

It is critical to recognize and identify the remaining aspects of sustainable construction. Overall, sustainable construction consists of three broad themes: people, planet, and profit, also known as the "triple bottom line". The objectives of these three themes are;

a. **People**: To recognize the needs of everyone impacted by construction, from inception of a project to demolition. The list includes artisans, site workers, the local communities, and the users of the building.

b. **Planet:** Protecting and enhancing the planet by reducing emissions and waste, and using natural resources responsibly.

c. **Profit:** Maximize profitability by optimizing resource utilization, including labor, materials, energy, and water. (Source: http://www.gcbl.org/economy)

Sustainable construction takes account of these objectives in a balanced way at all stages of a construction project.

2.1.3.6 Strategies and Drivers for Sustainable Construction

There are both mandatory and voluntary strategies designed to promote and enforce sustainable construction practices within the construction industry. One of the earliest strategies for driving change in the sector was the publication of *Rethinking Construction* in July 1998, commonly known as The Egan Report. This report criticized the underperformance of the construction industry and called for significant changes and improvements in the delivery of construction projects. The discussions and practices surrounding sustainable construction often emphasize efficient construction processes, material usage, the availability of technology, and other technical aspects that prioritize environmental health, as well as the well-being of building occupants, builders, the general public, and future generations (Rhydin, Y. & Vandergert, P, 2006: 5).

(a) Strategies for Sustainable Construction

i. **Design for Efficiency:** Incorporate energy-efficient design principles from the outset, including passive solar design, proper orientation, efficient layout, and effective insulation to reduce energy consumption for heating, cooling, and lighting. The primary uses of energy on construction sites are for site services like the office and lighting, as well as for the use of machinery, equipment, and general transportation for the purpose of delivering materials to and from the site. Using more energy-efficient techniques is encouraged in order to lower the energy costs associated with site services, particularly for the site office and site lighting. This includes using energy efficient lighting and heating equipment’s, as well as the monitoring and controlling the energy use according to requirements

ii. **Material Selection:** Choose environmentally friendly materials with low embodied energy, recycled content, and minimal environmental impact. Opt for locally sourced materials to reduce transportation emissions and support local economies.

iii. **Resource Conservation:** Optimize resource use through efficient construction practices, waste reduction, and recycling. Implement construction waste management plans to divert waste from landfills and maximize material reuse and recycling.

iv. **Water Efficiency:** Install water-saving fixtures, greywater recycling systems, and rainwater harvesting to reduce water consumption and promote water efficiency in construction and building operations.

v. **Renewable Energy Integration:** Incorporate renewable energy sources such as solar panels, wind turbines, or geothermal systems to generate clean energy onsite and reduce reliance on fossil fuels.

vi. **Healthy Indoor Environment:** Prioritize indoor air quality, thermal comfort, and natural lighting to create healthy and comfortable indoor environments for occupants. Use non-toxic building materials, adequate ventilation systems, and daylighting strategies to enhance occupant well-being.

vii. **Smart Technologies:** Incorporate smart building technologies, energy management systems, and real- time monitoring tools to optimize energy performance, identify opportunities for energy savings, and enhance operational efficiency.

By implementing these strategies, construction projects can minimize environmental impact, conserve resources, reduce operating costs, and create healthier and more sustainable built environments for current and future generations.

(b) Drivers for Sustainable Construction:

i. **Regulatory Requirements:** Government regulations and building codes increasingly require adherence to sustainability standards and green building practices. Compliance with these regulations serves as a primary driver for integrating sustainable construction practices into building projects.

ii. **Market Demand:** Growing consumer awareness and demand for environmentally friendly buildings drive developers and construction companies to adopt sustainable construction practices. Green buildings are perceived as more desirable, attracting tenants, investors, and buyers who prioritize sustainability.

iii. **Cost Savings and Risk Mitigation:** Sustainable construction practices often result in long-term cost savings through reduced energy and water consumption, lower operating costs, and increased asset value. Investing in energy-efficient design and technologies can yield significant returns on investment over the lifespan of a building. Risk Mitigation: Sustainable buildings are often more resilient to climate change impacts, natural disasters, and regulatory changes. Adopting sustainable construction practices can mitigate risks associated with environmental uncertainty, future regulatory requirements, and market shifts.

iv. **Innovation and Technology:** Advances in green building technologies, materials, and construction methods make sustainable construction more feasible and cost-effective. Innovation drives the development of energy-efficient systems, renewable energy solutions, and eco-friendly materials, facilitating the adoption of sustainable construction practices.

v. **Health and Well-being:** The focus on occupant health and well-being is a significant driver for sustainable construction. Green buildings prioritize indoor air quality, natural lighting, thermal comfort, and ergonomic design features, promoting a healthier and more productive indoor environment for occupants.

vi. **Supply Chain Influence**: Increased scrutiny of supply chains and material sourcing practices prompts construction companies to prioritize sustainable and ethical sourcing of materials. Supply chain transparency and responsible sourcing are essential considerations for achieving sustainability goals in construction projects.

vii. **Global Sustainability Goals:** International initiatives such as the UN Sustainable Development Goals (SDGs) and the Paris Agreement on climate change set ambitious targets for reducing carbon emissions, promoting sustainable development, and enhancing resilience. Sustainable construction plays a crucial role in achieving these global sustainability goals.

viii. **Waste Management**: In 2001, construction site and demolition waste in Britain was 94 million tones (24% of all waste generated). Approximately 13 million tons of materials are delivered to the site each year but are never used. Building Excellence, 2004, p. 2. Given these details, it is critical to manage waste on-site in order to reduce the amount of waste generated on the building site. Separating or segregating the waste as it is produced is the first necessary step. The waste needs to be recycled or reused. Alternatively, it can be sold or sent to a waste management center where it will be recycled or used for other purposes. In addition, waste resulting from unsold materials and packaging can be sent back to suppliers via the purchasing policy.

By addressing these drivers, stakeholders in the construction industry can accelerate the transition towards more sustainable and resilient built environments, benefiting both society and the environment.

2.1.3.7 Sustainable Materials

Sustainable materials play a crucial role in reducing the environmental impact of building construction and promoting resource efficiency. Below are some examples of sustainable materials commonly used in building construction:

i. **Straw Bales**: Embracing an age-old method, straw bale construction uses natural, locally sourced materials, moving away from modern building innovations. Instead of conventional materials like concrete, wood, or plaster, straw bales fill wall frames, offering a cost-effective, sustainable choice. Straw, a quickly renewable resource, provides excellent insulation when sealed properly, making it suitable for both hot and cold climates.

ii. **Grass Crete**: Grass Crete combines concrete with open spaces that allow grass or other plants to grow through, making it ideal for floors, paths, and driveways. This approach not only reduces concrete consumption but also enhances storm water absorption and drainage.

iii. **Rammed Earth:** For a durable, natural option, rammed earth involves compacting soil into wooden molds to create concrete-like walls. This age-old technique, enhanced with rebar or bamboo for safety and powered tampers for labor efficiency, provides long-lasting structures that have supported civilizations for millennia.

iv. **Hemp Crete:** Made from the woody interior of hemp plants and bound with lime, Hemp Crete offers a strong, lightweight alternative to traditional concrete. With its lower transport energy demands and renewable, fast-growing source material, Hemp Crete is an eco-friendly building solution.

v. **Bamboo:** Long valued in many parts of the world, bamboo is a locally accessible, sustainable material with high tensile strength and lightness. Its fast growth and renewability make it an excellent substitute for imported materials, especially for building frames, and it serves as an eco-friendly option in post-disaster rebuilding or remote areas.

vi. **Recycled Plastic**: By incorporating recycled plastics and waste into concrete, researchers aim to reduce emissions and material weight, repurposing plastic that would otherwise end up in landfills.

vii. **Wood:** Traditional wood remains advantageous over industrial materials like steel or concrete, absorbing CO_2 as it grows and requiring less energy to process. Harvested from well-managed forests, wood is renewable and contributes to biodiversity.

viii. **Mycelium:** Derived from the root structure of fungi and mushrooms, mycelium can be grown around natural composites like ground straw to produce lightweight, sturdy building materials. Its unique appearance and natural formation make it a futuristic but sustainable choice.

ix. **Ferrock:** An innovative material, Ferrock is made from recycled steel industry waste and is even stronger than concrete. It absorbs carbon dioxide as it cures, which helps reduce its environmental impact and creates a carbon-neutral alternative to traditional concrete.

x. **High-Performance** Glass: Energy-efficient glass systems with coatings like low-E and spectrally selective layers optimize daylight, solar heat control, and thermal performance, reducing heating and cooling demands.

xi. **Green Concrete:** Green concrete uses recycled aggregates, alternative binders, and cementitious materials like fly ash, resulting in lower embodied carbon and environmental impact. This sustainable concrete innovation includes high-performance mixes, pervious, and self-healing options.

xii. **Timber Crete**: Combining sawdust with concrete, Timber Crete reduces the weight of traditional concrete, cutting transportation emissions and reusing waste sawdust. It can be molded into standard shapes such as bricks and pavers, offering an energy-efficient building alternative.

2.2 Design consideration

Designing a 5-star hotel to be energy-efficient, promote sustainability, and improve thermal comfort involves carefully considering architectural and environmental parameters. Key factors include window size, window orientation, and shading devices.

a. **Window Size:** The size of windows has a significant impact on a building's energy efficiency. Larger windows can reduce the need for artificial lighting, thereby conserving energy. However, they can also lead to increased heat gain, resulting in higher cooling loads. The use of energy-efficient glazing is essential to mitigate heat transfer, ensuring a balance between natural light and thermal performance (Xu et al., 2019). Properly sized windows contribute to sustainability by minimizing reliance on artificial lighting, reducing electricity consumption and carbon emissions (Nguyen et al., 2019). From a thermal comfort perspective, appropriately sized windows provide ample natural light and enhance views, contributing to occupant well- being, though careful consideration is required to avoid excessive heat gain or loss (Kim & Kim, 2019).

b. **Window Orientation:** The orientation of windows is crucial for maximizing natural daylight while minimizing heat gain or loss. South-facing windows (in the Northern Hemisphere) can capture passive solar heat during winter, aiding in heating, whereas north-facing windows provide consistent light without substantial heat gain (Omer, 2019). This strategic placement reduces the dependency on artificial heating, cooling, and lighting systems, enhancing energy efficiency and promoting sustainability (Hwang et al., 2019). Proper window orientation also ensures stable indoor temperatures and adequate natural light, preventing discomfort caused by overheating or cold drafts, thereby improving thermal comfort (Cheung et al., 2019).

c. **Shading Device:** Shading devices, such as overhangs, louvers, and blinds, play a pivotal role in controlling the amount of solar radiation entering a building. These devices can significantly reduce cooling loads by blocking direct sunlight during peak hours while still allowing natural light to penetrate (Taleghani et al., 2019). Effective shading reduces the need for air conditioning, thus lowering energy consumption and greenhouse gas emissions, aligning with sustainable design principles (Berkovic et al., 2019). Additionally, shading devices enhance thermal comfort by preventing glare and overheating, maintaining stable indoor temperatures and improving visual comfort for occupants (Aksamija, 2019).

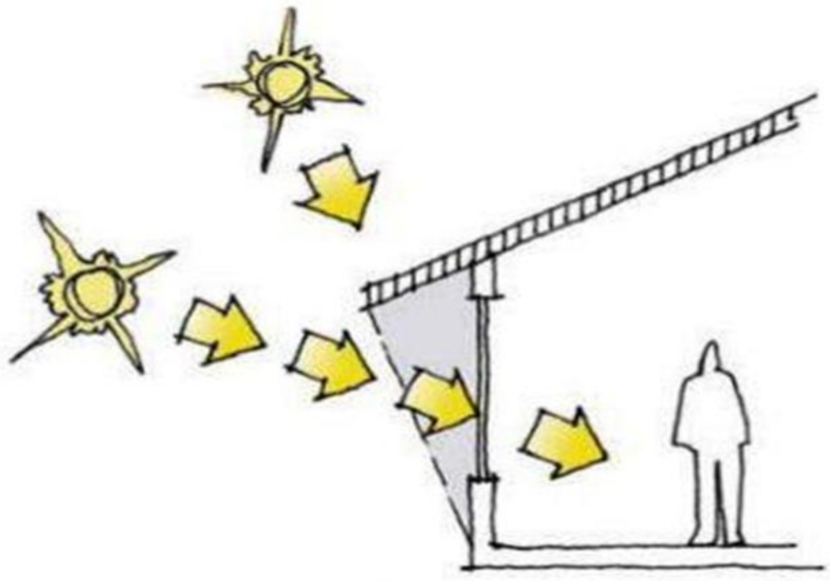

Figure 2.1: Window overhangs
(Source: Passive design toolkit, 2009)

Additional Considerations

To further enhance energy efficiency, sustainability, and thermal comfort, other factors should be considered:

i. **Insulation**: Proper insulation in walls, roofs, and floors is essential to prevent heat loss in winter and heat gain in summer (Alwetaishi, 2019).

ii. **Building Materials**: Using sustainable and energy-efficient building materials with low environmental impact and high thermal performance is crucial (Kylili et al., 2019).

iii. **Ventilation**: Incorporating natural and mechanical ventilation systems improves indoor air quality and reduces reliance on HVAC systems (Wang et al., 2019).

iv. **Renewable Energy Sources**: Integrating renewable energy systems, such as solar panels or wind turbines, can generate clean energy on-site (Rizwan et al., 2019).

v. **Smart Building Technologies**: Implementing smart systems for lighting, heating, and cooling optimizes energy usage based on occupancy and environmental conditions (Mastropietro et al., 2019)

2.2.1 Passive Design Strategies for Minimizing Energy Consumption

Passive design strategies have proven to be extremely effective and can greatly contribute in decreasing the cooling load of buildings. Passive design strategies are crucial for minimizing energy consumption in buildings. These strategies harness natural energy sources such as sunlight, wind, and thermal mass to maintain comfortable indoor environments without relying heavily on mechanical systems. Key passive design strategies include:

i. **Building Orientation and Layout**

Proper building orientation and layout can significantly reduce energy consumption. Orienting the building to maximize solar gain in winter and minimize it in summer helps regulate indoor temperatures naturally. According to Attia et al. (2021), optimal orientation reduces the need for artificial heating and cooling, thereby lowering energy consumption. Additionally, designing the layout to allow for natural cross-ventilation can enhance air circulation and reduce the need for air conditioning (Sadineni et al., 2021). . The application of orientation in enhancing energy efficiency is illustrated in Figure 2.2 In general, north and south facing is the best preferred orientation.

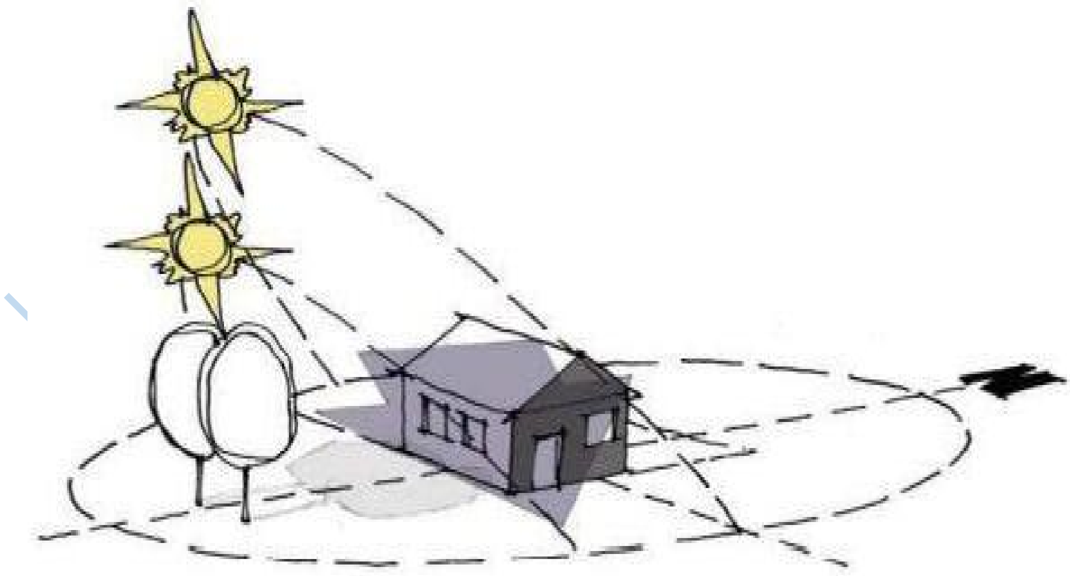

Figure 2.2: Building orientation.
(Source: Passive design toolkit, 2009)

ii. Thermal Mass

Thermal mass involves using materials that absorb, store, and release heat slowly, helping to stabilize indoor temperatures. Materials such as concrete, brick, and stone can absorb heat during the day and release it at night, reducing the need for heating and cooling systems. Studies by Zhang et al. (2022) have shown that buildings with high thermal mass can maintain more stable temperatures, thus improving energy efficiency. Appropriate use of thermal mass throughout a building can make a big difference to comfort and cooling bills (Chris, 2008). This is illustrated in Figure 2.3 using insulated brick cavity walls.

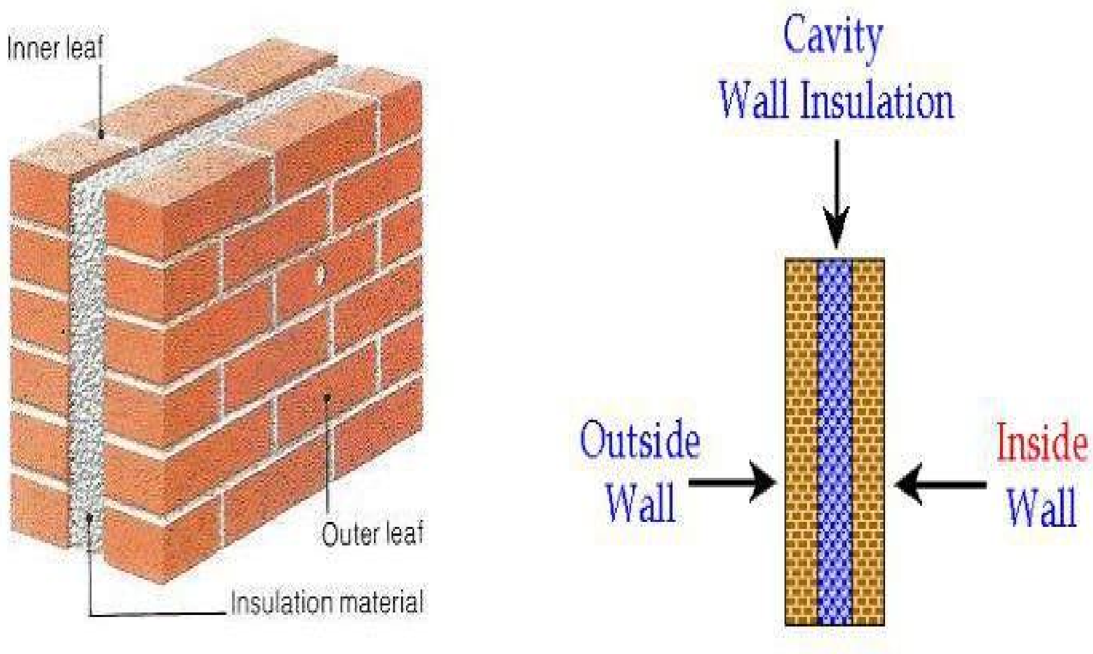

Figure 2.3: Insulated brick cavity walls absorb heat thereby cooling the interior

(Source: www.smarthousingmanual.com, 2002)

ii. Insulation

High-quality insulation in walls, roofs, and floors is essential for minimizing heat loss in winter and heat gain in summer. Proper insulation reduces the load on heating and cooling systems, leading to significant energy savings. As noted by Alam et al. (2020), advancements in insulation materials, such as vacuum-insulated panels and aerogels, have further enhanced the energy-saving potential of buildings.

iii. Solar Shading

Effective solar shading devices, such as overhangs, louvers, and exterior blinds, can block excessive solar radiation, preventing overheating in summer while allowing sunlight in winter. Lee et al. (2022) demonstrated that adjustable shading devices could significantly reduce cooling loads and enhance occupant comfort by controlling glare and solar gain.

iv. Green Roofs and Walls

Green roofs and walls provide insulation, reduce the urban heat island effect, and enhance biodiversity. They can significantly lower indoor temperatures, reducing the need for air conditioning. Research by Manso et al. (2021) indicates that green roofs can reduce energy consumption for cooling by up to 25% in summer months.

Plate 2.1: Green roof and garden
(Source: https://www.yourhome.gov.au/materials/green-roofs-and-walls, Paul downton, 2013).

Plate 2.2: Sydney apartment 'living' green wall
(Source: https://www.yourhome.gov.au/materials/green-roofs-and-walls, Paul downton, 2013).

v. Window Glazing

Advanced window glazing technologies, such as double or triple glazing and low-emissivity (Low-E) coatings, can improve thermal performance by reducing heat transfer. As indicated by Chan et al. (2020), modern glazing options can minimize heat loss in winter and reduce heat gain in summer, contributing to overall energy efficiency. This type of glass is used in environmentally friendly construction with the goal of reducing heat gain and loss, making structures much cheaper to heat and cool over the course of the year and enhancing energy efficiency. This is illustrated in Figure 2.3.

Plate 2.3: Use of solar reflective glass to enhance the cooling of the building interior
(Source: www.smarthousingmanual.com, 2002).

vi. Building form

According to Givoni (1998), a building's form is primarily determined by whether air conditioning is planned or natural ventilation is to be the primary means of ventilation. He suggests open forms for naturally ventilated buildings and compact shapes for those who live in buildings with air conditioning. Large surfaces are preferred over compact buildings by Gut and Ackerknecht (1993) because they facilitate nighttime heat emission andventilation. Thus, rather than being compact, the building forms should be open and outward-oriented. Effect of building forms on energy efficiency is illustrated in Figure 2.4 Compactness of the building minimizes the surface area of the building envelope, resulting in a reduction of the heat gain through the envelope.

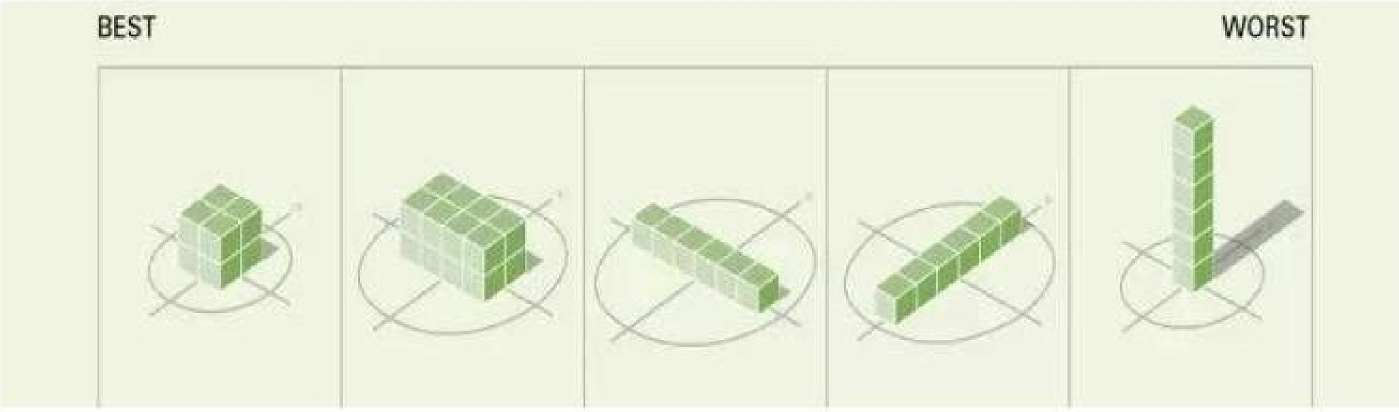

Figure 2.4: Effect of building form on energy efficiency.
(Source: Passive design toolkit, 2009)

vii. Landscape

Landscaping serves as an effective method for protecting buildings from excessive solar heat gains and redirecting wind to facilitate natural ventilation. Plants help prevent most solar radiation from reaching surfaces like concrete, brick, and asphalt. By modifying the surrounding microclimate and reducing irradiance, landscaping plays a key role in reducing energy consumption for cooling, with studies showing that well-planned landscaping can lead to energy savings of 25-80% on air conditioning (Nyuk and Yu, 2009). Raeissi and Taheri (1999) highlight the advantages of tree planting, stating that it can lead to energy savings, reduced noise and pollution, and improved temperature and humidity regulation, along with psychological benefits for people. Their research concludes that the cooling load of a house can be reduced by 10%-40% through proper tree planting. Additionally, trees can complement window overhangs by effectively blocking low morning and afternoon sunlight, as shown in Plate I.

Plate 2.4: Good use of climbers and trees to reduce penetration of heat into the building, Rockhurst University,Kansas City, U.S.A.
(Source: Ogunsote, PrucnalOgunsote, Adegbie, 2005).

viii. Natural ventilation

Natural ventilation involves the movement of fresh air into a building to replace hot air, and it serves several important functions in the building sector. According to Watson and Labs (1983), these functions include:

a. Satisfying the fresh air needs of the occupants: This ensures a supply of fresh oxygen and removes stale air, contributing to healthier indoor environments.

b. Increasing the rate of evaporative and sensible heat loss from the body: This helps cool the body by facilitating heat loss through evaporation and sensible heat transfer.

c. Cooling the building interior by exchanging warm indoor air with cooler outdoor air: This process helps reduce indoor temperatures and maintain thermal comfort.

Givoni (1998) emphasizes that cross-ventilation can enable faster cooling and improve ventilation. He notes that in hot-humid regions, especially in developing countries where air conditioning is not affordable, buildings designed for cross-ventilation are ideal. Givoni recommends buildings with a spread-out layout and openable windows to promote this type of ventilation. Watson & Labs (1983) further explain that natural ventilation can be generated by two primary forces:

a. Temperature difference between the outdoors and the indoors

b. Wind flow against the building

a. Temperature Difference between the Outdoors and the Indoors.

When a mass of air inside the room is heated, it expands and becomes less dense and rises. If openings are provided at different heights on the building's envelope, the indoor pressure is higher at the upper opening and lower at the lower opening. This pressure differences generate an inward flow at the lower opening and an outward flow at the upper one. When thermal forces discharge air from a building, the action is termed as stack effect.

b. Wind Flow against the Building.

As wind blows against a building, the air in front of the building is compressed and creates a pressure zone. The air next to the leeward wall and above the roof expands and the pressure is reduced, creating a suction zone. These pressure differences between any two points on the building"s envelope determine the possibility for ventilation when openings are provided at these points (driving force) and if air can flow inside the building through openings with the higher pressure to openings exposed to a zone with lower pressure. Cross- ventilation is defined as the situation in which outdoor air can flow in through inlet openings, located in the pressure zone, and flow out via outlet openings located in the suction sections of the building. Other common natural ventilation and thus cooling techniques is the use of courtyards. A study of courtyards by Ali (2007) in Dhaka uses "two typologies of six storied residential apartments, namely, the courtyard type and the non-courtyard type for comparison of thermal data. The results of this comparative analysis reveal that the buildings with courtyards are much more comfortable and thus desirable for the dwellers of Dhaka, which also has a tropical hot-humid climate like Ilorin.

c. Daylighting

Day-lighting reduces the need for electric lighting and contributes to bright indoor environments. The selection, size and placement of windows will determine the level of natural day-lighting in a room. Things to consider are the path of the sun and seasonal variations, optimal amount of day-light, glare control and the resultant heat gains and losses associated with the choice of windows and frames. Krarti (2005) conducted a simplified analysis method to evaluate the potential of day-lighting to save energy associated with electric lighting use in commercial buildings. Performance of daylighting are investigated for several combinations of building geometry, window opening size, and glazing type for four geographical locations in the United States. Sunlight tubes utilize the state of the art design and technology to capture sunlight from the rooftop or exterior walls, redirect it down a highly reflective shaft and then diffuse an abundance of pure day-light throughout the interior space.

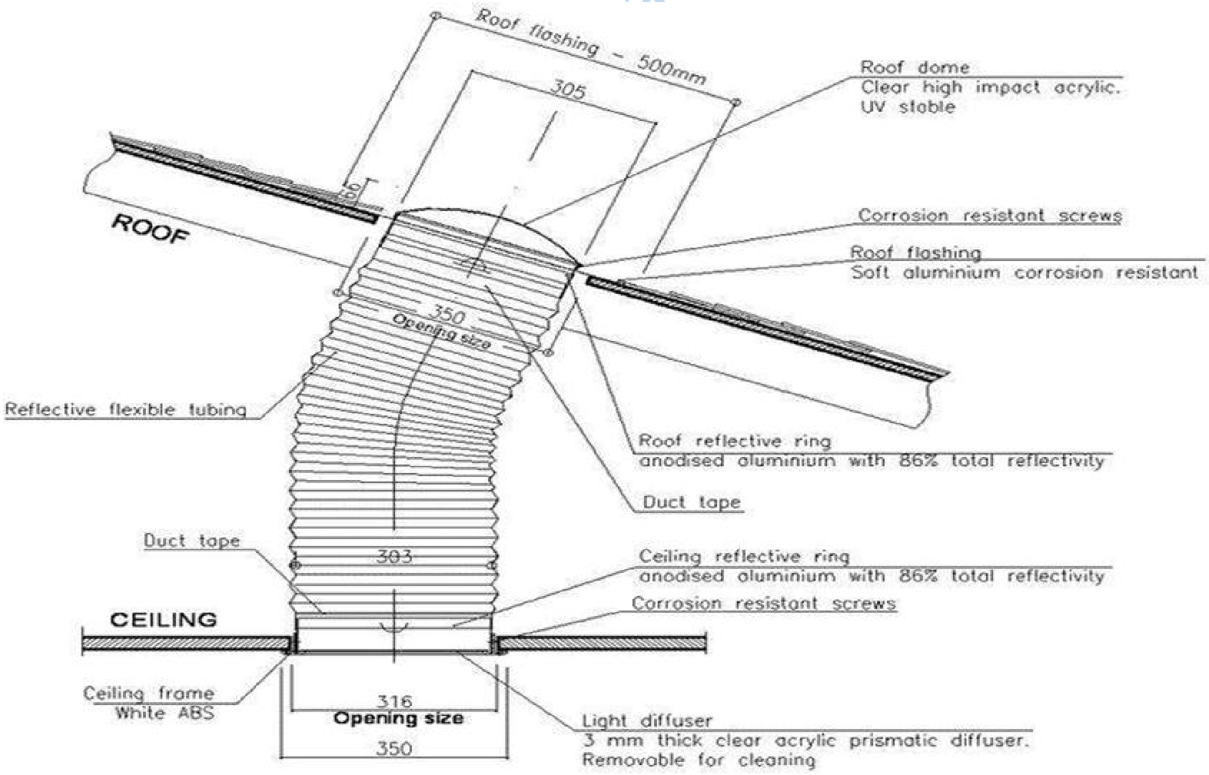

Figure 2.5: Details of a sunlight tube
(Source: www.solatubes.com, 2014).

Plate 2.5: Sunlight tube captures day-lighting from the exterior walls of a building
(Source: www.solatubes.com, 2014).

The use of atrium using ethylene tetra-fluoro-ethylene (ETFE) as material for covering the atrium is another method of capturing day-lighting into the building interior. Ethylene tetrafluoro-ethylene is a polymer, a transparent plastic related to teflon. This material is replacing glass and plastic in some of the most innovative buildings being designed and constructed today. When compared to glass, it's 1% the weight, transmits more light, is a better insulator, and costs less to install. Ethylene tetra-fluoro-ethylene is also resilient (able to bear 400 times its own weight, with an estimated 50-year life-span), and recyclable.

2.3 Empirical Review

2.3.1 General overview of luxury Hotels and the Hospitality sector

A luxury hotel is a high-end accommodation establishment that provides exceptional service, amenities, and comfort to guests seeking a premium hospitality experience. Luxury hotels epitomize the pinnacle of hospitality, offering an opulent and exclusive experience to discerning guests. Renowned for their exquisite design, impeccable service, and premium amenities, these establishments cater to individuals seeking a heightened level of comfort and indulgence. From lavish accommodations to Michelin-starred dining, luxury hotels prioritize every aspect of the guest experience.

The hospitality sector, encompassing hotels, resorts, and related services, plays a vital role in the global economy. It spans a wide spectrum, ranging from budget-friendly options to ultra-luxurious establishments. The sector thrives on delivering exceptional customer service, creating memorable experiences, and adapting to ever-evolving consumer preferences.

Luxury hotels often feature meticulously designed interiors, state-of-the-art technology, and personalized services. The architecture and decor are crafted to evoke a sense of grandeur, reflecting the cultural and aesthetic influences of the region. Guests can expect spacious rooms or suites adorned with high-end furnishings, premium bedding, and cutting-edge amenities.

Service excellence is a hallmark of luxury hospitality. Staff members are trained to anticipate and fulfill guests' needs with a blend of professionalism and warmth. Personalized concierge services, private butlers, and bespoke experiences contribute to an atmosphere of exclusivity.

Dining in luxury hotels is an exquisite affair, with renowned chefs curating gastronomic delights to tantalize the taste buds. Fine dining restaurants within these establishments often boast awards and accolades, offering guests a culinary journey that complements the overall luxurious experience.In recent years, sustainability has become a focal point for the hospitality sector, including luxury hotels. Many establishments are incorporating eco-friendly practices, energy-efficient technologies, and locally sourced materials to align with growing environmental consciousness among travelers.

Papers Selected for Review in this Study

In view of that, Eight (8) papers were reviewed namely;

i. Review on Design Strategies of Energy Saving Office Building with Evaporative Cooling in Tropical Region by Rizvanda Ryan Savero, et.al. (2020).

ii. Energy Efficiency Design Strategies in Office Buildings: A Literature Review by Erebor E. M, et.al. (2021).

iii. Exploring Passive Design Techniques to Achieve Energy Efficiency in Regional Shopping Mall Design by Wayii Serekara Kennedy, F.F.O Daminabo (2022).

iv. Enhancing energy efficiency through passive design: a case study of halls of residence in Covenant University, Ogun State by O. A. Alagbe et.al. (2019).

v. The Application of Passive Design Strategies as Sustainable Operation and Maintenance in a Model Conference Centres (A Case Study of Aminu Kano Centre for Democratic Research and Training (Akcdr&T)) by Alfa Namadi Sharif, et.al. (2021).

vi. A framework Approach to the Design of Energy Efficient Residential Buildings in Nigeria by Dr Ekele Thompson Ochedi (2021).

vii. Performance of passive design strategies in hot and humid regions. Case study: Tangerang, Indonesia Yanmeng Chen et.al, (2020).

viii. Building Envelope Retrofitting Strategies for Energy-Efficient Office Buildings in Saudi Arabia by Nedhal Al-Tamimi (2022).

Table 2.1 Review on Strategies on Energy Saving Office Building with Evaporative Cooling in Tropical Region by Rizvanda Ryan Savero, et.al. (2020)

Author And Year of Publication	***Rizvanda Ryan Savero, et.al. (2020)***
Research Questions	What are the factors of building heat control and the criteria required in designing energy-saving office building? How to apply evaporative cooling techniques to design the energy saving office building?
Aim	This research is aimed at reviewing the theories and design of energy-saving office buildings that apply evaporative cooling concepts to inhibit solar heat and improve natural cooling
Objectives	Assess design Strategies that enhances energy Saving Office Building with evaporative cooling in Tropical Region. Identify the theories and design of energy-saving office buildings that apply evaporative cooling concepts to inhibit solar heat and improve natural cooling

Methodology	The method used is literature searching from books, journals, precedents, and other relevant sources. The literature includes the following: (1) the theory of building passive design; (2) the theory of passive cooling related to the evaporative cooling technique; (3) the theory of shape and geometry of energy-saving buildings; (4) the precedent about energy-saving office building; (5) the evaporative concept; and (6) the shape and geometric for the energy-saving office building
Findings	It was discovered from the results that the building's arrangement with the opening facing north and south provides an vantage in reducing heat insulation. The best building orientation is the smallest surface area facing east-west, providing an external wall outside the room. Optimizing natural light can reduce the energy consumption of artificial light and reduce heat gain from artificial light. Different building geometry has affected their solar exposure as some shapes receive more solar radiation than others resulting in higher cooling loads inside the building.

Source (Researchers Field Work)

Table 2.2 Energy Efficiency Design Strategies in Office Buildings: A Literature Review by Erebor E. M, et. al. (2021).

Author And Year of Publication	***Erebor E. M, et. al. (2021)***
Research Questions	What are the energy efficiency design strategies integrated in office buildings? What categories of energy efficiency design strategies are used in office buildings; How do you establish the most implemented energy efficiency design strategy in office buildings?
Aim	The study is aimed at identifying and categorizing existing energy efficiency design strategies integrated in office buildings from literature, towards contributing to the general discuss on ways of promoting energy efficiency strategies in the development of the built environment.
Objectives	Identify the energy efficiency design strategies integrated in office buildings; Identify the categories of energy efficiency design strategies used in office buildings; and Establish the most implemented energy efficiency design strategy in office buildings.
Methodology	A six-step process was used in carrying out the document review process: (i) Identification of the research problem;

	(ii) Formulation of research questions; (iii) Identification and selection of relevant literature; (iv) Evaluation of selected literatures; (v) Interpretation of findings. The articles reviewed were identified from the searches conducted in two prominent online databases of research and academic literature namely: Science Direct and Google Scholar. These databases were chosen because they have a large repository of research materials of peer reviewed articles.
Findings	The study found that 29 energy efficiency design strategies have been linked to office buildings. The top three of these strategies are those associated with building envelope.

Source (Researcher's Field Work)

Table 2.3: Exploring Passive Design Techniques to Achieve Energy Efficiency in Regional Shopping Mall Design by Wayii Serekara Kennedy, F.F.O Daminabo (2022).

Author And Year of Publication	***Wayii Serekara Kennedy, F.F.O Daminabo (2022).***
Research Questions	What are the appropriate passive cooling strategies which enhance thermal comfort that are suitable in the hot dry climate of Mafara? What is the possible improvement in indoor temperature and comfort that can be achieved by applying passive cooling strategies? How can passive cooling be improved through design processes that will provide thermal comfort in the design of school of environmental studies in Mafara?
Aim	This study intends to explore and apply passive design techniques to achieve energy-efficiency in the design of a regional shopping mall in such climate.
Objectives	Identify various passive cooling strategies that enhance thermal comfort suitable in hot dry climate of Talata Mafara. Assess the use of computer simulation software to find out the improvements that can be achieved by modifying building components and design elements that enhance thermal comfort for the geographical conditions of Talata Mafara.

Methodology	The first step established the theoretical underpinning for this research. Furthermore, it seeks to identify the analytical approach and topics to be addressed in the case study. This phase consists mostly of thorough literature evaluations of books, journal papers, research papers, and documents in order to find energy efficient design ideas that might be employed in the context of the research. The second phase included a second desk study to analyze and evaluate the data from the first and second phase investigations using quantitative and qualitative methodologies. The energy-saving concepts uncovered through the literature study were compiled and statistically analyzed to calculate the energy savings of characteristics that may be utilized in the setting of PH.
Findings/Results	Energy efficiency, as a result of its principles and features associated to the Passive approach, suggests the employment of simple approaches and strategies that will easily generate balanced and comfortable structures. The research study is based on the premise that the energy efficiency principle may be utilized to give means that are likely to lead to discoveries in the execution of future designs and constructions employing the aforementioned passive means using design methodologies, building techniques, and material use. design of shopping malls and other structures.

Source (Researchers Field Work)

Table 2.4: Enhancing energy efficiency through passive design: a case study of halls of residence in Covenant University, Ogun State by O. A. Alagbe et.al.(2019).

Author And Year of Publication	***O. A. Alagbe et.al.(2019).***
Research Questions	How can passive design strategies and the impact of passive systems such as natural ventilation and natural lighting to improve energy efficiency?
Aim	The aim of this research is to identify passive design strategies that can be used to improve energy efficiency and reduce energy consumption and in buildings in Nigeria.
Objectives	This objective of this paper is to investigate passive design strategies and the impact of passive systems such as natural ventilation and natural lighting to improve energy efficiency.
Methodology	The study area is Covenant University, Ota, Ogun State, Nigeria. There were 4 project areas categorized and analyzed based on their similarities in design and layout, these included: Post Graduate Halls of Residence, (Peter/ Esther/ Paul/ John Hall), (Mary/ Deborah Hall) and (Joseph/ Daniel/ Lydia/ Dorcas Hall). Covenant University operates 2 programmes, the undergraduate and Post Graduate programmes, each of which has their own various halls of residences at different locations

	on campus for both males and females. The structures for each are 4 storey floors with courtyards integrated into the building design to encourage airflow within building spaces, maximizing natural ventilation.
Fimdings	The research results obtained shows that more passive design principles such as: use of atrium, use of cavity walls and use of soft landscape need to be employed and properly maximized in design of unidorm.

Source (Researchers Field Work)

Table 2.5: The Application of Passive Design Strategies as Sustainable Operation and Maintenance in a Model Conference Centres (A Case Study Of Aminu Kano Centre for Democratic Research And Training (Akcdr&T)) by Alfa Namadi Sharif et.al. (2021).

Author And Year of Publication	***Alfa Namadi Sharif et.al. (2021).***
Research Questions	What are the impacts of integrating building with climate? How to determine which passive design variables are the most effective and applicable to public buildings more especially conference centre in hot dry climate of Kano city Nigeria.?
Aim	Thee aim of the research is to reduce over reliance in active design strategies in conference centers which are not cost effective and environmentally friendly through the application of passive

	design strategies.
Objectives	To evaluate impact of integrating building with climate. To determine which passive design variables are the most effective and applicable to public buildings more especially conference centre in hot dry climate of Kano city Nigeria.
Methodology	This is basically qualitative research. The objective of this research is centered on achieving sustainable conference centre through application of passive design strategies. The study adopted the case study research method, because this allows the researcher to explore and understand complex issues (Zaidah, 2007).
Findings	Passive design utilizes natural sources of heating and cooling breezes. It is achieved by appropriately orientating the building on its site and carefully designing the building envelope (roof, walls, windows and floor). External features such as fountain, soft landscaping and proper site planning improves micro climate which in turn helped in achieving good passive design.

Source (Researchers Field Work)

Table 2.6 A framework Approach to the Design of Energy Efficient Residential Buildings in Nigeria by Dr. Ekele Thompson Ochedi (2021).

Author And Year of Publication	***Dr. Ekele Thompson Ochedi (2021).***
Research Questions	What are the concepts of energy efficient residential buildings and its application on the study area? What is the energy performance of existing residential buildings taking into account socio-cultural aspects and to produce the proposed framework?
Aim	The aim of this paper is to promote and encourage sustainable building development in Nigeria by developing a systematic and context-based framework for the design of energy efficient residential buildings.
Objectives	Investigate the concept of energy efficient residential buildings and its application on the study area. Evaluate the energy performance of existing residential buildings taking into account socio-cultural aspects and to produce the proposed framework.

Methodology	Structured and semi-structured interviews were employed to collect data from architects in Lokoja, Nigeria. The interview instruments for both groups of architects and householders have two sections: section A involved structured questions for demographic data about the respondents while section B comprised of semi-structured questions aimed at generating data on existing approach to housing development and relevant data that will guide the development of the proposed framework. The areas covered by the interview instrument include current approach to the design of residential buildings, thermal comfort in residential buildings, views on how to achieve energy efficiency in buildings and limitations to the design and realization of energy efficient buildings. The interview with households centered on information about energy need, energy consumption, thermal comfort and views on traditional and modern buildings. The study adopted non-probability sampling for the selection of respondents for interviews involving both architects and householders. Non-probability sampling is time and cost effective compared with probability sampling. The latter was also impractical since participants are not equally likely to be selected due to the nature of inquiry.

Findings	This study evolved to produce a systematic and context-based framework for designing energy efficient residential buildings in Nigeria focusing on improving indoor thermal comfort, reducing energy demand and consumption of buildings. The adoption of a mixed method research design including interviews, case studies, measurement and observational survey and measurement, defined the research investigations and findings. These findings informed the development of the proposed framework, which is the main aim of this study. This methodology is unique and has not been found to be used in any study, especially on energy efficient residential buildings that adopted a combination of these research methods.

Source (Researchers Field Work)

Table 2.7 Performance of passive design strategies in hot and humid regions. Case study: Tangerang (2020)

Author And Year of Publication	***Yanmeng Chen et.al, (2020).***
Research Questions	How is the performance of passive design strategies in hot and humid regions assessed?
Aim	The aim of the paper is to evaluate thr performance of passive design strategies in hot and humid region in Tangerang, Indonesia.
Objectives	Assess the performance of passive design strategies in hot and humid regions.

Methodology	This research used both measurement and simulation methods to evaluate the effects of three passive design strategies on reducing cooling load and attaining a good daylight environment in an office in Tangerang, Banten, Indonesia. The passive design strategies are improving skin thermal insulation, natural ventilation by vertical operable vents, and solar shading by operable louvers. The main purpose of this research is to show the effect of the three passive design strategies on reducing cooling energy in hot and humid regions.
Findings	In this paper, three passive design strategies to reduce cooling energy and attain a good daylight environment in an office in Tangerang, Indonesia, will be evaluated using both measurement and simulation methods. Improving thermal insulation, natural ventilation, and solar shading are the strategies studied in this paper. The measurement result shows that the excessive daylight can be reduced by solar shading and the indoor temperature can be reduced by both solar shading and natural ventilation. The result of the simulation also validates the effects of shading and natural ventilation on lowering the indoor temperature and reducing the cooling load

Source (Researchers Field Work)

Table 2.8: Building Envelope Retrofitting Strategies for Energy-Efficient Office Buildings in Saudi Arabia by Nedhal Al-Tamimi (2022).

Author And Year of Publication	***Nedhal Al-Tamimi (2022).***
Research Questions	How can energy consumption be improved through retrofitting the building envelope? How can the effects of different retrofitting strategies of the building envelope in terms of changing the type of window's glass, adding thermal insulation layers, and applying egg-crate shading devices be investigated?
Aim	This study aims to evaluate the current scenario of energy performance in Saudi governmental office buildings.
Objectives	Evaluate the improvement in energy consumption through retrofitting the building envelope. Investigate the effects of different retrofitting strategies of the building envelope in terms of changing the type of window's glass, adding thermal insulation layers, and applying egg-crate shading devices.
Methodology	Reducing heat gain in harsh climates is one of the most important passive strategies to reduce energy consumption in buildings. This strategy is particularly useful in fully air- conditioned buildings such as offices. The energy performance of a government office building in Najran, KSA has been investigated using the dynamic simulation tool DesignBuilder. In this study, three aspects used as a basis for the strategies are glazing type, thermal insulation, and

	external shading devices. These strategies were chosen exclusively for their great effect in reducing direct solar heat gain through windows or lowering the heat conduction through building envelope elements. The requirements of the Saudi Building Code regarding the insulation of building envelope elements were taken into consideration in the development process.
Findings	The results reported that applying a combination of those strategies reduced total energy consumption by 26.81% compared with the current base case.

Source (Researchers Field Work)

Chapter Three

Research Methodology

Following the definition of the study's scope and goals, it is essential to adhere to the proper research methodology, which refers to a collection of techniques. Numerous research techniques have been used in this study to best fit the various research objectives.

This chapter focuses on how the research on evaluating energy efficiency and strategies for minimizing the consumption of energy in Luxury Hotels in Nigeria. In this chapter, Research Methodology, Strategy, design and Method of Data Collection placing it in context and defending its use in comparison to other approaches. Also, Case studies selection criteria, Case Studies, analysis of Case Studies, Case Study Synthesis and Deductions from case studies are discussed.

3.1 Research Design

An essential stage in carrying out a research project is having an appropriate research strategy, as it is the scientific study of the specific techniques, procedures, template, tools and mechanics utilized for identifying, selecting and processing and analyzing information and data for this research work. Having a research strategy is of upmost significance as it is being recognized by the researcher to have opened various means to collect and analyses data and information through the opportunity given to distinctively distinguish amongst the functions of the various tools.

3.1.1 Types and Source of Data

Information and data used in this research are;

i. Primary Data

ii. Secondary Data

Primary and Secondary Sources of data were used to extract information for this research. The primary data will be sourced from respondents through oral interviews and observations while the secondary data will be obtained from case studies and reliable internet sources.

3.1.1.1 Primary Data

a. Observation

According to (Ary, 2010) 'Observation is a basic method for obtaining data in qualitative research.' Meanwhile, Fraenkel and Wellen (2007) classify observation into three kinds; they are participant observation, nonparticipant observation, and naturalistic observation. Participant observation is a type of observation in which the observer takes part in the circumstance or environment that they are witnessing. Non-participant observation is when the observer is not involved in the action being observed or the situation they are observing. Following that, naturalistic observation entails watching people in their natural environment. Therefore, the researcher used non-participant observation to evaluate and examine different passive design strategies in each sample (case study) to accomplish energy efficiency. Without taking part, the researcher performed observation. While on site, the researcher did nothing more than wander and take in the office structure. The researcher took the necessary data during the observation using an observation checklist and field notes. The most common method used to get information about the various things around us, is to observe those things and also the various processes related to those things. Hence, it can be said that observation acts as a fundamental and the basic method of getting information about anything. But it must be kept in mind that observation is not just seeing things but it is carefully watching the things and trying to understand them in depth, in order to get some information about them. It can provide researchers with ways to check for nonverbal expression of feelings, determine who interacts with whom, grasp how participants communicate with each other, and check for how much time is spent on various activities. Observation reduces the incidence of "reactivity" or people acting in a certain way when they are aware of being observed, helps the researcher to develop questions that make sense in the native language or are culturally relevant, allows for richly detailed description, which they interpret to mean that one's goal of describing "behaviors, intentions, situations, and events as understood by one's informants" is highlighted.

b. Observation Checklist

A list of items that an observer will glance at while observing a building is known as an observation checklist. The observer may have created this list. In addition to providing structure and framework for an observation, observation checklists also function as a contract of understanding with the observer, who may feel more at ease and will receive detailed feedback on specific parts of the building.

3.1.1.2 Secondary Data

In order to evaluate design strategies for energy efficiency in an office building, necessary secondary data will be obtained by reading articles and journal, papers, etc. related to the topic. The internet was used to collect information regarding the locations of some of the senate buildings**.**

3.1.1.3 Choice of Variables

In research, variables are substances or variables that can be altered, managed, or assessed. These variables utilize various values and admit significant role in testing hypothesis and analyzing data.", Drew C., (2023). Variables that apply to energy efficient design as they relate to the Nigerian tropical climate and how they enhance energy efficiency in shopping plazas are analyzed. The following are such variables:

1. **Design for Climate**

a) Temperature

b) Frequency of Heat Waves

c) Rainfall

d) Flooding

2. Passive Cooling

a) Orientation

b) Landscape

c) Shading

d) Use of bright colors on the exterior wall surfaces

3. Daylighting and Natural Ventilation

a) Daylighting

b) Natural Vennilation

3.2 Selection Criteria for Case Studies

Case study research in Architecture goes beyond the documentation and description of the physical characteristics of the built environment. Therefore, to give a full assessment of the selected case studies in the research, they have to be judged based on the research question or proposed design problem. The parameters for the variables which satisfy the research questions and are to be used to assess the case studies are;

i. Building type

ii. Materials and Finishes

iii. Landscape elements

The following case studies were chosen with regards and emphasis laid on the scope and purpose of this research;

1. Lagos Continental Hotel, Lagos.
2. The Art Hotel, Lagos.
3. Transcorp Hilton Hotel,

4. Abuja.Burj Al Arab, Dubai.

5. Rosewood, Abudhabi

3.3 Case Studies Analysis

3.3.1 Case Study 1 – Lagos Continental Hotel

Plate 3.1: Exterior Facade of Lagos Continental Hotel
(Source: https://www.thelagoscontinental.com)

3.3.1.1 Background Information

The lagos continental hotel, formerly known as the intercontinental hotel is a 5-Star Hotel located at Plot 52A, Kofo Abayomi Street, Victoria Island, within the heart of the central business district of lagos Nigeria. it has a total 358 rooms, 37 suites and a presidential suite. standing at the height of 100m the hotel is the tallest in West Africa, with an amazing view of the Atlantic Ocean, Lagos creek and the city. It was built and established in 2013 by the Milan Group, an Indian-owned family conglomerate that existed and operated in Nigeria for over 40 years.

Architects: Design Group Nigeria ltd led by Arc. Ayotunde Sanni

Structural Engineers: IA Associates Limited

Materials: Concrete, Glass, Aluminium

Year: 2013

No of Floors: 23

3.3.1.2 Sustainable and Passive design Strategies Adopted

Sustainable and Passive design strategies are essential in reducing energy consumption and promoting environmental responsibility in buildings like Lagos Continental Hotel.

Sustainable Design Strategies

i. **Energy-Efficient Lighting:** The hotel utilizes energy-efficient lighting fixtures such as LED bulbs and compact fluorescent lamps (CFLs) throughout its premises. These lighting technologies consume significantly less energy than traditional incandescent bulbs, thereby reducing overall electricity usage.

ii. **High-Efficiency HVAC Systems:** Lagos Continental Hotel is equipped with high-efficiency heating, ventilation, and air conditioning (HVAC) systems. These systems are designed to optimize energy performance, minimize heat loss, and maximize indoor comfort for guests while reducing energy consumption.

iii. **Solar Power Integration:** The hotel harnesses solar energy through the installation of photovoltaic (PV) panels on its rooftops and parking areas. Solar power generation supplements the hotel's electricity demand, reducing reliance on grid power and lowering carbon emissions associated with energy production.

Passive Design Strategies

Passive cooling strategies assessed in Lagos Continental Hotel, Orientation Landscape, , Use of effective exterior finishes.

i. **Orientation:** The hotel is strategically oriented to maximize natural light exposure while minimizing solar heat gain. With the .longer sides facing north and south and shorter sides facing the east and west which is regarded as the perfect solar path. This helps reduce the need for artificial lighting and cooling during the day.

ii. **Landscape:** The landscape on the south side of the building is characterized with large surfaces of low grasses, asphalt driveways, hedges, walkways and very few shrubs while the north side is characterized by tall trees, growing trees and walkways.

iii. **Use of effective exterior finishes:** The building exterior is finished with glass and folded aluminum screens, see which improves the passive performance of the building by reducing the solar load.

3.3.1.3 Merits

i. he Lagos continental Hotel boasts OF a contemporary architectural design,AS The exterior acade and interior spaces showcase a modern aesthetic.

ii. It is an iconic building at a 100m height making it the tallest hotel in west africa.

iii. The use of high-quality materials, modern furnishings, and attention to detail within the hotel's interiors contribute to a luxurious atmosphere.

iv. The hotel is strategically located, its proximity to key areas such as business districts, cultural attractions, and waterfront view contributes to the hotel's appeal for both business and leisure travelers.

3.3.1.4 Demerits

i. The hotel is not environmentally sustainable as energy-efficient features, such as waste reduction measures, and the use of eco-friendly materials were not fully incorporated

ii. There is little vegetation around the structure because the property is mostly covered with hard surfaces, which will lead to excessive heating.

iii. Aluminum and glass used for exterior finishes have low thermal mass

iv. The hotel is dependent on artificial lighting is some areas of the hotel which increases energy consumption

3.3.1.5 Case Studies Deduction

i. Use of natural light and natural ventilation (mixed mode) to minimize energy demand,

ii. Automatic presence detectors/sensors and high efficiency lighting,

iii. Low Level of Natural indoor air quality and occupant's thermal and visual comfort increased by ventilation rates, quality of materials and views out,

iv. Potable water demand minimised though rainwater harvesting and condensate recovery from cooling units,

v. Use of water harvested for toilet flushing and irrigation,

vi. Pulverised fuel ash (PFA or fly ash) used as a cement replacement for part of the cement content Pfa is recycled from power plants and has low embodied energy as well as being environmentally friendly,

vii. Recycled and abandoned materials were used in the construction of the buildings, this help to reduce carbon footprints caused from manufacturing of building materials, and

viii. There is not enough carbon footprint offset on site.

3.3.2 Case Study 2 – The Art Hotel Lagos

Plate 3.2: Exterior Facade of The Art Hotel
Lagos (Source: https://arthotelng.com)

3.3.2.1 Background Information

The Art Hotel is situated in the highly desirable Oniru Chieftaincy Family Estate, at Plot 13A, Block 111, Yesufu Abiodun Oniru Way, Victoria Island, Lagos. It is a trendy, luxury 49-room boutique art hotel offering visitors a unique experience with awe inspiring themes and superior service. It is an artistic and luxury fusion of African culture and architectural excellence, which embodies the best of both worlds. An interest in low-tech and passive sustainable solutions is incorporated in the hotel's design.**Architects**: MOE+ Art Architecture

Contractors: Dutum Company Limited

Structural engineers: Pin consults associates

Materials: Concrete, sandcrete block walls, perforated aluminium panels

Year: 2015 - 2022

No of Floors: 6

3.3.2.2 Sustainable and Passive Design Strategies

i. **Natural Lighting:** The employment of an Atrium in the design of The Art Hotel, allows natural light to penetrate deeper into the building, reducing the need for artificial lighting during the day. By strategically designing the atrium with ample glazing and reflective surfaces, natural light can be effectively distributed throughout the hotel's interior spaces, minimizing reliance on electric lighting and reducing energy consumption.

Plate 3.3: Artrium with skylight at The Art Hotel Lagos
(Source: https://arthotelng.com)

ii. **Shading:** The Hotel building uses shading devices such as balconies and the Hexagonal perforated aluminum screens,. The combination of the overhangs, on the side elevations is very effective.

iii. **Use of effective exterior finishes:** The building exterior is finished with glass, green walls and perforated aluminum screens, which improves the passive performance of the building by reducing the solar load.

Plate 3.4: View of the Exterior finish of The Art Hotel Lagos
(Source: https://arthotelng.com)

3.3.2.3 Merits

i. The structure incorporates sustainable and eco-friendly architectural features which would aid energy efficiency
ii. The architectural design of The Art Hotel reflects a contemporary approach, staying in tune with modern construction materials.
iii. The hotel features the integration of local artwork & art like visual arts, sculptures, or other forms of artistic expression that enhances the overall aesthetic appeal of the building
iv. It features Clean modern finishes Strong luxurious colors, textures, patterns.
v. For additional lighting and energy efficiency an artrium was incorporated into the design and construction of the hotel.

3.3.2.4 Demerits

i. Inadequate parking spaces to cater for both guests and staff when there is a high influx at peak times.

ii. Aluminium has low thermal heat and can therefore hinder energy efficiency.

3.3.2.5 Case Studies Deductions

i. Climatic response was taken into consideration by positioning the building short facades facing east- west, and long facades north-south

ii. Combination of overhangs and shading devices and north-south elevation helps to prevent heat load and glare from sun radiation,

iii. Passive design strategies were incorporated in the building, to help reduce the requirement for air- conditioning and improving ample natural lighting,

iv. Interior wall finishes are non-volatile organic compounds

3.3.3 Case Study 3– Transcorp Hilton Hotel, Abuja

Plates 3.5: Exterior Facade of Transcorp Hilton Hotel, Abuja
(Source: Authors field work, 2024)

3.3.3.1 Background Information

The Transcorp Hilton Hotel Abuja stands as an architectural landmark in the capital city of Nigeria. Located at no 1 agunyi irosi st, maitama, abuja, is a prominent architectural marvel that seamlessly blends modern luxury with cultural elements, reflecting Nigeria's rich heritage. The hotel's grand facade, characterized by a blend of contemporary design and traditional Nigerian motifs, establishes a striking presence in the capital city. Preparatory work for the hotel began in 1981, at that time there were hardly any infrastructure in the city. To finance the job, National insurance company of Nigeria (NICON) took a loan of $118,875,000 from a consortium of foreign banks. The hotel was fully commissioned in 1987, and became the first five star hotel in Nigeria. The Hotel is the preferred space for many public and private functions in Abuja (Bureau of Public Enterprises, 2011) The hotel has a ‗y' shaped plan with 670 rooms and is 10 storey high. The rooms are furnished in art deco style, original artwork on the walls and marble in the bathrooms. The rooms are double banked opening into a poorly lit corridor. The building is designed as 90 framed structures, constructed from concrete, glass and steel materials. (Bureau of Public Enterprises, 2011)

Architects: living design (sweden), 3adb ltd

Stuctural engineer: oasisgate konsult ltd

Materials: Concrete, Block Walls, Glass

Year: 1987

No of Rooms/Floors: 667/10

3.3.3.2 Merits

i. The incorporation of local materials and artistic elements pays homage to the nation's diverse cultural identity, creating a unique and immersive experience.

ii. The architects have successfully utilized natural light, creating a warm and inviting ambiance throughout the interior spaces.

iii. Landscaping around the hotel complements the design, creating a harmonious blend between the built environment and the surrounding greenery.

iv. Cutting-edge technology is seamlessly integrated into the architectural design, enhancing the overall guest experience.

v. Adequate parking space is provided to cater for the needs of guests during peak period.

3.3.3.3 Demerits

i. There is room for improvement in energy-efficient features, waste reduction measures, and the use of eco-friendly materials.

ii. Glass used for exterior finishes have low thermal mass.

iii. Inadequate accessibility and circulation

Plate 3.6: Grand Entrance at Transcorp Hilton Hotel Characterized by Canopy, Also Serve as Shading device(Source: Authots field work, 2024)

Plate 3.7: Site Landscape at the transcorp Hilton Hotel, Abuja
(Source: Authors field work, 2024)

3.3.4 Case Study 4 – Burj Al Arab, Dubai

Plate 3.8: Exterior Facade of Burj Al Arab, Dubai
(Source: www.canva.com)

3.3.4.1 Background Information

The Burj Al Arab is a distinctive sail-shaped luxury hotel located in Dubai, United Arab Emirates built on a manmade island called palm jumeirah. Standing at 321 meters (1,053 feet), it is renowned for its iconic design and opulent amenities. Completed in 1999, the structure symbolizes modern Dubai's architectural prowess and is often hailed as one of the world's most luxurious hotels. Its interior features lavish decor, panoramic views, and a range of exclusive services, contributing to its status as a symbol of luxury and extravagance.

Architects: wkk architects lead by tom wright

Contractors: WS Atkins Partners Overseas

Materials: Concrete, galvanized steel, mosaic tiles

Year: 1993 - 1999

No of Floors: 60

Floor Area: 111,500 sqm

3.3.4.2 Sustainable Design Strategies

i. **Passive Solar Design:** The hotel's distinctive sail-shaped structure is not only an architectural marvel but also serves a functional purpose. Its unique design maximizes natural daylight penetration into the interior spaces, reducing the need for artificial lighting during the day. Additionally, the building's orientation and facade design minimize solar heat gain, thus reducing the demand for cooling.

ii. **Energy-Efficient Lighting:** Burj Al Arab utilizes energy-efficient lighting fixtures throughout its premises. LED bulbs and other high-efficiency lighting technologies are employed to minimize electricity consumption while providing optimal lighting levels for guests and staff.

iii. **High-Performance HVAC Systems:** The hotel features state-of-the-art heating, ventilation, and air conditioning (HVAC) systems that are designed for energy efficiency and optimal comfort. These systems incorporate advanced controls and zoning capabilities to maximize energy savings while maintaining individualized temperature preferences in different areas of the hotel.

3.3.4.3 Passive Design Strategies

iv. **Orientation and Circulation:** The building's orientation reduces heat gain in the summer months. The south elevation has the maximum surface area exposed to heat absorption. • People can access the hotel through a helicopter that lands on the roof. The main entrance features a grand stairway, escalator, and elevators. For air, a revolving door serves as a locking mechanism to prevent the stack effect, which happens when hot air rises and cool air falls in a tall building.

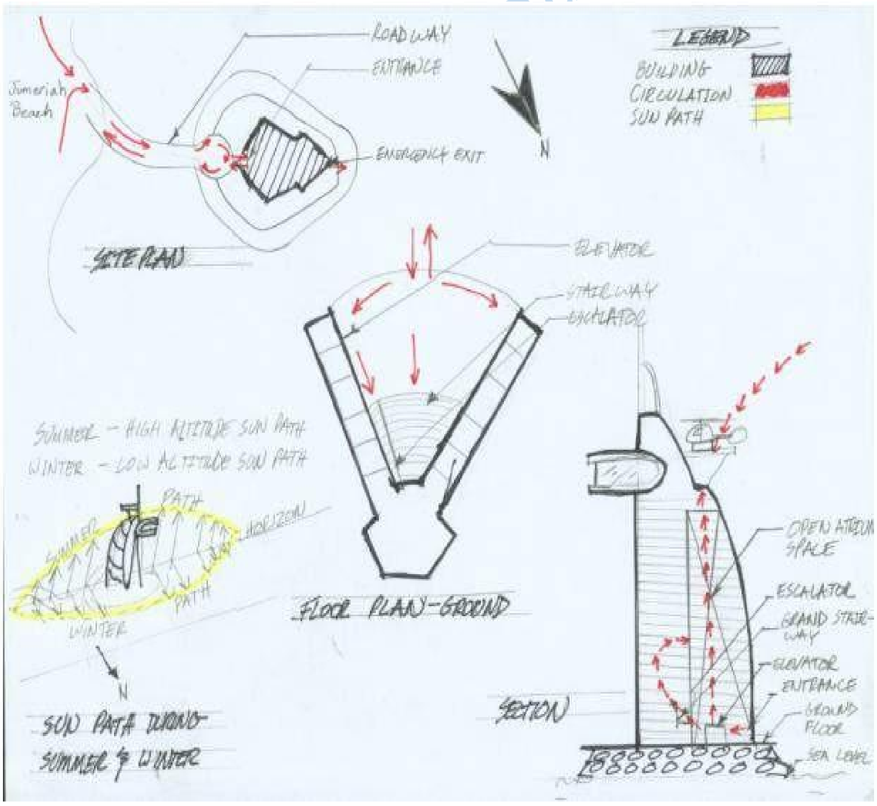

Figure 3.1: Sketches of various plans or the burj Al-Arab
(Source: https://sites.google.com/site/ae390spring2012burjalarab/architecturalsystems/1-drawings-diagrams)

v. **Building Envelope:** The hotel's building envelope is designed with high-performance materials and incorporating a membrane facade made from ETFE films, PVC-coated polyester fabrics and PTFE- coated glass fabrics. These mostly highly translucent mesh fabrics are extremely resistant to extreme weather conditions.

Plate 3.9: Pictorial view if building envelope material, Also showing Helipad
(Source: Architects field work, 2024)

vi. **Natural Ventilation:** The design incorporates natural ventilation strategies by including operable windows, vents, and atriums to facilitate airflow throughout the building. Cross-ventilation is encouraged to enhance indoor air quality and provide passive cooling, reducing reliance on mechanical ventilation systems.

vii. **Passive Solar Design Features:** Passive solar design principles are integrated into the architecture, including features such as solar shading, orientation, and thermal mass. These elements help harness solar energy for heating, lighting, and ventilation purposes, reducing the hotel's reliance on conventional energy sources.

3.3.4.4 Environmental analysis

(a) Wind Effects:

i. Geographic location subjects the hotel to severe weather conditions including strong winds and occasional violent thunderstorms.

ii. Due to the structure’s proximity to its adjacent hotel resort, wind tunnel testing was considered to ensure a safe design.

iii. Wind speed of 45 meters per second, under the recommendations of Dubai Municipality, was adopted for the design.

(b) Seismic Impact:

i. It is not located in an earthquake intensive zone. However, southern Iran which is only 100 miles away to the north is subjected to moderate earthquake risk and in turn which could create tremors in Dubai if a seismic event were to occur in Iran.

ii. To reinforce the structure from any potential swaying, two tuned mass dampers, weighing about 2 tonnes each, limit vibrations in the tubular steel mast that projects 60 m above the building.

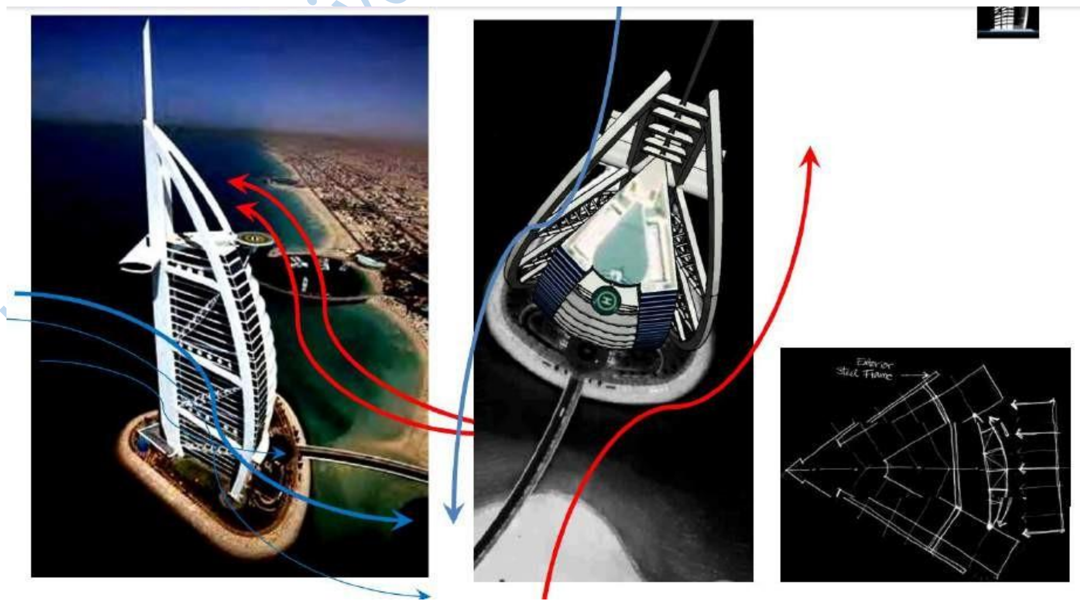

Figure 3.2: Wind impact on the Burj Al arab
(Source: Architects field work, 2024)

3.3.4.5 Merits

i. The sail shaped structure sigfnifies an architecturally innovative exterior and truly exuberant interior.

ii. There are flowers throughout the hotel and even in suites which promotes sustainability.

iii. Burj Al Arab utilizes advanced technologies to minimize energy consumption and reduce its environmental impact.

iv. For air, the revolving door located at the main entrance acts as a locking mechanism to prevent a phenomenon known as the stack effect, which occurs when the hot air rises and the cool air falls in a tall building

3.3.4.6 Demerits

i. The Burj Al Arab HAS limited exterior space for recreational and outdoor activities.

ii. The design of the Burj Al Arab have raised concerns about its long-term structural sustainability AS The challenges associated with maintaining SUCH architectural feat over time could lead to increased maintenance demands and costs.

iii. There is not enough greenery within the structure that can enhance sustainability.

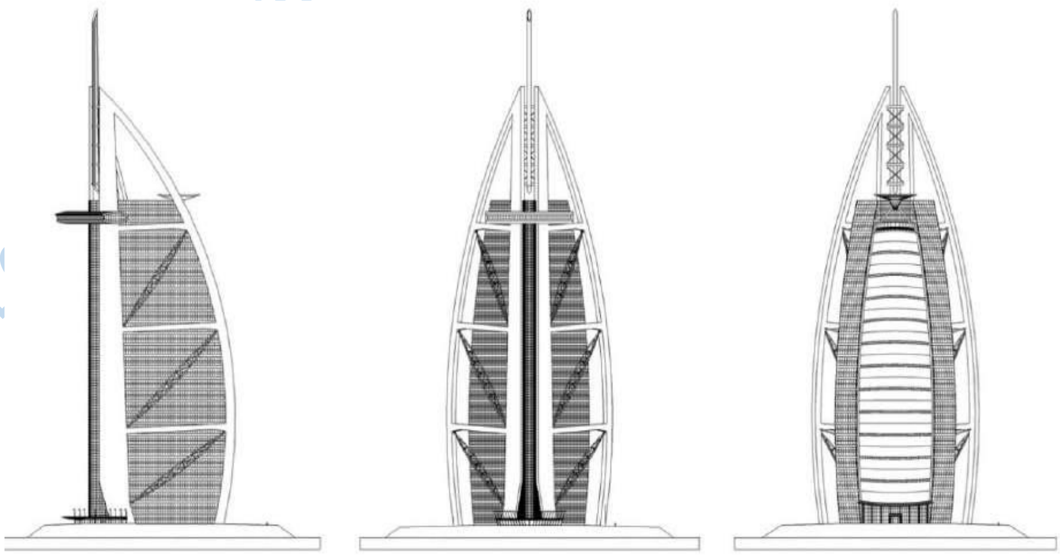

Figure 3.3 Elevations of the iconic Burj khalifa
(Source: Architects online research 2024

3.3.5 Case Study 5 – Rosewood Abudhabi

Plate 3.10: Exterior Facade of Rosewood Abudhabi
(Source: Archdaily.com, 2015)

3.3.5.1 Background Information

Rosewood Abu Dhabi is a luxury hotel and residential tower located on Al Maryah Island. The inspiration for the design was derived from the falcon and from the art of falconry, which has a long history in the Middle East, and remains an important part of local heritage and culture. The way in which the falcon's wings overlap its body inspired the exterior massing and the overlapping volumes and textures of the exterior wall. The design we created is not a literal translation of an idea, but a sculptural manifestation that reflects the falcon's beauty, elegance and precision. This inspiration provided us with a dynamic form that is found in nature, and has regional and cultural significance.

It is a new 1,099,000 sq. ft. (102,000 m²) luxury, mixed-use development. The complex includes a five-star 189-room Rosewood hotel, 131 serviced apartments, banquet facilities, meeting facilities, spa, fitness center, retail space, restaurants, and parking.

Architects: HANDEL ARCHITECTS

Structural Engrs: MagnussonKlemensic Associates

Materials: Concrete, Galvanized Steel, Mosaic Tiles **Year**: 2013

No of **Floors**: 60

Floor Area: 102000 sqm

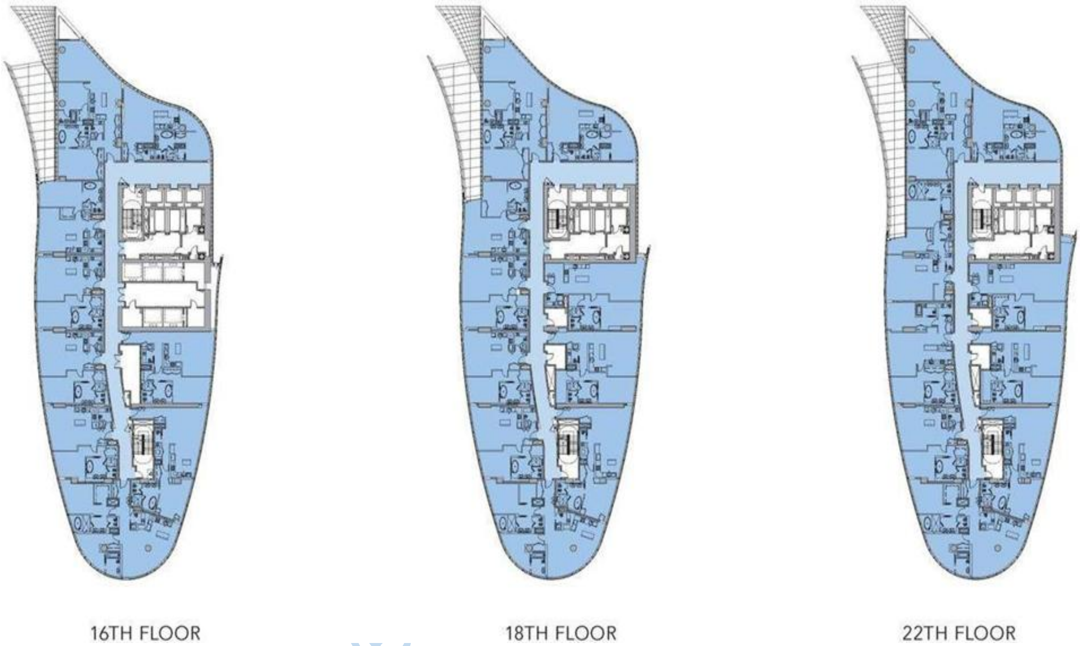

Figure 3.4 Rosewood abudhabi typical floor plans
(Source archdaily.com, 2015)

3.3.5.2 Merits

i. The structure has a sleek and modern design, blending seamlessly with the urban landscape.

ii. The use of high-quality materials and attention to detail reflects sophistication.

iii. Sustainable features, such as energy-efficient systems, further enhance its positive attributes, aligning with contemporary environmental considerations.

3.3.5.3 Demerits

iv. Limited integration of traditional Emirati architectural elements, potentially impacting cultural resonance.

v. There is not enough greenery within the structure that can enhance sustainability.

vi. Rosewood Abu dhabi has limited exterior space for recreational and outdoor activities.

3.4 Case study synthesis

a) Common Spaces and Facilities

All these hotels feature expansive and luxurious lobbies, multiple dining options, and a variety of leisure facilities such as pools, fitness centers, and spas. They also cater to business and event needs with conference rooms and meeting spaces. Retail spaces and additional amenities like beauty salons and shops are standard.

b) Special Spaces and Facilities

Each hotel distinguishes itself with unique features:

i. Burj Al Arab Iconic helipad, underwater restaurant, and floating terrace.

ii. Rosewood Abu Dhabi Executive lounge, art gallery, and marina views.

iii. Transcorp Hilton's extensive business facilities, children's recreational areas, and presidential suites.

iv. Lagos Continental Hotel's sky bar, helipad, and art collection.

v. The Art Hotel's art gallery, artist-in-residence programs, and private cinema.

c) General Deduction from case study

High-end hotels incorporate a mix of common luxurious amenities and unique, special features to differentiate themselves and enhance guest experiences. While common facilities ensure comfort and convenience, special spaces provide unique experiences that align with the hotel's brand identity and target market. Integrating art, culture, and unique services such as private cinemas or helipads adds value and appeal, especially in competitive markets. These hotels also blend functional business spaces with leisure facilities, catering to both business and leisure travelers.

Chapter Four

Site Analysis and Design Synthesis

4.1 Study Area/Site Selection

Adjacent to Lagos' central business district, Eko Atlantic City enjoys unrivaled accessibility and connectivity. It is conveniently accessible via major roadways, including Ahmadu Bello Way and Ozumba Mbadiwe. The city's proximity to key economic hubs and entertainment venues further enhances its appeal as a premier destination for business and leisure travelers alike. Its sweeping pedestrian promenade encircles the marina offering views from the sleek yachts to the dazzling architecture. Its will become a center for leisure and social activities.

4.1.1 Site Location/Description

The proposed site is located in Marina district which is one of the most stunning residential and commercial hubs in Eko Atlantic, Lagos designed for mixed use development. Notable Land marks in close proximity to the site are Azuri towers and Eko pearl towers, It is located on 6°24'31.8"N 3°24'16.8"E.

Figure 4:1: Site Location map
(Source: Authors field work (2024)

4.1.2 Site Analysis

Here are some of the key aspects that an architect should consider when analyzing the site:

Geographical Location: The site is located on the Marina District of Eko atlantic city, which is one of the major islands in the Lagos Lagoon, Eko Atlantic City is an ambitious urban development project located on the coast of Lagos, Nigeria. The Marina District is one of the prominent areas within this development. Situated on the Atlantic Ocean, Eko Atlantic City is built on reclaimed land, stretching over 10 square kilometers. The Marina District, in particular, is strategically positioned to leverage its waterfront location, offering stunning views and opportunities for maritime activities. Firstly, its proximity to the Lagos Lagoon provides an opportunity for waterfront development, which may be attractive for some types of projects such as hotels, restaurants, or residential properties.

Secondly, its location on Lagos Island means that it is well-connected to other parts of the city via major road networks and bridges such as the Third Mainland Bridge and the Falomo Bridge. This makes it easily accessible for both commuters and visitors.

Thirdly, Marina's status as a high-end residential area means that it is likely to have a certain level of affluence and demand for luxury goods and services. This may make it an attractive location for certain types of businesses such as high-end retail, gourmet restaurants, and boutique hotels.

Finally, the presence of key amenities may also be a factor in a site analysis, as these amenities can help to attract visitors and residents to the area.

Sunrise and Sunset: The sunrises at about 6:32am in the morning and sets at about 6:54pm in the evening on the site. The east and west side of the building should be shaded from the sun; solar panels can also be placed on the building to utilize the sun light hitting that part of the building to generate energy for the building.

Prevailing Winds: Generally, Lagos experiences two main wind patterns throughout the year: the northeast trade winds and the southwest monsoon winds. The northeast trade winds blow from the northeast between November and March, bringing dry and dusty Harmattan winds to the region. These winds can cause a drop in temperature and reduced visibility due to dust and haze. From around April to October, the southwest monsoon winds known locally as the "Rainy season winds" bring moisture and heavy rainfall to the region, as they blow from the southwest over the Atlantic Ocean. During this season, the wind patterns can be characterized by frequent thunderstorms, heavy rainfall, and occasionally strong gusts.

Figure 4:2: Site Analyss
(Source: Authors field work (2024)

a) Topography

The site being located at Eko atlantic city which is on a relatively flat terrain, so it is essential to assess the site's slope, water table, and drainage. This will help determine the foundation type and will aid both the Architect and the Structural Engineer in designing a stable structure.

b) Infrastructure

The site has access to different infrastructure such as access to roads, water, and electricity and so on. The north- west of the site, is a view of the Atlantic Ocean; with access road on all boundaries of the site; The site infrastructures are the social and supporting facilities connected with the site.

c) Vegetation

The site is characterized by its sparse vegetation and Loamy soil due to the land filling that occured, so it is essential to preserve as much of the site's natural environment as possible.

d) Climate

Lagos is located on the Atlantic coast of Nigeria and has a tropical savanna climate, characterized by two distinct seasons – the rainy season and the dry season

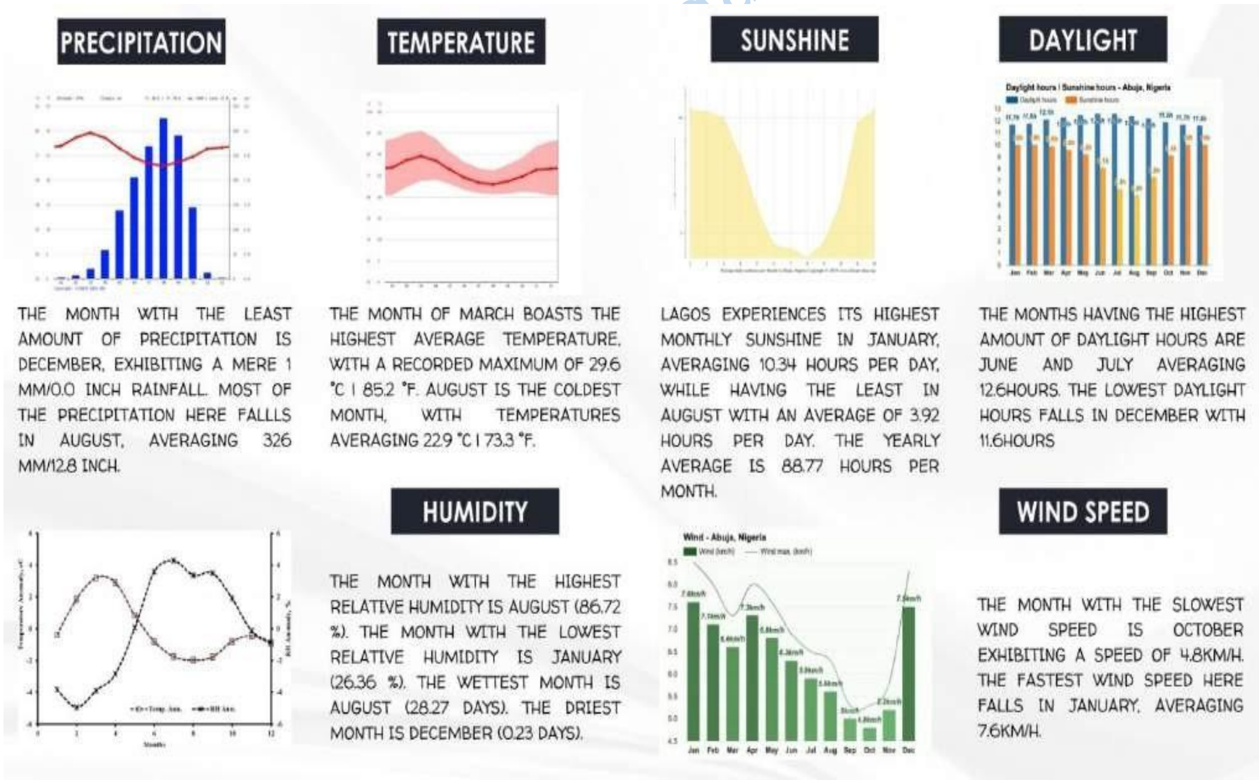

Figure 4:3: Climatic analysis
(Source: Authors field work (2024)

4.2 Project Analysis/ Design Synthesis

4.2.1 Design Criteria

Energy is necessary for buildings' activities. Lighting, ventilation, insulation, and controls have been enhanced and these are significant features to achieve energy efficiency. Since the aim of the design is to Minimize the consumption of energy and also promote sustainability. Hence, the following were considered when designing the building:

i. Building Form: The building has to have a simple form to prevent heat trapping into the building's exterior surface.

ii. Windows: The use of normal size fenestrations will allow sufficient lighting & ventilation of interior spaces.

iii. Functionality: he design will be made to perform its functions by adequately allocating spaces to standards

iv. Walls: materials that minimizes heat absorption should be used to construct walls

v. Orientation: The building's layout and windows will be properly aligned with the path of the sun to maximize natural light and heat gain in the rainy season while minimizing overheating in the summer.

vi. Landscaping: this is to provide shade, reduce wind impact, and even act as an insulating layer around the building

vii. Aesthetics: The design wil be visually appealing by creatively planning of the entire facility including its layout.

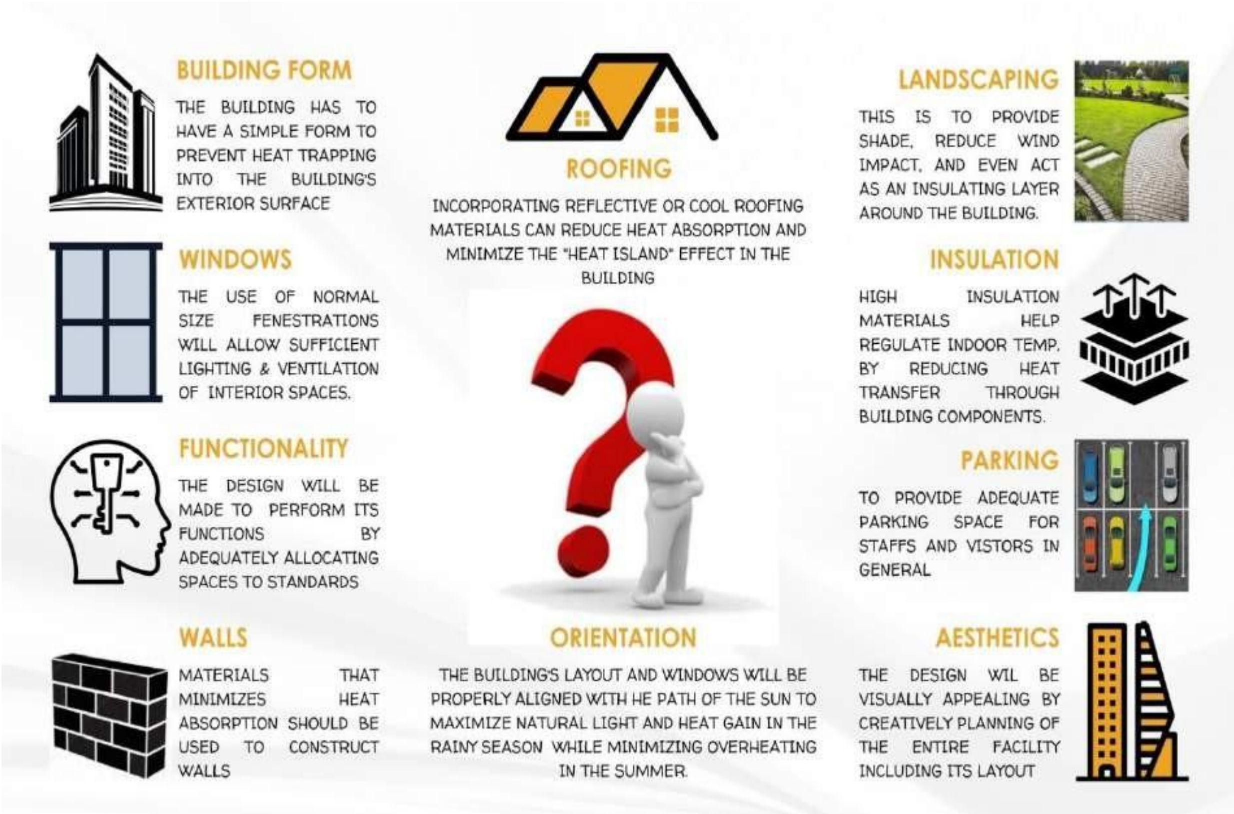

Figure 4.4: Design Consideration
(Source: Authors field work (2024)

4.2.2 Brief Analysis

The proposed design is a Five star Luxury Hotel, to be located in Marina, Eko Atlantic city, Lagos State. The Proposed Hotel will be an abode for all forms of Hospitality and leisure activities together with other activities such as commercial activities, support and storage, collaborative activities, physical fitness, training, and so on and shall be accessible to all.

4.2.3 Brief Development

Provisions were made for the following spaces in the design of a 5 star Hotel

- Grand Lobby
- Retail Stores
- Restaurants
- Administrative office spaces

- Mine Kitchen
- Staff lounge and rooms
- Breakfast café
- Super Mart
- Outdoor Sport Facilities
- Flower garden
- Fitness Centre
- Banquet Hall
- Multipurpose Hall
- Sauna / Spa
- Unisex Salon
- Outdoor lunge
- Roof top swimming pool
- Roof garden
- Deluxe suite
- Twin Deluxe Suite
- Deluxe King Suite
- Executive Suite
- Executive Plus Suite
- Grand Premier Suite
- Honeymoon Suite

- Family Retreat Suite
- Presidential Suite

4.2.4 Conceptual Development

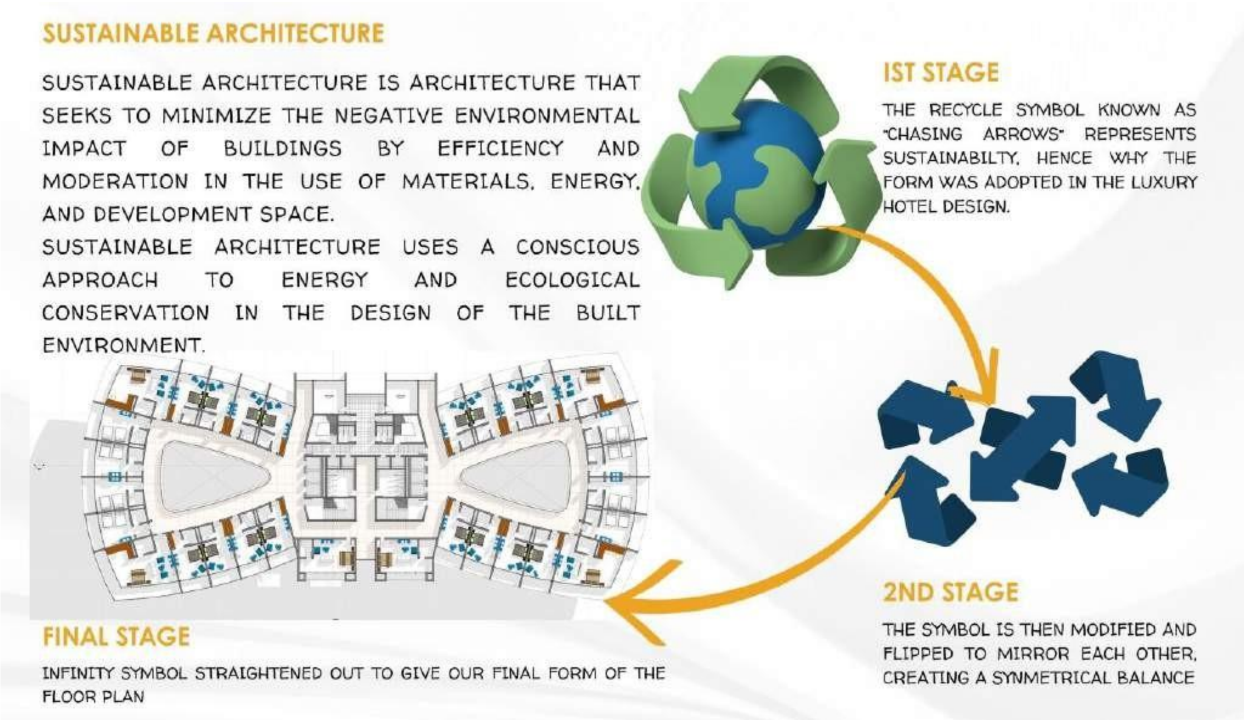

Figure 4:5: Conceptual Development
Source: Authors field work (2024)

4.2.5 Functional Relationship

Designing a 5-star hotel involves creating a seamless integration of various functional areas to ensure smooth operations, guest satisfaction, and a luxurious experience. The functional relationship of different spaces within the hotel is critical to achieving this. The Ground floor, First floor is opened to the General Public, While the remaining floor areas is strictly for guests, Services and Staffs.

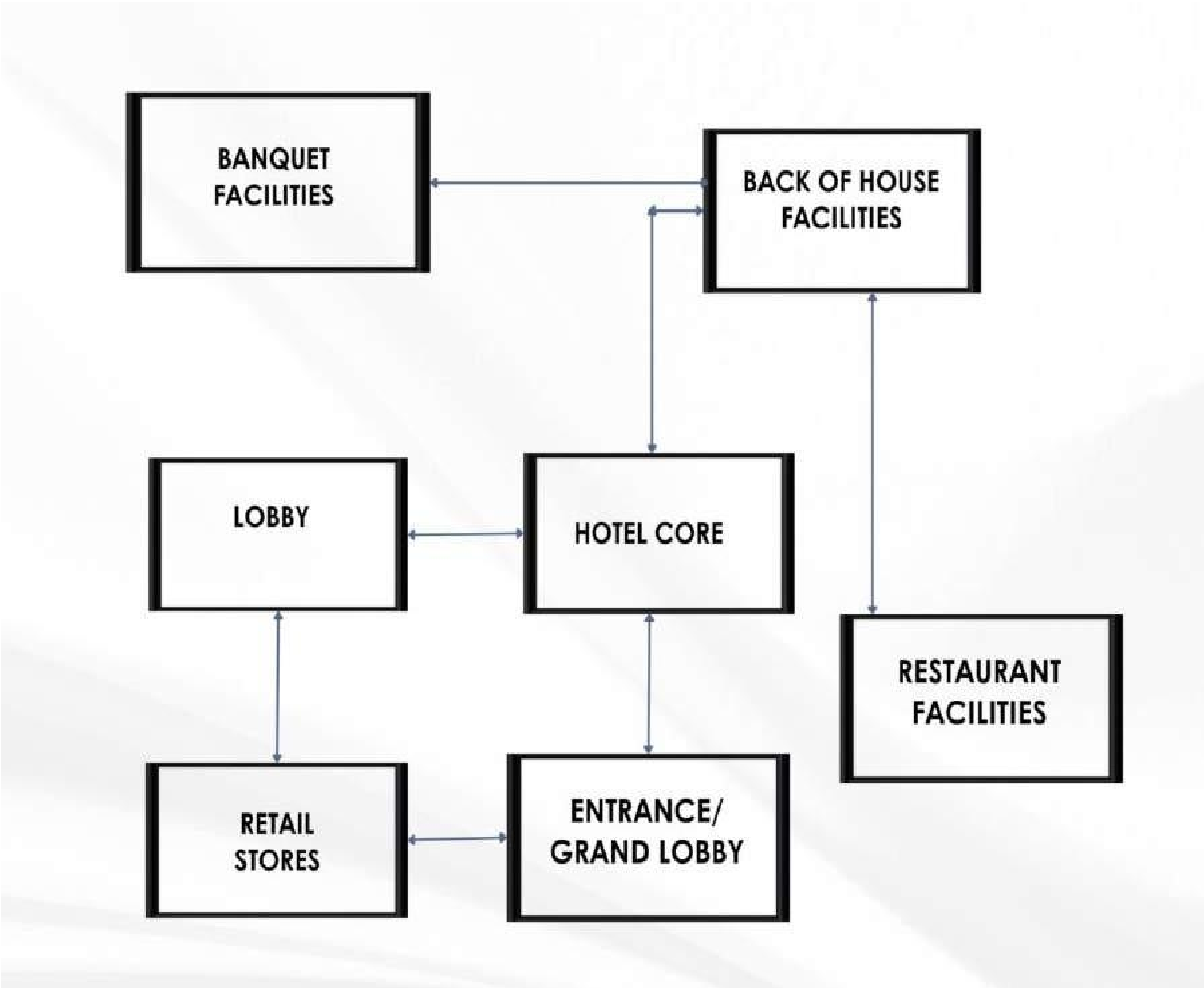

Figure 4.6: Functional Flow of the Ground Floor plan
(Source: Authors field work, 2024)

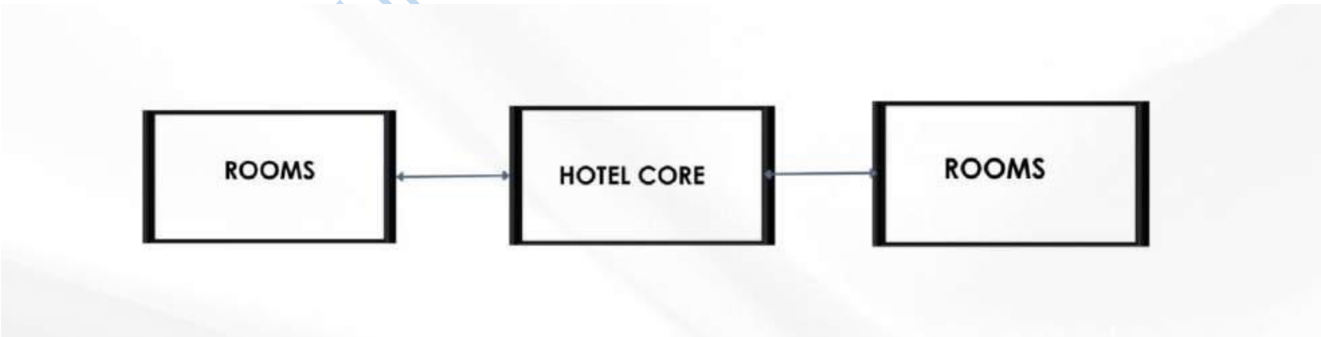

Figure 4.7 Functional flow of the Room Floor Plans
(Source: Authors field work, 2024)

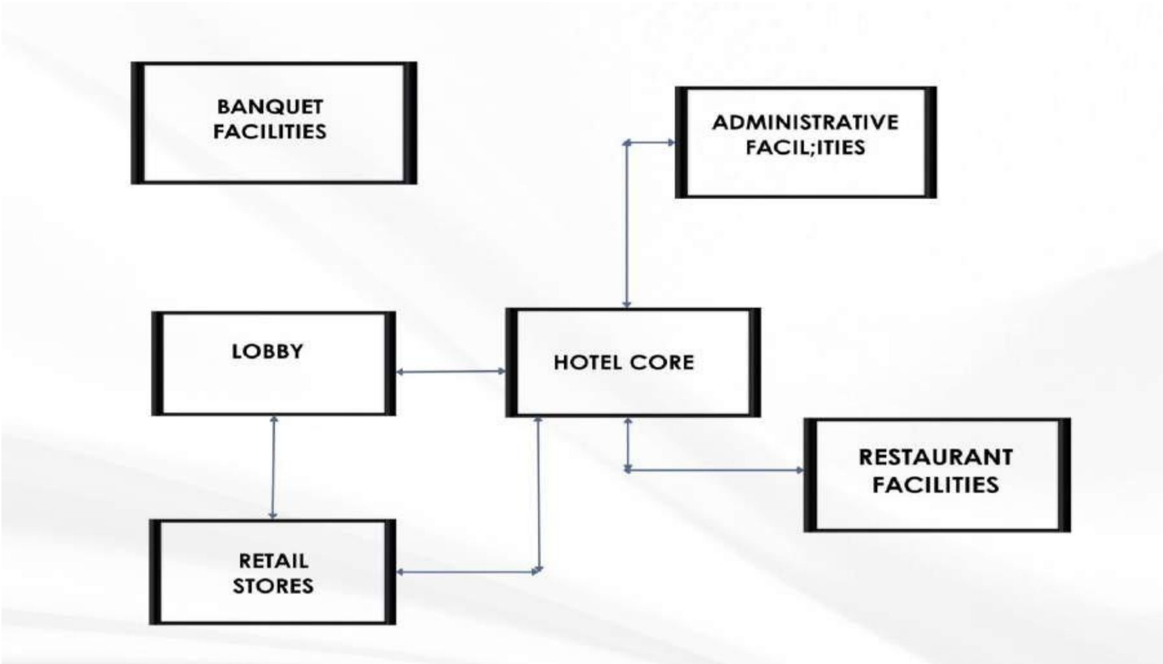

Figure 4.8: Functional flow of the second floor Plan
(Source: Authors field work, 2024)

4.2.6 Space Allocation / Schedule of Accommodation

Schedule of accommodation of the Hotel includes the space areas, important considerations for space allocations and the area for office activities.

Table 4.1: Accommodation Schedule of each floor of Dangote Hotel building

Floor	***Usage***	***Area (m^2)***
20th Floor	Presidential Suites	2220
19th floor	Apartments Suites	2220
18th floor	Apartments Suites	2220
17th floor	Apartments Suites	2220
16th floor	Apartments Suites	2220

15th floor	Apartments Suites	2220
14th floor	Apartments Suites	2220
13th floor	Apartments Suites	2220
12th floor	Service Floor	2220
11th floor	Rooms Suite	2220
10th floor	Rooms Suite	2220
9th floor	Rooms Suite	2220
8th floor	Rooms Suite	2220
7th floor	Rooms Suire	2220
6th floor	Rooms Suite	2220
5th floor	Rooms Suite	2220
4th floor	Room Suite	2220
3rd floor	Room Suite	2220
2nd floor	Services/ Roof garden/ Swimming pool	5450
1st floor	Mixed used Floor	5330
Ground Floor	Grand Lobby/ Mixed use	6590
Basement	Parking Lots/Controlled Access	6590
Total		63110

Source (Researchers Field Work)

Table 4.2: Room Typologies of the Dangote Hotel Building

S/N	*Room Name*	*Description*	*No of Spaces*	*Area (m²)*
1	Presidential Suite	Waiting area, Snooker, Living area, Dinning, Visitors toilet, Chef kitchen, Restaurant, 3 bedrooms, (2 en-suite) Private office, Conference room	2	515
2	Family Retreat Suite	Living area, Dinning, Kitchen, Two bedrooms (en- suite)	28	118
3	Honeymoon Suite	Anteroom, Living area, Dining and Kitchen, One Bedroom	28	92
4	Grand Premier Suite	Anteroom, Living area, Kitchen, One Bedroom	7	90
5	Executive Plus Suite	Open plan Living area, bedroom and dining, workspace	14	59
6	Executive Suite	Open plan living area and bedroom, workspace	36	51
7	Deluxe King Suite	Queen size bed	18	34

8	Twin Deluxe Suite	Two King size beds	72	31
9	Deluxe Suite	King size bed	144	24

Source (Researcher's Field work)

4.2.7 Construction Materials and Methods

Designing and constructing a 5-star luxury hotel requires meticulous planning and the use of high-quality materials and construction methods to ensure durability, aesthetic appeal, and sustainability. This project includes innovative features such as a glass, concrete, and aluminum facade, green roofs, rooftop gardens etc. Below are the detailed construction methods and materials incorporated in the design of Dangote Hotels:

i. **Foundation and Structural System**

Due to the loose soil at Eko Atlantic City and robust nature of the 20-floor Dangote Hotels, to support the load, a deep foundation system such as bored piles or drilled shafts can be used. This ensures stability and minimizes settlement, especially if the soil conditions are not ideal. The whole building should be constructed with a central core made up of reinforced concrete. This central core houses the Mechanical systems, Vertical transportation system, Chute, Escape Hole and all Major Hotel services. Reinforced concrete and steel are typically used for the structural frame. Concrete provides excellent compressive strength, while steel offers superior tensile strength. A combination of reinforced concrete columns and steel beams can optimize structural performance.

ii. **Facade Design**

In the design of Dangote Hotels, High-performance, double-glazed or triple-glazed low-E (low emissivity) glass is used to maximize energy efficiency by reducing heat gain and loss. Glass provides a sleek, modern appearance and allows for natural lighting. Concrete is also used for the façade with a high-quality finish as concrete is durable, provides excellent thermal mass, and can be molded into various shapes and textures to enhance the building's aesthetics. Rhomboid Aluminum cladding panels are used due to their lightweight, corrosion resistance, and ease of installation to provide shading as well as add to the aesthetics of the facade.

Plate 4.1: Façade of building showing materials used
(Source: Authors proposed design, 2024)

iii. Green Design

The introduction of plants on the facade involves using planters integrated into the building structure. These systems include modular panels with growing media and irrigation systems to support plant growth. Plants improve air quality, provide insulation, and enhance the building's aesthetic appeal. The green roof on the second floor and rooftop garden involves a multi-layer system:

a) **Waterproof Membrane**: Prevents water infiltration into the building structure.

b) **Root Barrier**: Protects the waterproof membrane from root penetration.

c) **Drainage Layer**: Facilitates water drainage to prevent waterlogging.

d) **Filter Fabric**: Prevents soil particles from clogging the drainage layer.

e) **Growing Medium**: A lightweight, engineered soil mix that supports plant growth.

f) **Vegetation**: Drought-resistant plants, shrubs, and small trees suited to the local climate.

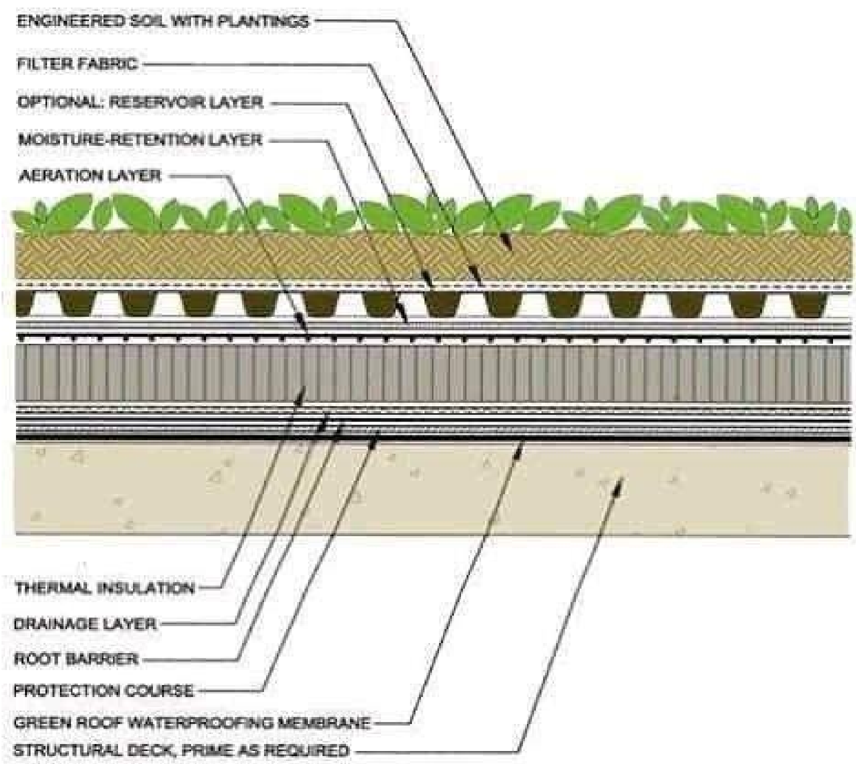

Figure 4.9: Green roof detail
(Source: Pinterest.com/Greenroofdetails)

iv. Infinity Swimming Pool

The pool structure is made from reinforced concrete, ensuring it can withstand the water pressure and provide a leak-proof basin.: A high-quality waterproof membrane is applied to prevent water leakage.The interior surface of the pool can be finished with tiles, fiberglass, or a special pool plaster for a smooth, aesthetically pleasing look.The infinity edge requires precise leveling and construction to create the visual effect of water extending to the horizon. A catch basin and pump system are necessary to recycle the overflow water back into the pool.

v. Helipad

The helipad requires a robust structure, typically constructed from reinforced concrete or steel, designed to support the weight of helicopters and resist dynamic loads during takeoff and landing. mThe surface is coated with a non-slip, durable material to withstand rotor wash and harsh weather conditions. Lighting, markings, and safety netting are essential for safe helicopter operations. Additionally, fire suppression systems should be in place.

vi. Interior Design and Materials

High-quality materials such as marble, granite, hardwood, and luxury vinyl tiles are used for flooring in public areas, while plush carpets may be used in guest rooms for added comfort. Wall finishes include a combination of high-end materials like wood paneling, textured wallpapers, and decorative plaster to create an opulent ambiance. Decorative ceilings with recessed lighting, chandeliers, and acoustic panels to enhance aesthetics and comfort and acoustics. Custom designed, high-end furniture and fixtures that reflect the luxury status of the hotel.

vii. Sustainability and Energy Efficiency

High-efficiency HVAC systems with advanced controls to optimize energy use while maintaining indoor comfort. LED lighting systems with smart controls to reduce energy consumption. Low-flow fixtures, greywater recycling, and rainwater harvesting systems to minimize water usage. Integrated systems to monitor and control building operations for enhanced efficiency and occupant comfort.

vii. Safety and Security

Comprehensive fire safety systems including sprinklers, smoke detectors, and fire-resistant materials. Advanced security systems with surveillance cameras, access control, and 24/7 security personnel to ensure guest safety. By employing these construction methods and materials, the hotel not only achieves a high standard of luxury and aesthetic appeal but also incorporates sustainable practices that enhance energy efficiency and environmental responsibility.

4.2.8 Building services

Designing a 20-floor luxury hotel requires integrating comprehensive building services to ensure the highest levels of comfort, efficiency, and safety for guest such as:

i. Heating, Ventilation, and Air Conditioning (HVAC)

Centralized systems like boilers or heat pumps provide consistent and efficient heating. Underfloor heating should be used in premium areas such as spas and bathrooms for additional comfort. Advanced ventilation systems to ensure a constant supply of fresh air while removing stale air. This includes mechanical ventilation with heat recovery (MVHR) systems to improve energy efficiency.

ii. Electrical Systems

A robust electrical infrastructure with redundant power supplies and backup generators ensures uninterrupted service. High-quality electrical panels and distribution boards manage the power needs of the building. LED lighting solutions with smart controls provide energy-efficient and customizable lighting options. Mood lighting in guest rooms, public spaces, and exterior lighting enhances the ambiance. : State-of-the-art communication systems include high-speed internet, VoIP telephones, and integrated PA systems for announcements and background music.

iii. Plumbing Systems

Advanced plumbing systems ensure a reliable supply of hot and cold water. Pressure-boosting systems maintain water pressure across all floors. Efficient drainage systems prevent waterlogging and ensure quick removal of wastewater. Grease traps in kitchen areas and oil separators in service areas maintain hygiene and compliance. Comprehensive fire suppression systems, including wet and dry sprinkler systems, fire hydrants, and hose reels, are strategically placed throughout the building.

iv. Fire Safety Systems

Smoke detectors, heat detectors, and multi-sensor detectors provide early warning of fire. These are connected to an addressable fire alarm system that identifies the exact location of any incident.Automatic sprinkler systems, foam suppression systems in specific areas, and portable fire extinguishers are essential components. Emergency lighting, illuminated exit signs, and an integrated public address system guide occupants to safety.

v. Security Systems

Electronic key card systems, biometric scanners, and secure entry points tocontrol access to guest rooms and restricted areas. High-definition CCTV cameras cover all public areas, entry points, and critical infrastructure. Monitoring stations enable real-time surveillance and recording. Alarm systems with motion detectors and glass break sensors protect against unauthorized entry.

vi. Lifts

Six High-speed, high-capacity lift are provided for efficient vertical transportation for guests and staff. While 4 Service lift handle housekeeping and deliveries separately.

viii. Waste Management Systems

A chute was provided for there by collecting waste at the basement floor to ensure proper disposal of waste materials.

Chapter 5

Conclusion and Recommendations

5.1 Project Appraisal

Because buildings are designed using renewable and clean technology, local climate andmaterials, and natural ventilation, climate-responsive and sustainable design concepts are advantageous from the very beginning of the design process. The concept of Sustainable design thereby promotes healthier living and working environments. This includes improved indoor air quality, natural lighting, and the use of non-toxic materials, which can enhance occupant health and comfort. In this study, an adaptive strategy was employed to assess passive cooling strategies for building occupants. Early on in the design process, building energy calculations are particularly helpful since they help designers make decisions about how much energy will be used when the structures are actually in use. In addition to preventing poor building performance brought on by energy outages, this would also help buildings adapt to Nigeria's unreliable power system.

5.2 Conclusion

A comprehensive evaluation of various passive design strategies has been conducted and their application to Luxury Hotels, highlighting their potential to significantly enhance energy efficiency while maintaining occupant comfort. The findings underscored the significance of passive design in creating high-performing, eco- friendly office spaces that can reduce energy consumption, greenhouse gas emissions, and operational costs over the building's lifetime.

The unique climatic conditions and specific challenges faced in Lagos State provided an essential context for the research. By identifying and analyzing various climatic data, local building codes, and regulations, the project aimed to develop contextually appropriate passive design strategies that would maximize energy efficiency and promote sustainability in the proposed Dangote Hotels.

The incorporation of passive design principles and sustainable practices into the design of

Dangote Hotels has the potential to set a precedent for sustainable development in Lagos. By utilizing natural ventilation, solar shading, thermal mass, and daylight optimization, the Dangote Hotels can serve as a flagship example of energy-efficient and Sustainable design conscious architecture in the region.

However, it is crucial to acknowledge that passive design is just one component of the broader sustainable design framework. The implementation of these strategies requires a multidisciplinary approach involving architects, engineers, urban planners, and policymakers working in tandem to achieve the highest levels of energy efficiency and sustainability.

In addition to the design phase, the post-occupancy performance evaluation of the Dangote Hotels will be equally critical. Continuous monitoring and analysis of the building's energy performance, indoor environmental quality, and user satisfaction will provide valuable feedback for further refinements and optimization of passive design strategies.

Generally, methods used by the selected case studies can be applied in the construction and design of Hospitality buildings in Nigeria to reduce the negative impacts of building design construction, and operation on the environment.

5.3 Recommendations

Based on our evaluation of passive design strategies for energy efficiency through sustainable practices, the following recommendations are projected:

1) Government should develop and enforce Building Codes that incorporate passive design strategies and also ensure that these set of codes encourage energy efficiency, insulation and sustainable building practices.
2) Government should offer financial incentives or tax breaks to developers and building owners who implement passive design strategies such as tax credits for energy-efficient buildings
3) Building professionals such as Architects, Engineers, Contractors and other professionals in

the built environment should foster collaboration among each other from early design stages. Integrated design teams can better incorporate passive design strategies into projects.

4) Research on innovative passive design research on innovative passive design strategies, materials, and technologies should be encouraged by the government. This should be further shared with the building industry to promote continuous improvement.
5) Building professionals should stay updated on the latest developments in passive design strategies through workshops, courses and certifications related to sustainable building practices.
6) Architects and others should ensure that construction practices align with the design's intent. Proper installation of insulation, sealing, and ventilation systems is crucial for passive design success.
7) Builders should be an advocate for passive design strategies in project discussions with clients. Highlight the long-term energy and cost savings with these strategies.

Overall, passive design strategies can significantly improve the energy efficiency of a building while enhancing occupant comfort and well-being. By adopting a Sustainable and holistic approach that considers the building's unique characteristics and the local climate, building owners and managers can reduce energy consumption, lower operating costs, and contribute to a more sustainable future.

5.4 Contribution to Knowledge in Architecture

This study discussed evaluating passive design strategies in minimizing energy consumptions Luxury Hotels through sustainable practices, here are some prospective contributions to knowledge:

1) Comprehensive Framework for Passive Design in Luxury Hotels: This thesis establishes a comprehensive framework that integrates various passive design strategies tailored specifically for luxury hotels. It provides detailed guidelines on implementing these

strategies, including natural ventilation, daylighting, thermal mass utilization, and shading devices. This framework serves as a valuable reference for architects and designers aiming to create energy-efficient luxury hotel environments.

2) Quantitative Analysis of Energy Savings: By employing advanced simulation tools and real-world case studies, this research quantitatively analyzes the energy savings achieved through passive design strategies. The results offer empirical evidence of the effectiveness of these strategies, providing a robust foundation for advocating their adoption in the luxury hospitality sector.

3) Sustainable Practices Integration: The thesis explores the integration of sustainable practices, such as the use of local and sustainable building materials, green roofs, and water conservation techniques, in conjunction with passive design strategies. This holistic approach not only minimizes energy consumption but also promotes overall sustainability, contributing to the broader discourse on sustainable architecture.

4) Design Innovations for Comfort and Luxury: One of the critical contributions of this thesis is demonstrating how passive design strategies can be innovatively adapted to meet the comfort and luxury expectations of high-end hotel guests. By incorporating elements like aesthetically pleasing shading devices, strategic placement of thermal mass, and seamless integration of natural ventilation, the research shows that sustainability and luxury are not mutually exclusive but can complement each other.

5) Case Studies and Best Practices: The inclusion of detailed case studies of luxury hotels that have successfully implemented passive design strategies provides practical insights and best practices for the industry. These case studies highlight the challenges faced, solutions employed, and the resultant benefits, serving as a valuable resource for architects, designers, and hotel operators.

5.5 Areas of Further Research.

While this project has evaluated the effectiveness of passive design strategies for minimizing the consumption of energy in Luxury Hotels through sustainable practices, there is still room for further research in this area. Some areas that could benefit from further investigation include:

1) The impact of passive design strategies on indoor air quality and occupant health and well-being.
2) The evaluation of Sustainable design practices in different types of Hotels and climates.
3) The integration of passive and sustainable design Practices for energy efficiency and occupant comfort.
4) The development of innovative materials and technologies that can enhance the effectiveness of passive and sustainable design Practices.

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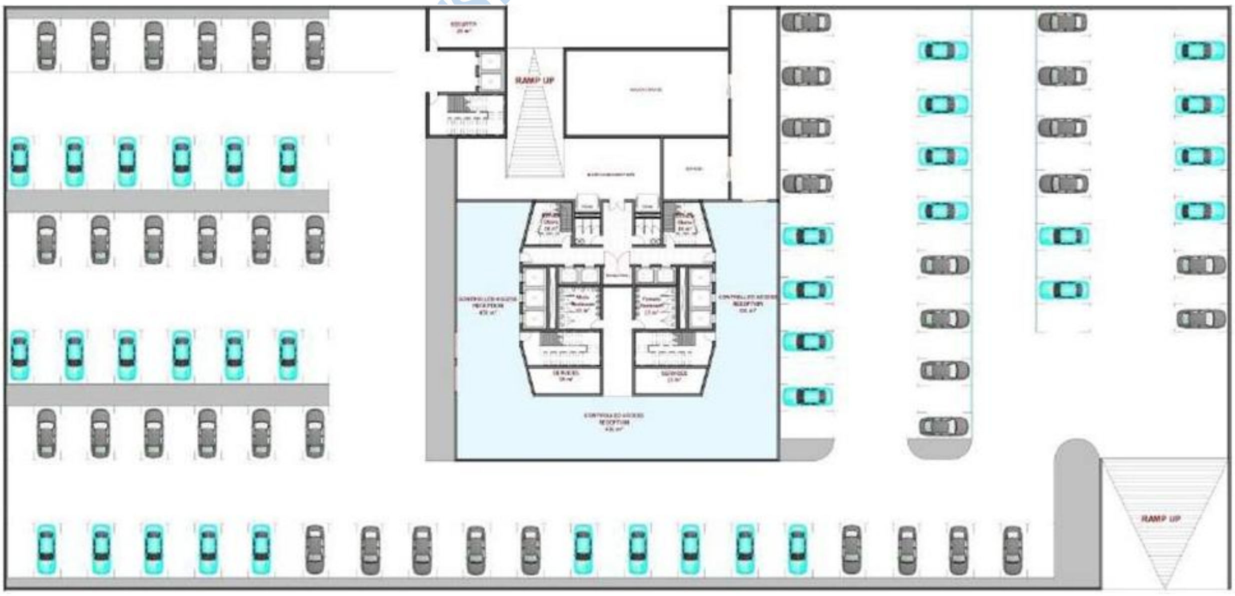
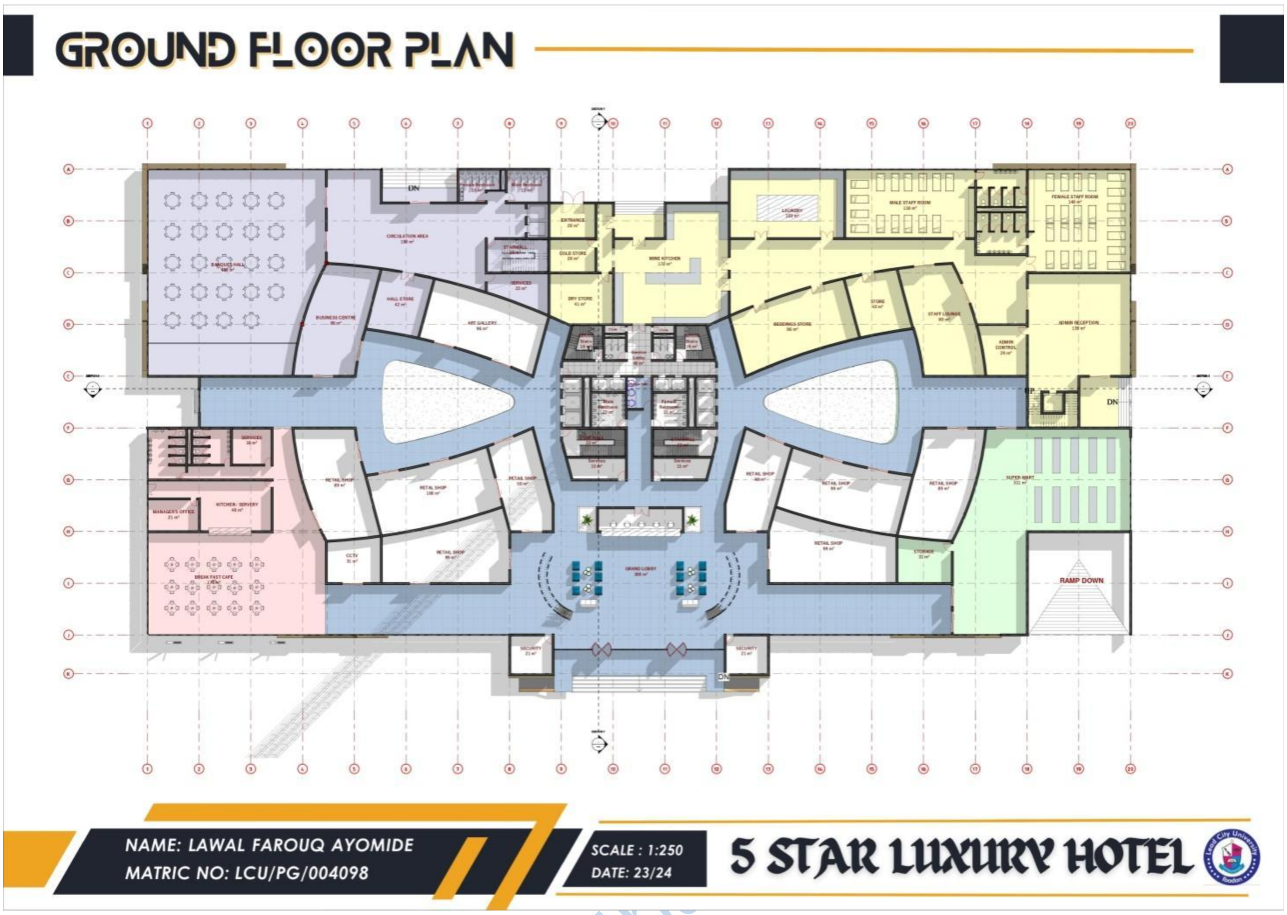
Appendices – Appendix 1 - Presentation drawings

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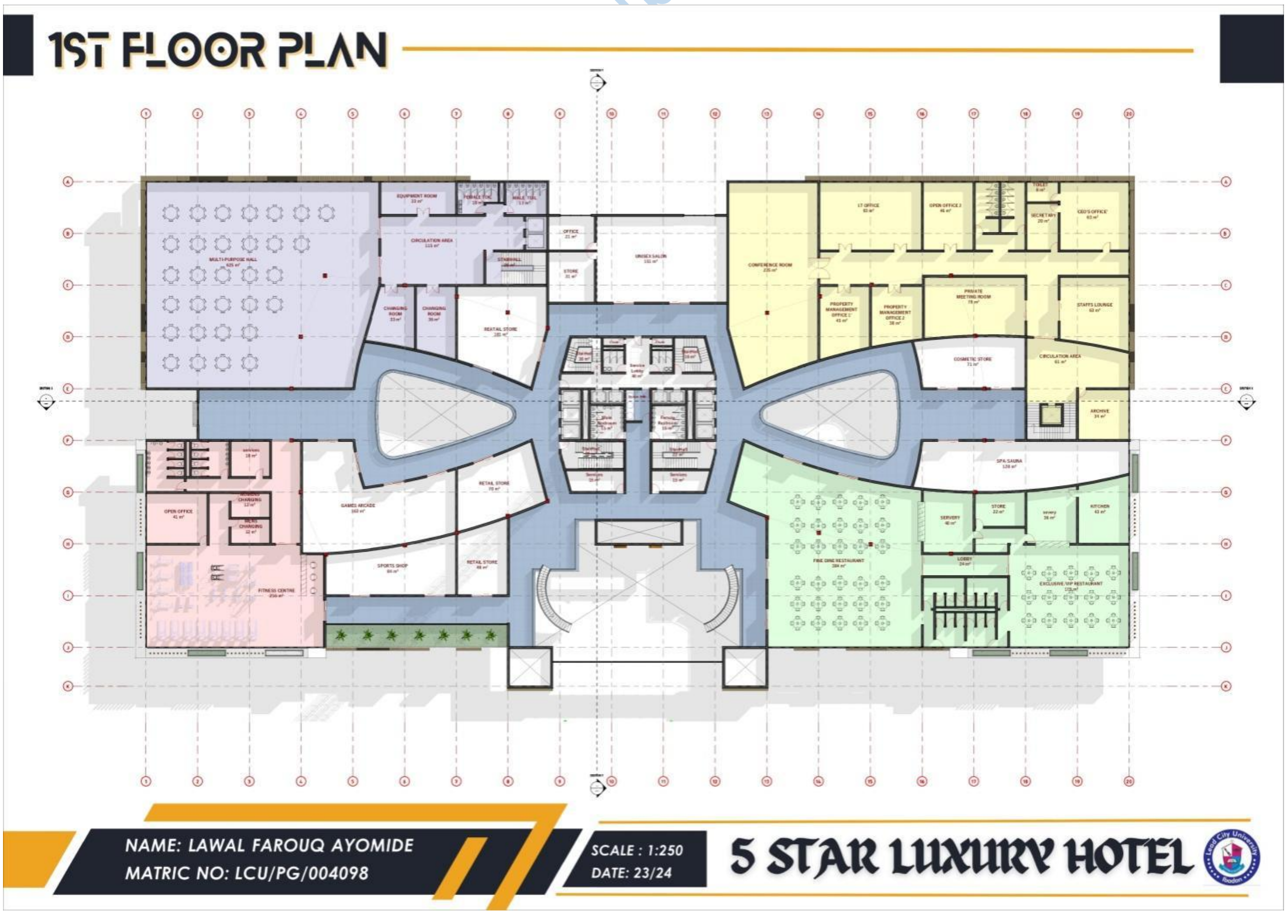
MATRIC NO: LCU/PG/004098
SCALE : 1:250
DATE: 23/24
5 STAR LUXURY HOTEL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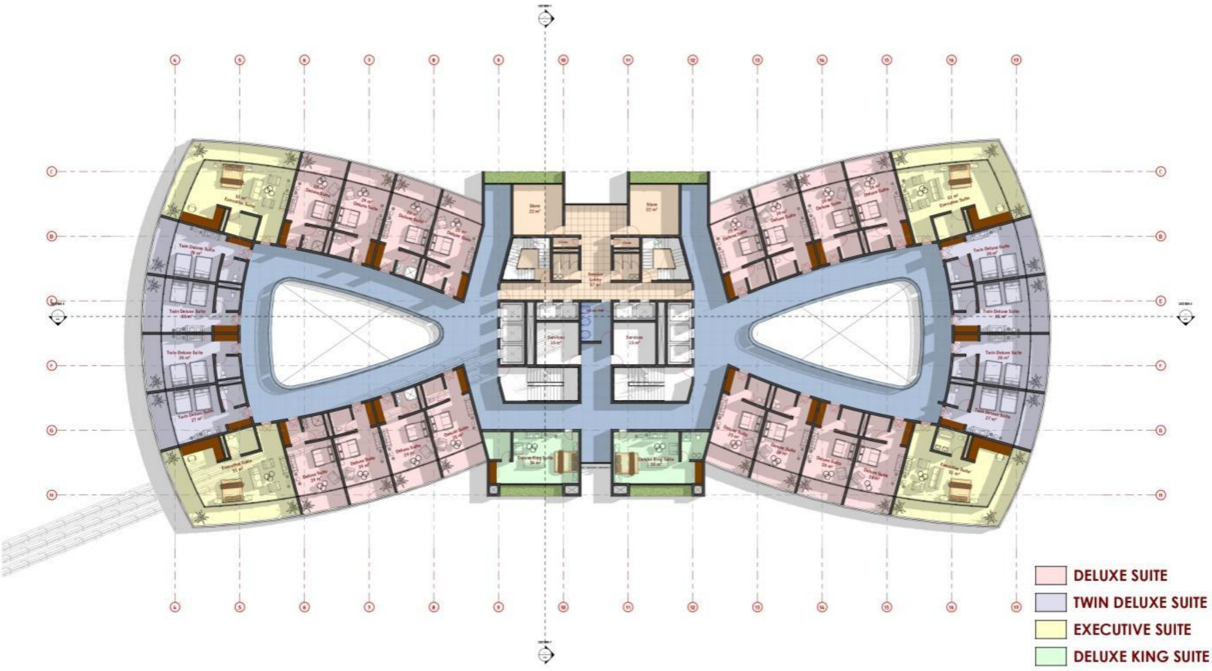
DATE: 23/24
5 STAR LUXURY HOTEL

TYPICAL 3RD TO 11TH FLOOR PLAN



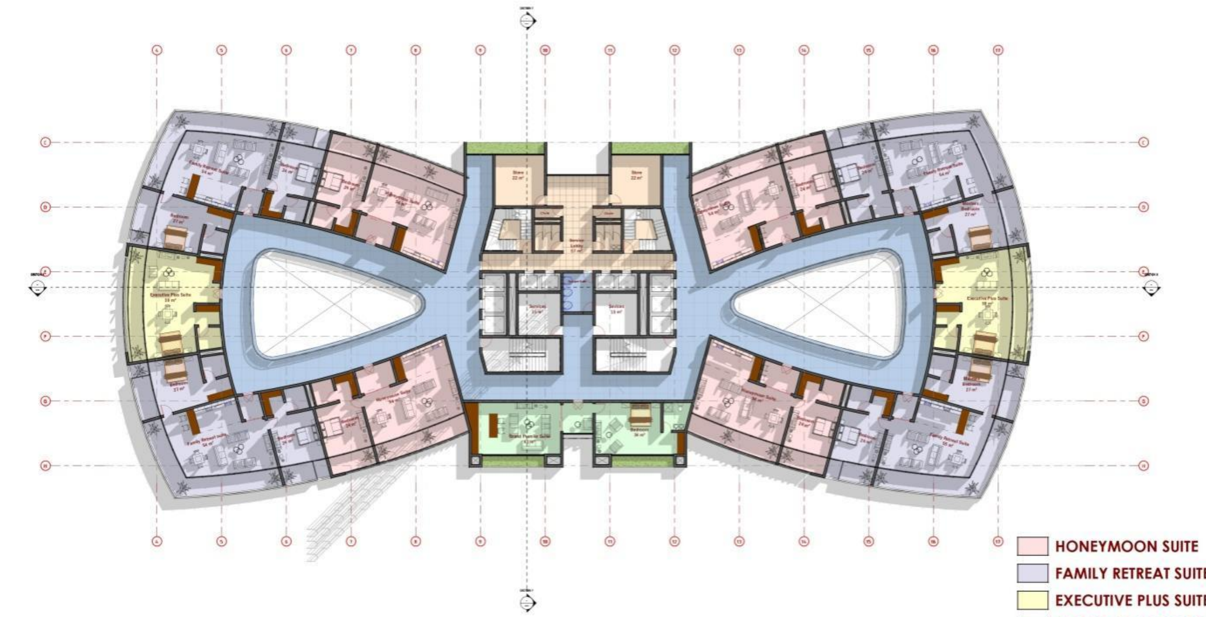
- DELUXE SUITE
- TWIN DELUXE SUITE
- EXECUTIVE SUITE
- DELUXE KING SUITE
- SERVICE MOVEMENT

NAME: LAWAL FAROUQ AYOMIDE
MATRIC NO: LCU/PG/004098

SCALE : 1:200
DATE: 23/24

5 STAR LUXURY HOTEL

TYPICAL 13TH TO 19TH FLOOR PLAN



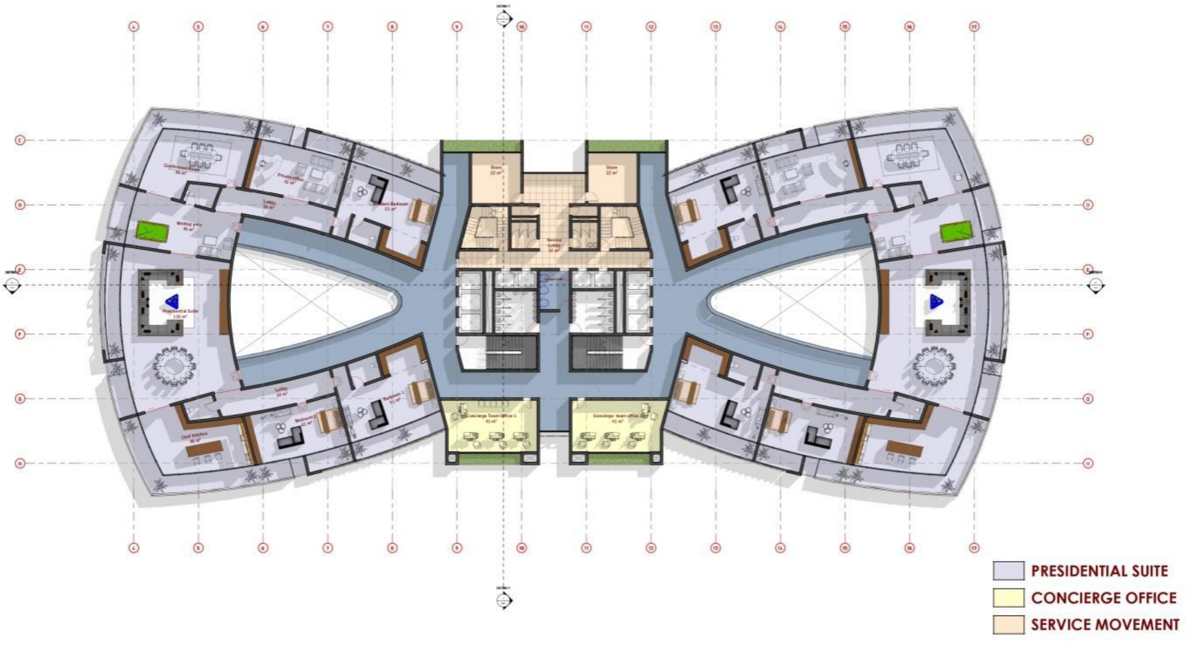
- HONEYMOON SUITE
- FAMILY RETREAT SUITE
- EXECUTIVE PLUS SUITE
- GRAND PREMIERE SUITE
- SERVICE MOVEMENT

NAME: LAWAL FAROUQ AYOMIDE
MATRIC NO: LCU/PG/004098

SCALE : 1:200
DATE: 23/24

5 STAR LUXURY HOTEL

20TH FLOOR PLAN

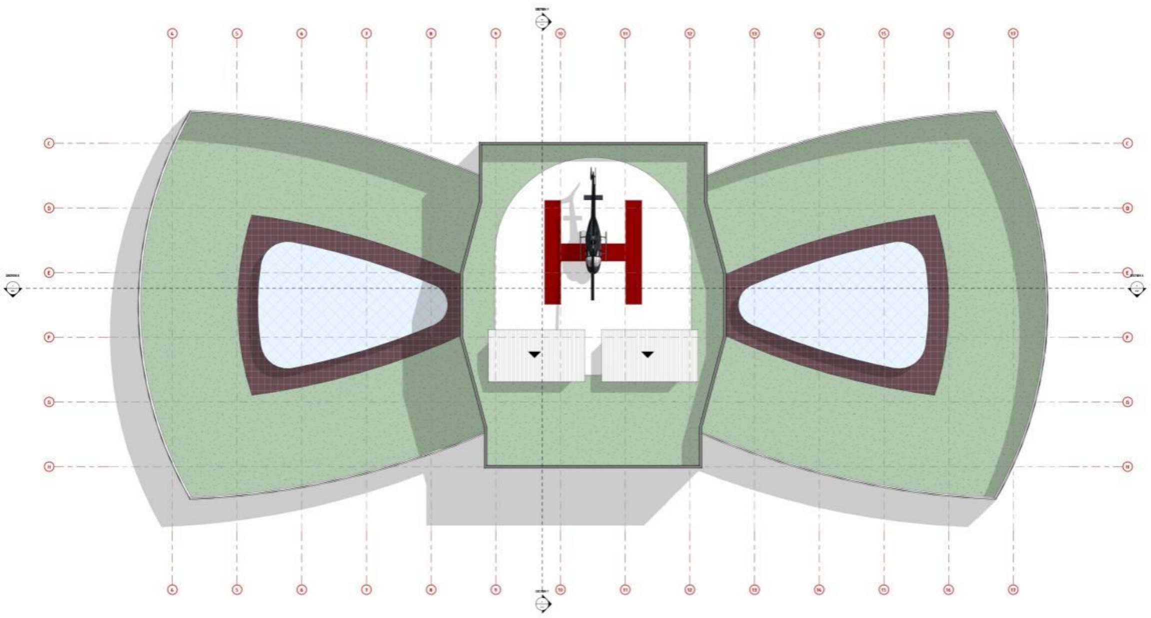


NAME: LAWAL FAROUQ AYOMIDE
MATRIC NO: LCU/PG/004098

SCALE : 1:200
DATE: 23/24

5 STAR LUXURY HOTEL

ROOF PLAN



NAME: LAWAL FAROUQ AYOMIDE
MATRIC NO: LCU/PG/004098

SCALE : 1:200
DATE: 23/24

5 STAR LUXURY HOTEL

3D VIEWS

APPROACH VIEW

BIRDS EYE VIEW

3D VIEW

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DATE: 23/24

5 STAR LUXURY HOTEL

3D VIEWS

AERIAL VIEW OF DANGOTE HOTELS

3D VIEW

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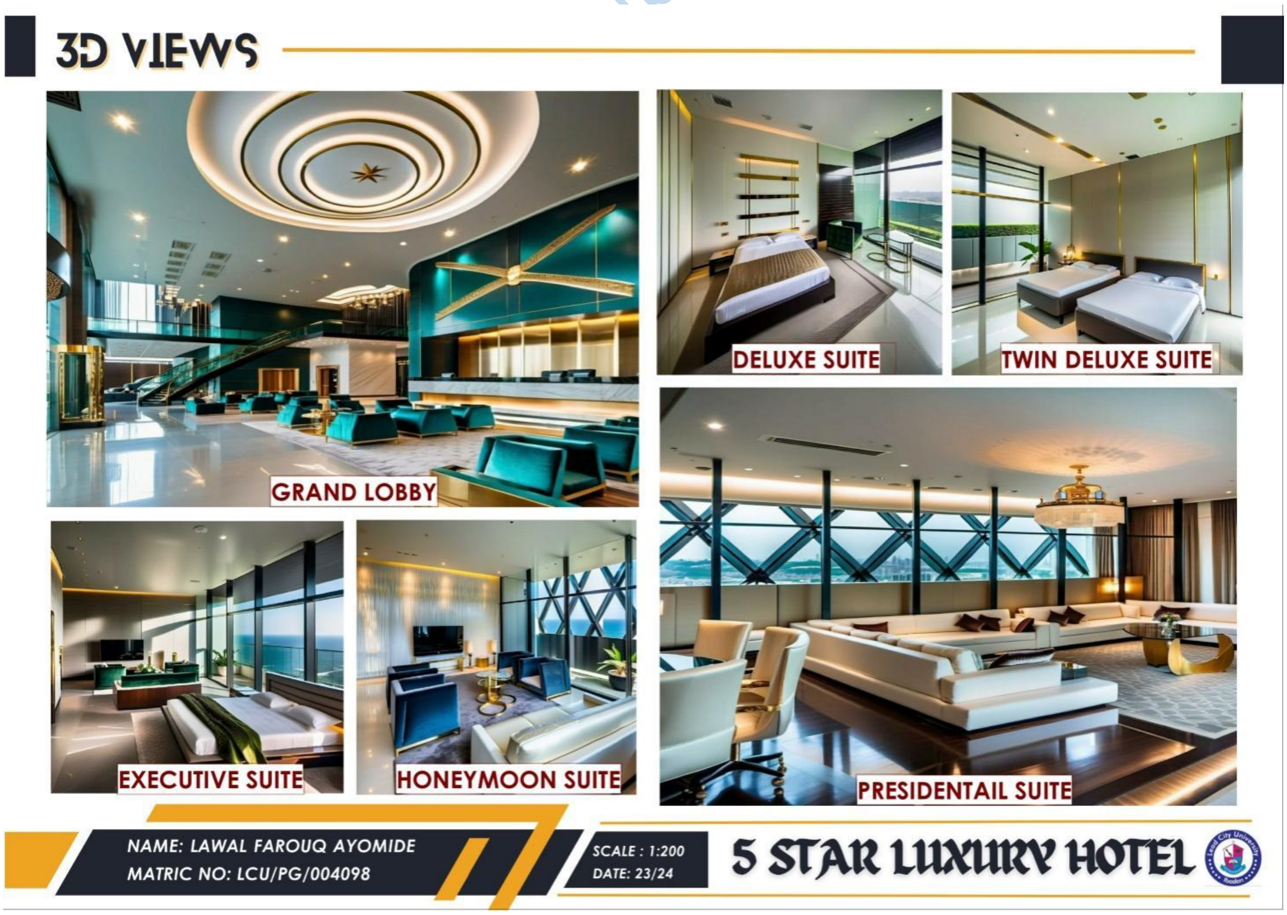
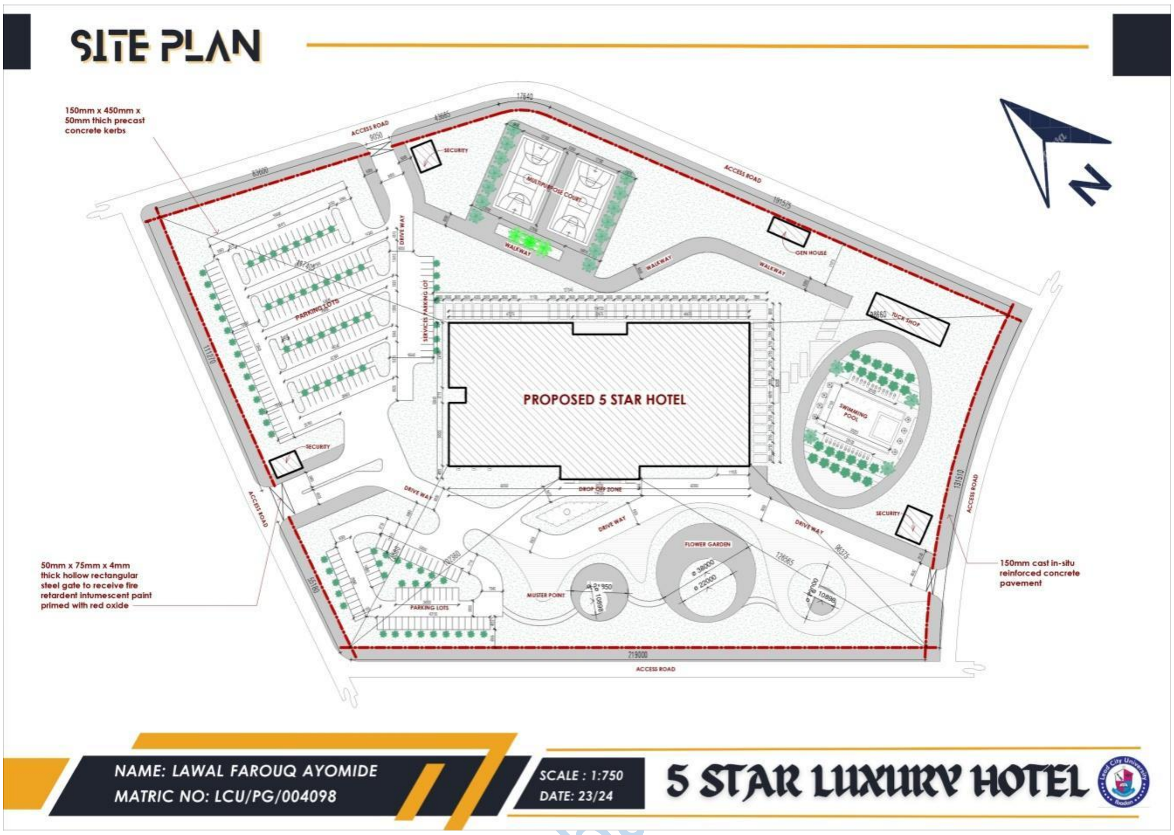
SCALE : 1:200
DATE: 23/24

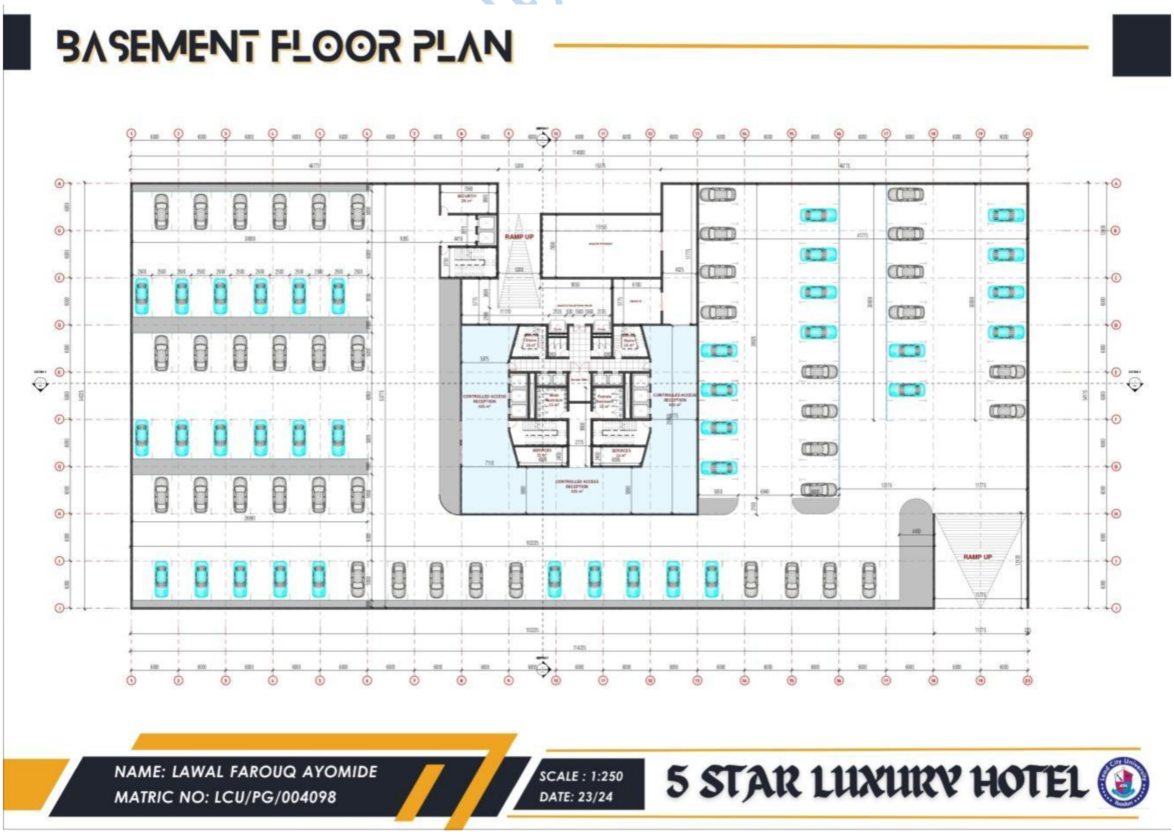
5 STAR LUXURY HOTEL


3D VIEWS
MAIN SWIMMING POOL AREA
INFINITY POOL / LOUNGE AREA
VIEW OF ROOF GARDEN
NAME: LAWAL FAROUQ AYOMIDE
MATRIC NO: LCU/PG/004098
SCALE : 1:200
DATE: 23/24
5 STAR LUXURY HOTEL

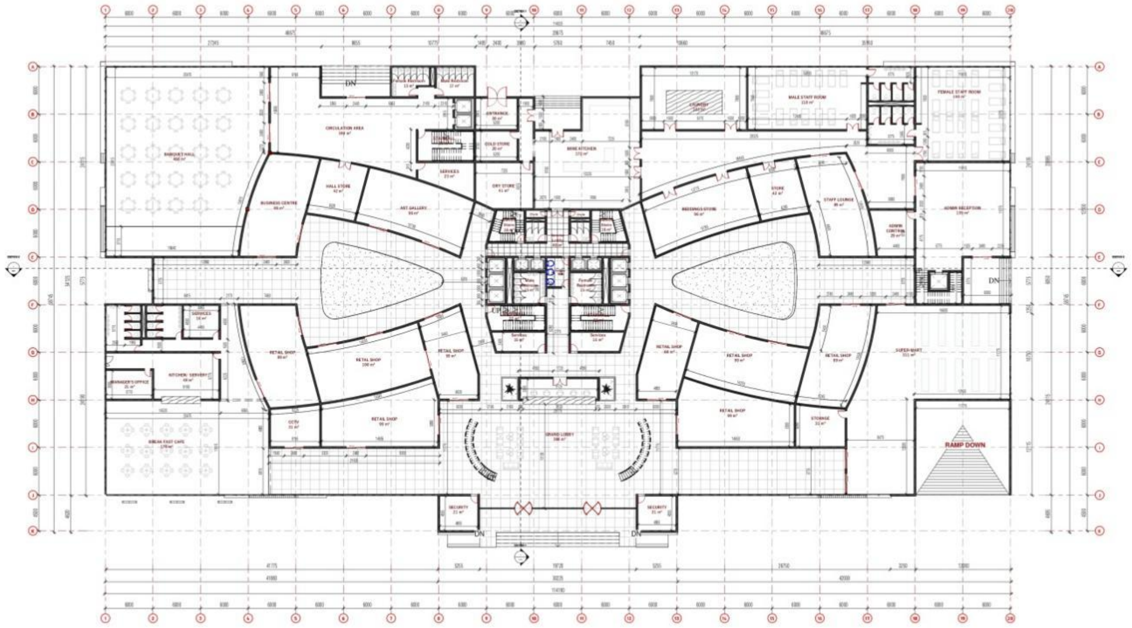

3D VIEWS
DELUXE SUITE
TWIN DELUXE SUITE
GRAND LOBBY
EXECUTIVE SUITE
HONEYMOON SUITE
PRESIDENTAIL SUITE
NAME: LAWAL FAROUQ AYOMIDE
MATRIC NO: LCU/PG/004098
SCALE : 1:200
DATE: 23/24
5 STAR LUXURY HOTEL

Appendices – Appendix 2 – Working Drawings





GROUND FLOOR PLAN



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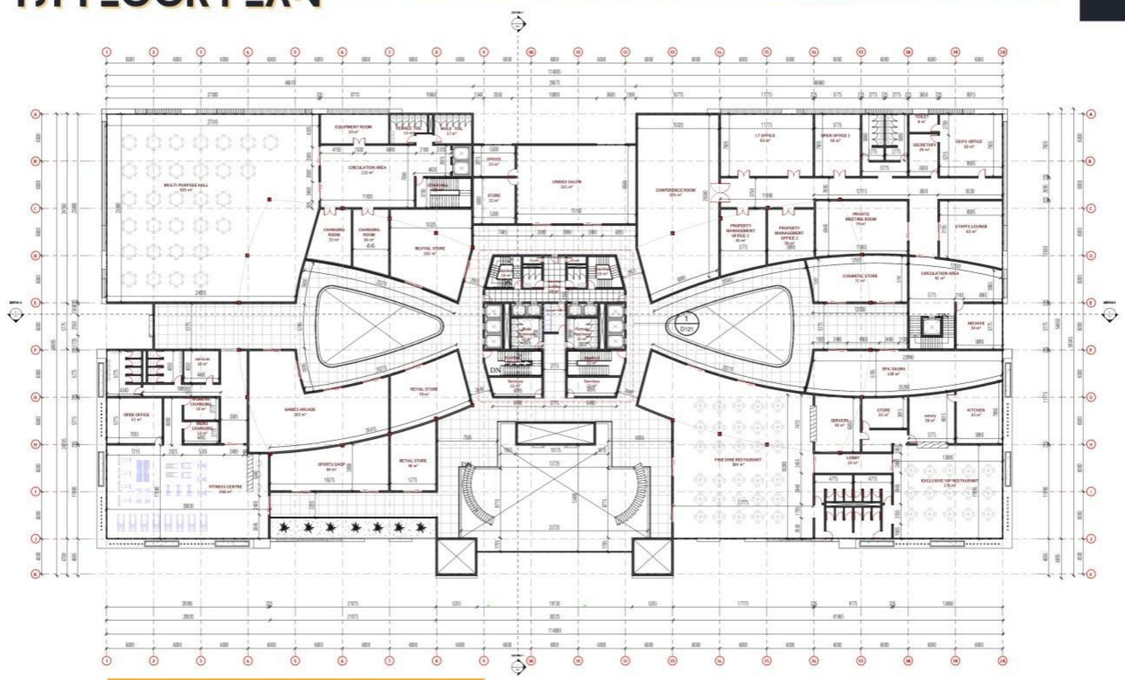
MATRIC NO: LCU/PG/004098

SCALE : 1:250
DATE: 23/24

5 STAR LUXURY HOTEL

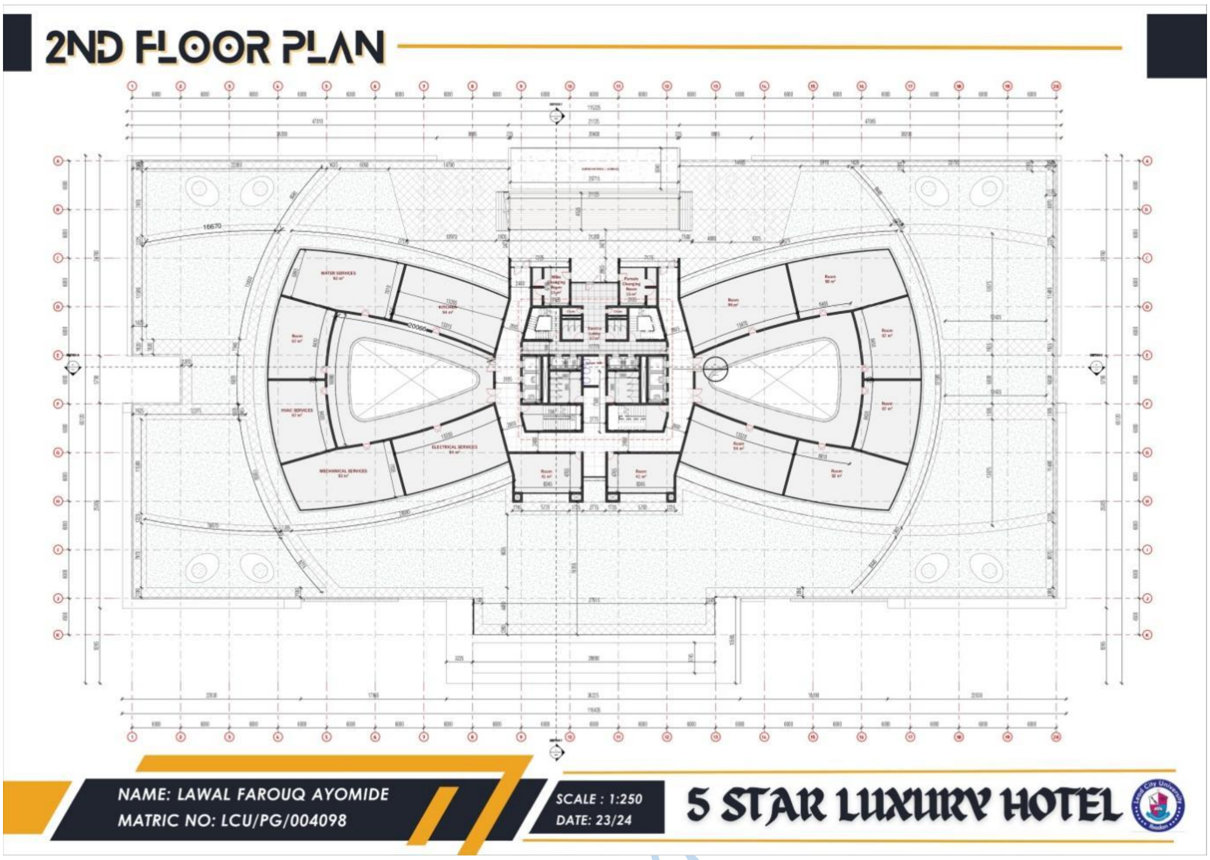
1ST FLOOR PLAN



NAME: LAWAL FAROUQ AYOMIDE
MATRIC NO: LCU/PG/004098

SCALE : 1:250
DATE: 23/24

5 STAR LUXURY HOTEL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SCALE : 1:250
DATE: 23/24
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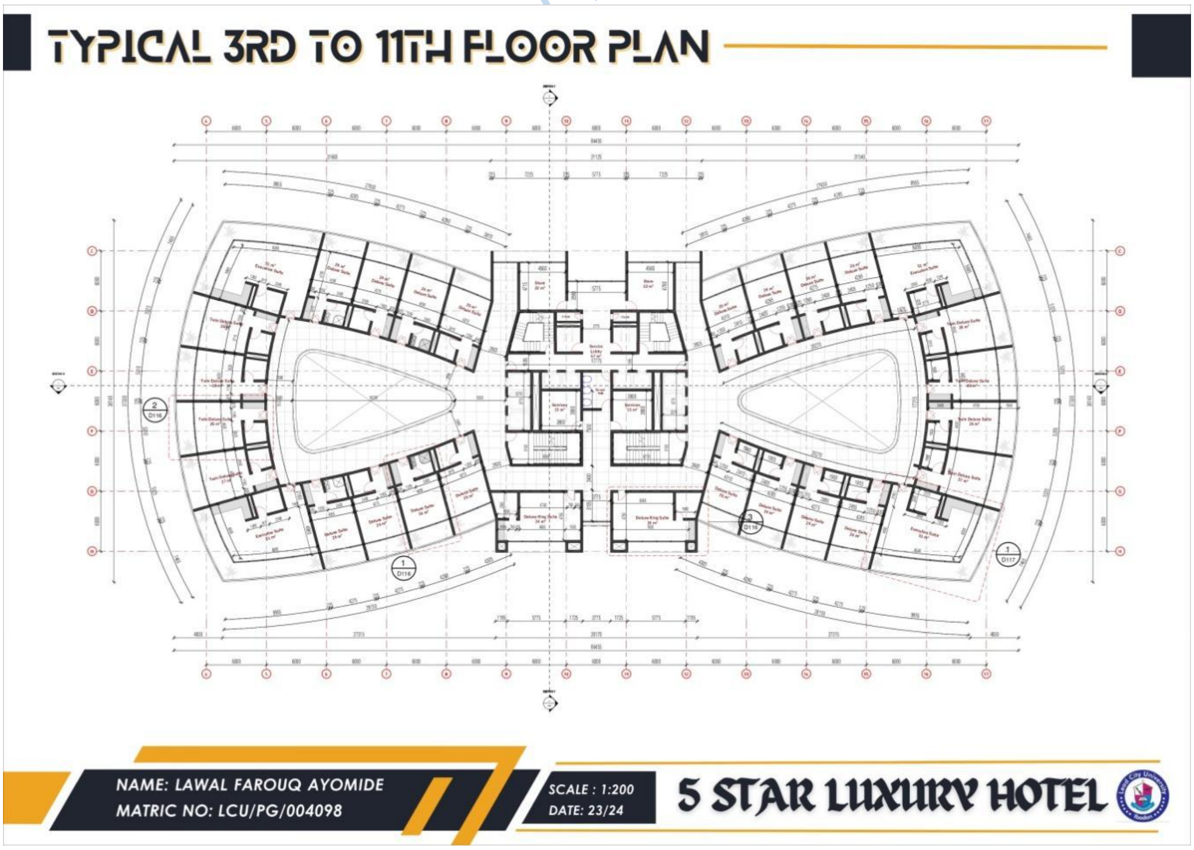
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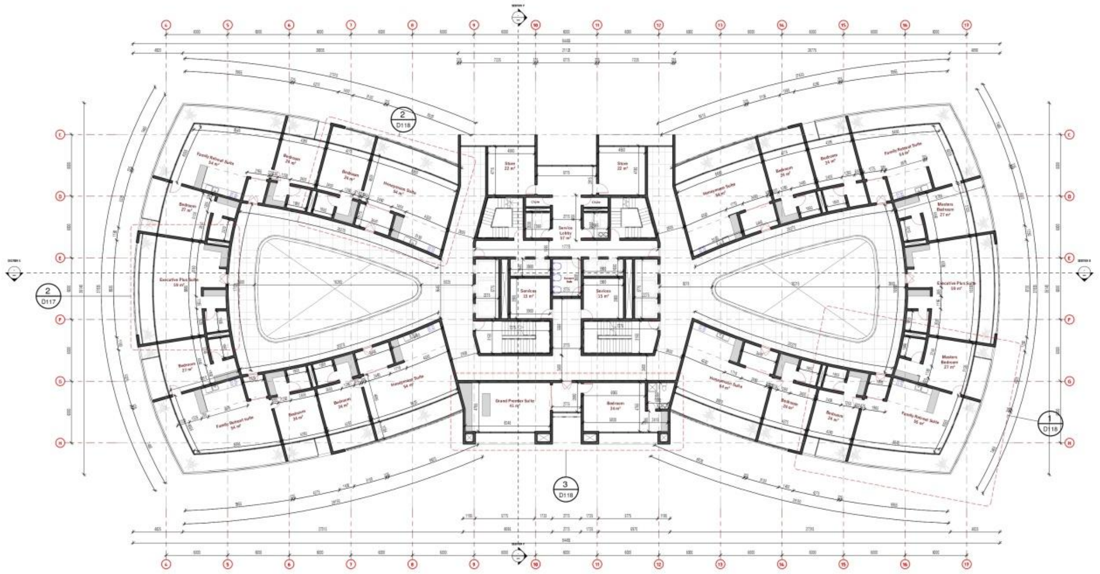
SCALE : 1:200
DATE: 23/24
5 STAR LUXURY HOTEL

TYPICAL 13TH TO 19TH FLOOR PLAN



NAME: LAWAL FAROUQ AYOMIDE
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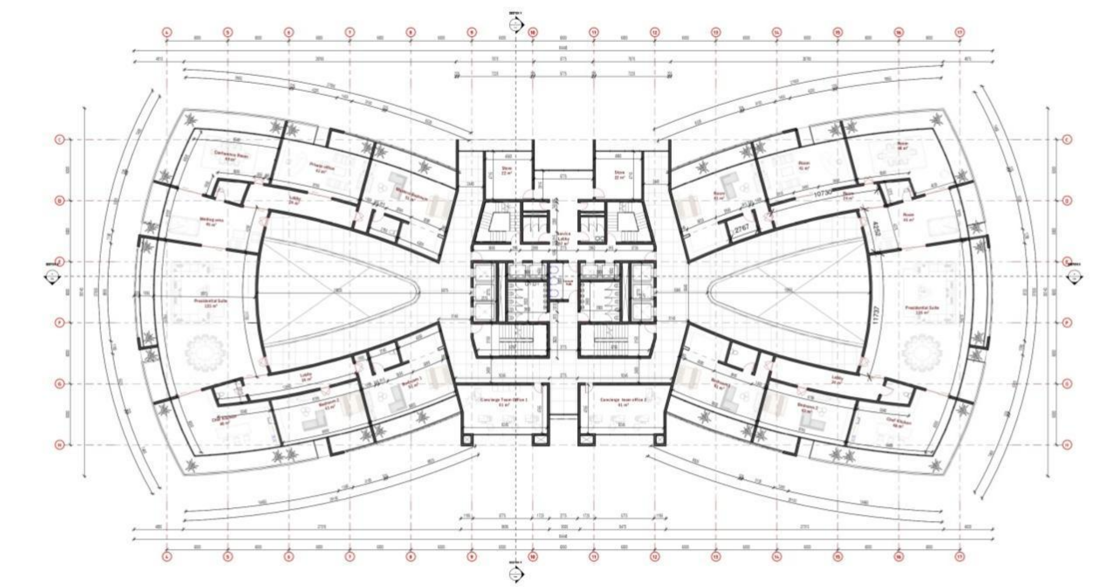
20TH FLOOR PLAN



20th Floor Level Copy 1

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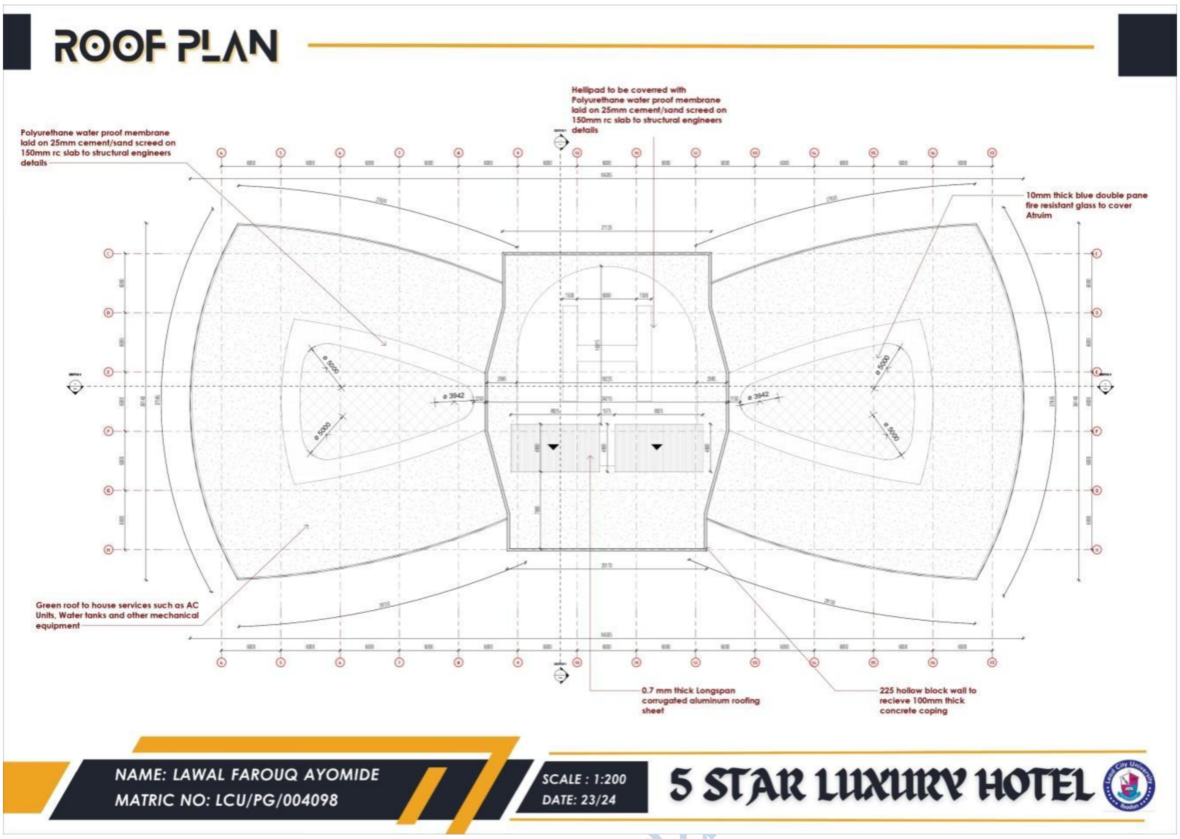
ROOF PLAN
Hellipad to be coverred with Polyurethane water proof membrane laid on 25mm cement/sand screed on 150mm rc slab to structural engineers details
Polyurethane water proof membrane laid on 25mm cement/sand screed on 150mm rc slab to structural engineers details
10mm thick blue double pane fire resistant glass to cover Atruim
Green roof to house services such as AC Units, Water tanks and other mechanical equipment
0.7 mm thick Longspan corrugated aluminum roofing sheet
225 hollow block wall to recieve 100mm thick concrete coping
NAME: LAWAL FAROUQ AYOMIDE
MATRIC NO: LCU/PG/004098
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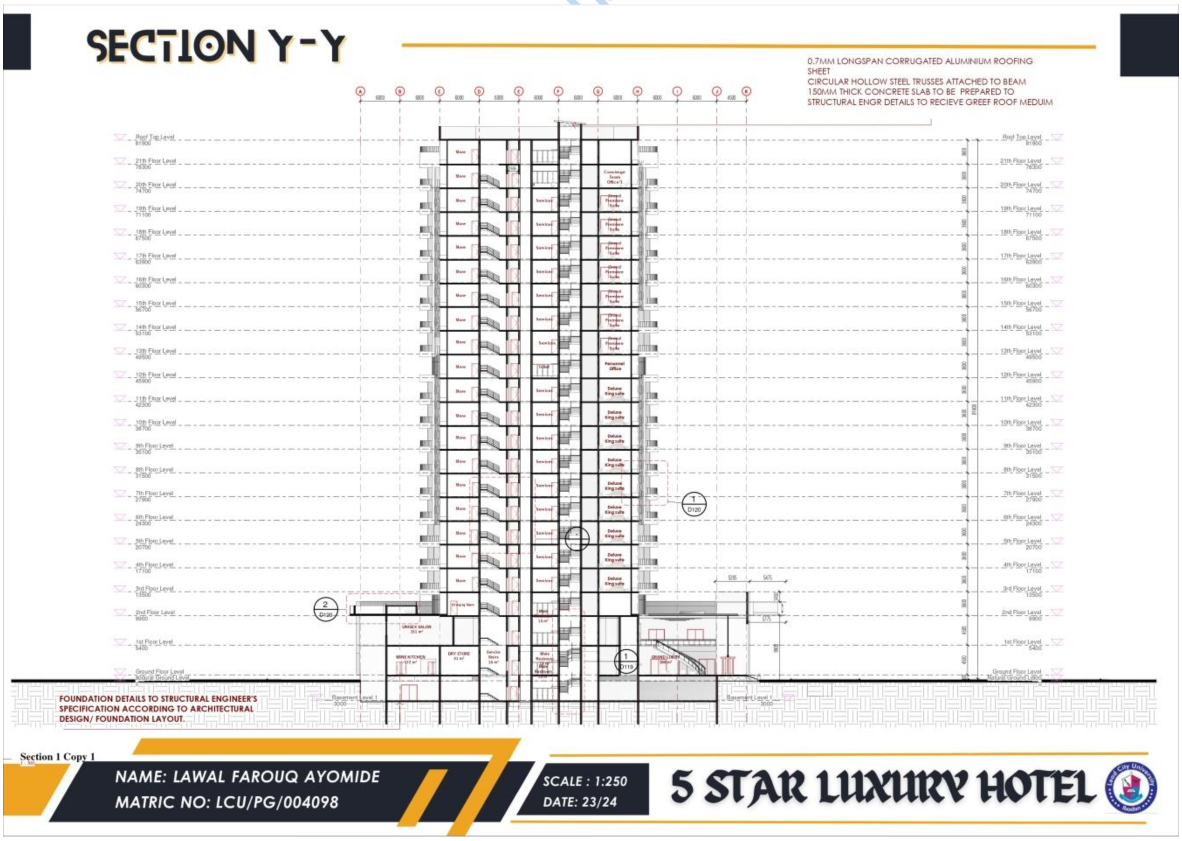
DATE: 23/24
5 STAR LUXURY HOTEL


SECTION Y-Y
0.7MM LONGSPAN CORRUGATED ALUMINIUM ROOFING SHEET
CIRCULAR HOLLOW STEEL TRUSSES ATTACHED TO BEAM
150MM THICK CONCRETE SLAB TO BE PREPARED TO STRUCTURAL ENGR DETAILS TO RECIEVE GREEF ROOF MEDUIM
FOUNDATION DETAILS TO STRUCTURAL ENGINEER'S SPECIFICATION ACCORDING TO ARCHITECTURAL DESIGN/ FOUNDATION LAYOUT.
Section 1 Copy 1
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MATRIC NO: LCU/PG/004098
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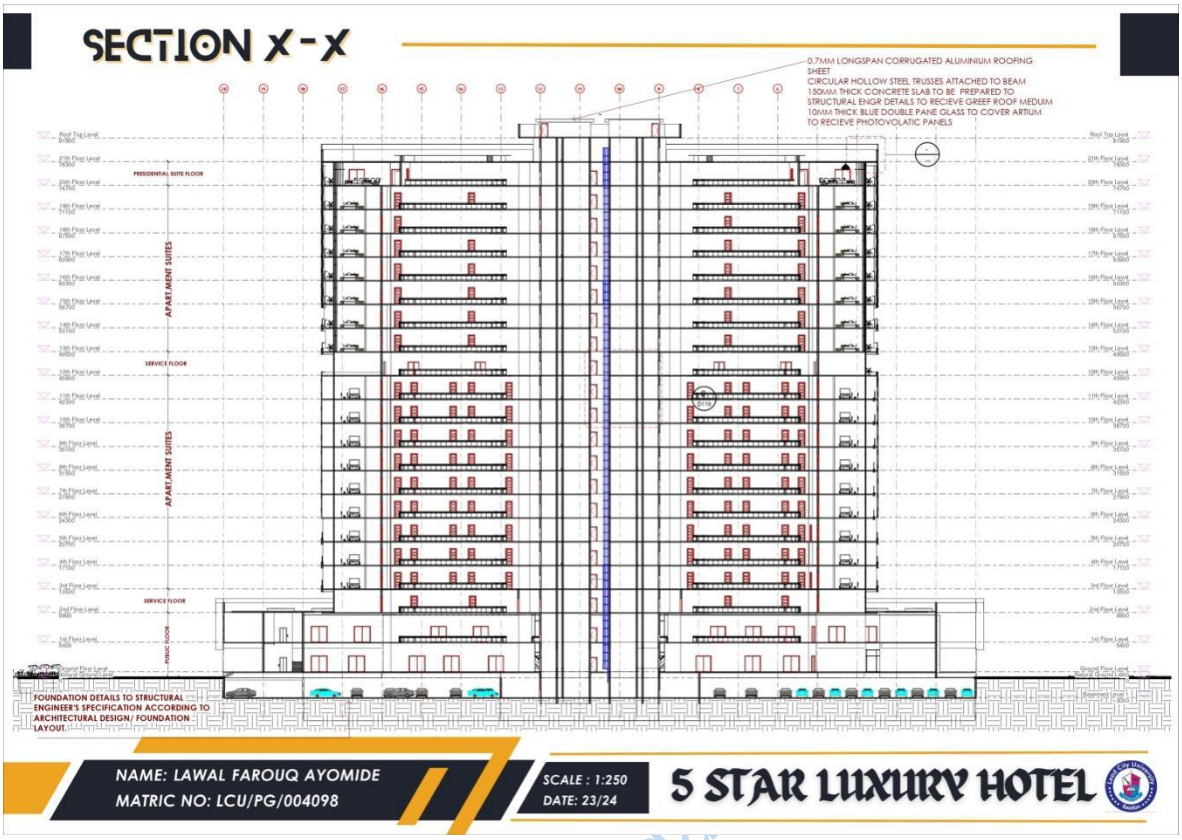
DATE: 23/24
5 STAR LUXURY HOTEL


SECTION X-X
0.7MM LONGSPAN CORRUGATED ALUMINIUM ROOFING SHEET
CIRCULAR HOLLOW STEEL TRUSSES ATTACHED TO BEAM
150MM THICK CONCRETE SLAB TO BE PREPARED TO STRUCTURAL ENGR DETAILS TO RECIEVE GREEF ROOF MEDUIM
10MM THICK BLUE DOUBLE PANE GLASS TO COVER ARTIUM TO RECIEVE PHOTOVOLATIC PANELS
PRESIDENTIAL SUITE FLOOR
APART MENT SUITES
SERVICE FLOOR
APART MENT SUITES
SERVICE FLOOR
PUBLIC FLOOR
FOUNDATION DETAILS TO STRUCTURAL ENGINEER'S SPECIFICATION ACCORDING TO ARCHITECTURAL DESIGN/ FOUNDATION LAYOUT.
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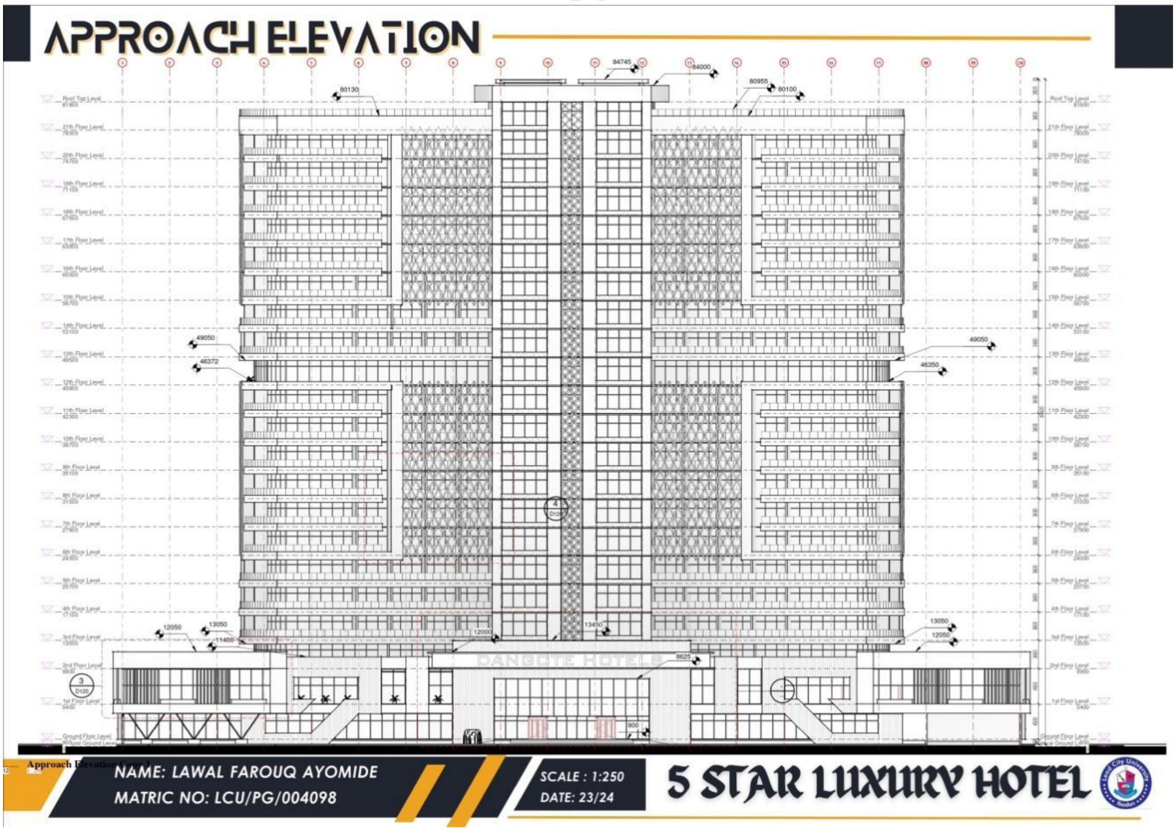
APPROACH ELEVATION
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MATRIC NO: LCU/PG/004098
SCALE : 1:250
DATE: 23/24
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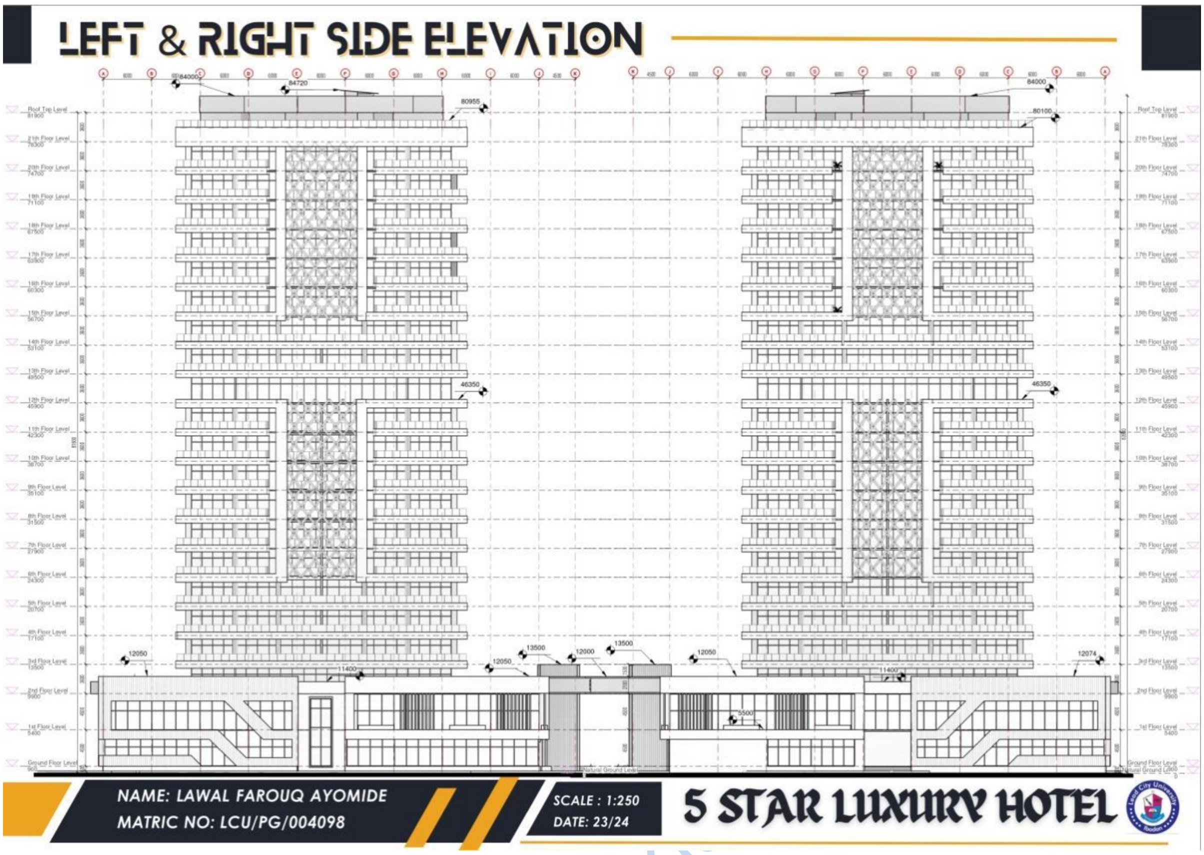
LEFT & RIGHT SIDE ELEVATION
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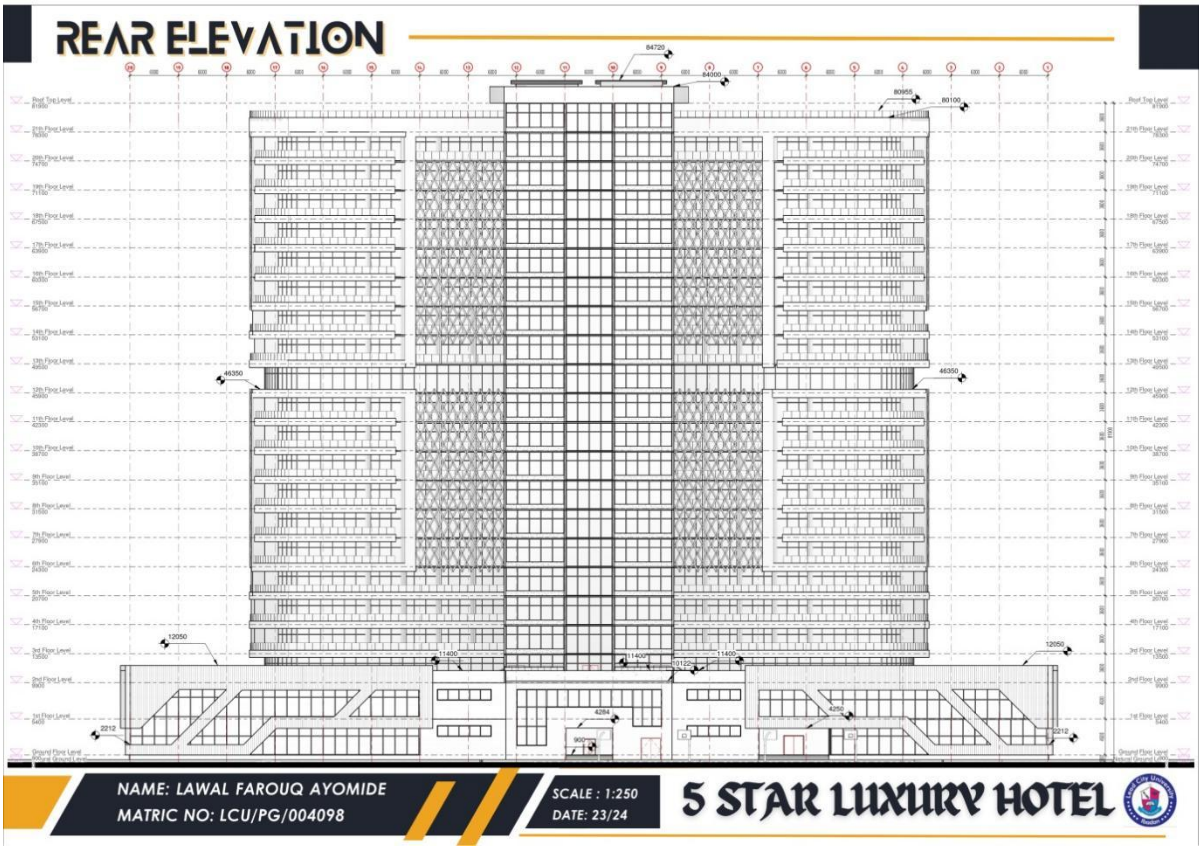
SCALE : 1:250
DATE: 23/24
5 STAR LUXURY HOTEL


REAR ELEVATION
NAME: LAWAL FAROUQ AYOMIDE
MATRIC NO: LCU/PG/004098
SCALE : 1:250
DATE: 23/24
5 STAR LUXURY HOTEL

Bio Data

A. Personal Data:

1. Full Name:	**LAWAL, Farouq Ayomide**
2. Address:	Lagos, Nigeria
3. Email Address:	Farouqlawal7@gmail.com
4. Phone Number:	08147393933
5. Date of Birth:	7th July,1999
6. Place of Birth:	Lagos, Nigeria
7. Nationality:	Nigerian
8. Marital Status:	Single
9. Name and Address of Next of Kin:	Lawal Fawaz Ayodeji, Lagos

B. Educational Background

1. Educational Institutions Attended with Dates and Qualification:

Qualifications	Institution	Date
MSc Architecture	Lead City University, Ibadan, Oyo State.	2022 - Ongoing
BSc Architecture	University of Ilorin, Ilorin, Kwara State.	2015 – 2021
Secondary School Leaving Certificate	Ansar-ud-deen College Isolo, Lagos State	2011 - 2014
Primary School Leaving Certificate	Dawah International Nursery and Primary School, Lagos State.	2002 -2008

C. Awards and Fellowships:

D. Work Experience

1. Stalwarts Architects (Design Architect): January 2023 – Till Date

2. LABSCA (Corper Architect): October 2021 – October 2022

3. ICE Projects (Junior Architect): July 2021 - September 2021

E. Publication –

…………………………..   ……………………………

Signature   Date

The University Compliance Certification

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…………………………..   ………………………….

Signature   Date

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