Green Mixed Use Tower for Urage Real Estate Limited, Glova Road, Old Ikoyi, Lagos, Nigeria.
(Design Strategies to Achieve Green Architecture in High Rise Buildings)

Adebusola Oluwaseyi AWOYEMI
LCU/PG/005067

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 fulfilment of the Requirements for the Award of Master Degree (MSc) in Architecture

2024

Certification

This is to certify that Adebusola Oluwaseyi AWOYEMI, with matriculation number LG/PG/005067 carried out this research work titled 'Design Strategies To Achieve Green Architecture In High Rise Buildings' 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.

………………………………… …………………………………

Arc. Adedeji Afolabi **Date**

(Supervisor)

…………………………………

…………………………....

Dr. Oludare Obaleye **Date**

(Head of Department)

Dedication

This research is dedicated to God Almighty.

Acknowledgement

I am grateful to Lead City University (LCU) for providing this amazing opportunity and supportive environment for my research, as well as for the use of their library in the process of gathering my data. I truly value the Post Graduate academics and administrative staff.
My appreciation is extended to the Head of Department of Architecture, Arc. Dr. Oludare Obaleye, for the opportunity to do research in this unique field with the topic, 'Design Strategies To Achieve Green Architecture In High Rise Buildings' and my thesis supervisor, Arc. Afolabi Adedeji, for the guidance received throughout this process; other lecturers like Dr. Ayanleke Babalola, Arc. Demola Adeola, who have contributed great knowledge to this work.
I place on record, my sincere thank you to all other lecturer of the Department Of Architecture, Lead City University, Ibadan, Oyo State, Nigeria for their encouragement.

I also thank my husband Mr. Awoyemi Olaoluwa and our baby, Awoyemi Michelle Omomure, and my friends for their unceasing encouragement and support.

Even though the above-mentioned institutions and persons have assisted in the process of this research work, I alone stand responsible for the errors, if any, found in the work.

Abstract

Green architecture, otherwise known as green design or sustainable architecture, is an approach to building that prioritizes reducing negative impacts on the environment and promoting the health of individuals. Architects in the modern world are increasingly seeking solutions that not only provide a desirable living environment for humans, but also minimize harm to the planet. By utilizing the harmonious order present in nature as a design model, architects implement strategies and technologies that support sustainable architecture. Thus, this study aims to explore and assess design strategies to achieve strategies to achieve green architecture in high rise buildings within Nigeria. Employing a case study approach, four cases were examined, consisting of one local mixed use building and three international. These case studies were evaluated based on design strategies identified from empirical studies in the literature review, which includes; energy efficiency in building design, sustainable materials, biodiversity and green spaces and indoor environmental quality. By incorporating these design strategies to achieve green architecture in high rise buildings mitigate the environmental impact. Making use of these guidelines by construction stakeholders like architects, engineers, and others involved in designing and constructing mixed use tower buildings in Nigeria can effectively conserve energy resources, reduce carbon footprint, and enormously contribute to the goal of green architecture.

Keywords:

Biodiversity and Green Spaces, Energy Efficiency, Environmental quality, Environmental Sustainability, Green Architecture, Mixed Use, Sustainable Materials.

Word Count: 210

Table of Contents

Contents

Page

List of Table

Table	Title	Page

List of Figures

Figure **Title**

Page

List of Plates

Chapter One

Introduction

1.1 Background of the Study

Green architecture, sometimes referred to as sustainable architecture or green design, is a method of constructing that places an emphasis on minimizing adverse effects on the environment and enhancing human health. These days, more and more architects are looking for ways to limit environmental damage while also creating a pleasant living environment for people. Architects employ technology and practices that assist sustainable architecture by drawing inspiration from the harmonic order found in nature.

This strategy also emphasizes the use of non-toxic materials, waste management, and energy efficiency. In order to reduce its negative effects on the environment, green architecture also promotes the use of recycled and reused materials and water conservation. By preserving natural resources for the long term, green architecture seeks to strike a balance between the requirements of the present and those of future generations. Green architecture seeks to design structures that are both environmentally and economically sustainable by fusing conventional architectural principles with cutting-edge technology. (Romouzy & Elfatah, 2023).

It is also known as "sustainable architecture". This design approach seeks to integrate with the surrounding natural environment while minimizing adverse effects on the environment. It takes into account social, economic, and environmental sustainability, green architecture is essential to the transition to sustainable development. Additionally, promoting a thorough understanding of sustainable design concepts and practices requires the incorporation of sustainability within architectural education.

1.2 Statement of the Research Problem

In the face of escalating environmental concerns, rapid urbanization, and the need for resilient and inclusive urban spaces, the conventional approach to architecture and urban planning has come under scrutiny. The current paradigm often emphasizes resource-intensive construction methods, energy-inefficient buildings, and lacks a holistic integration of sustainable practices. As a result, cities are grappling with escalating carbon footprints, loss of biodiversity, and the social inequities associated with urban development.

1.3 Aim and Objectives.

AIM:

The aim of the study is to investigate design strategies to achieve green building in high rise building to achieve good environmental performance.

OBJECTIVES:

1. To investigate design strategies to achieve green building in high rise building focus on sustainability, energy efficiency, and overall environmental performance.
2. To evaluate the effectiveness of green building in high rise building
3. To develop design recommendations in order to achieve green building in high rise building focusing on sustainability, energy efficiency, and overall environmental performance.

1.4 Research Questions/ Research Hypothesis

1. What impact does green building in high rise building currently have on the environment?
2. What are the design strategies that can be adopted to achieve green architecture in high rise?

3. Wat are the challenges in adopting strategies to achieve green architecture in high rise building?

1.5 Significance of the Study

The study of green architecture holds significant potential to transform the built environment by addressing critical issues such as:

i. Environmental sustainability, energy efficiency, and human well-being. Synthesizing findings from various research studies is crucial for a comprehensive understanding of the significance of studying green architecture

ii. The role of green decoration materials in promoting energy conservation and environmental protection, stressing the importance of studying the impact of Industry on these materials and their application in public architectural engineering

iii. Bridging the gap in knowledge and practice, promoting the adoption of green architecture principles globally, particularly in developing countries.

1.6 The Scope of the Study

This thesis in terms of scope is limited to the study of green architecture focusing on specific research questions and objectives like energy efficiency in building design, renewable energy integration, sustainable materials and construction practices, biodiversity and green spaces, waste reduction and recycling, indoor environmental quality.

Green architecture is a dynamic and evolving field, and a comprehensive study that can contribute valuable insights to the ongoing efforts to create sustainable, environmentally friendly built environments.

1.7 Limitation of the Study

One of the major limitation of the study is not having access to full details of some of the case studies. Some of the case studies are not accessible during visit because of security and privacy, and their detailed information can't be gotten on the internet.

1.8 Operational Definition of Terms

1. Energy-Efficient: Energy efficiency simply means using less energy to perform the same task
2. Eco-friendly building : designed to have little or no damaging effect on the environment
3. Water conservation: Water conservation is the practice of using water efficiently to reduce unnecessary water usage
4. Environmental impact: An environmental impact is defined as any change to the environment, whether adverse or beneficial, resulting from a facility's activities, products, or services
5. Technology: the application of scientific knowledge for practical purposes
6. Eco-friendly: designed to have little or no damaging effect on the environment
7. Green buildings: A green or sustainable building is a building that, because of its construction and features, can maintain or improve the quality of life of the environment in which it is located.
8. Sustainability: sustainability refers to the ability to maintain or support a process continuously over time.
9. Thermal comfort: it is defined as a person's neutral feeling in relation to a given thermal environment, without sweating.

Chapter Two

Literature Review

2.3 Conceptual Review

2.1.1 Green architecture

A network of natural and semi-natural regions that offer crucial ecosystem services, such as relaxation, climate management, and air and water purification, is referred to as "green infrastructure." Through the integration of green infrastructure into tall structures, Working with enhancing citizen living standards and bolstering global efforts to slow down climate change, cities can improve their ecological resilience (Milosevic. *et al.,* 2023).

The adoption of green architecture in high-rise buildings is crucial for sustainable urban development (Yuan, 2023).

Green structures, often referred to as sustainable buildings, emphasize ecologically friendly procedures at every stage of the building's existence, from design to destruction. High-rise structures are criticized for using a lot of energy, but they also have advantages like mixed-use features and effective land use, which makes them sustainable in the context of recent developments in environmental systems. Elevated livability, less environmental impact, and energy savings can result from high-rise building incorporating green technology, materials, and design concepts. In order to save costs and guarantee environmental compatibility, high-rise green buildings will need to rely on technology breakthroughs, research, education, and cooperation amongst several stakeholders. (Yuan, 2023)

2.1.2 Energy Efficiency In Building Design:

Due to a lack of available land, rising urbanization and population density have made high-rise building construction more necessary. A lot of work has gone into designing or retrofitting high-rises in a sustainable and energy-efficient manner to lessen their substantial environmental implications. A great deal of research has been done on how to lower the energy consumption or carbon emissions of high-rise buildings (Fatemeh_M. et al., 2020).

Considering the building industry generates 40% of global energy consumption and approximately 30 percent of greenhouse gas emissions, it has a substantial impact on the environment (Gan *et al*., 2019).

In recent decades, there has been an increased necessity to construct High-Rise Buildings (HRB) due to the rapid development of the metropolitan population. Various nations or areas have varying definitions of high-rises, or tall structures, depending on the number of floors or meters they include.

2.1.2.1 Factors Influencing the Energy Efficiency of High-Rise Buildings

Factors influencing the energy efficiency of high-rise buildings include building characteristics like standard floor area, floor height, and window-to-wall ratio (Xiangning Li *et al.,* 2023). Strategies such as building orientation, envelope design, and renewable energy use play crucial roles in reducing energy consumption in high-rise office buildings (Ezema *et al*., 2022). Energy-efficient methods like modern insulation materials and green building technologies contribute significantly to enhancing energy efficiency in buildings (Sheina *et al*., 2022). Window parameters, opaque materials, and shading elements impact overall building energy performance, with effective combinations leading to reduced cooling loads and energy consumption (Siti, *et al*., 2022). Geometrical shape also affects energy consumption in high-rise buildings, with circular shapes proving most suitable in certain climatic regions, emphasizing the importance of design factors in energy efficiency (Mohanad *et al*., 2022).

1. Architectural Factor

These are the components related to the building's design. These components include building envelopes, shape, height, spatial linkages, and construction purposes (figure 2.0). Building type influences energy consumption instantly by determining the variety of occupants (Mohammad *et al*., 2023).

An important component affecting high-rise buildings' energy efficiency is their architecture. Crucial roles are played by elements including window specifications, building characteristic factors, design priorities, and solar energy system integration (Szdgmfpe *et al.,* 2013).

Research shows that factors including floor height, window-to-wall ratio, and standard floor space affect the overall amount of energy used per unit area (Ezema *et al*., 2022).

High-rise buildings can save a significant amount of energy by including energy-efficient design components like window glazing, shading elements, and opaque materials (Krivenko et *al*., 2022).

Furthermore, maximizing energy efficiency in high-rise structures requires the integration of solar energy systems; nevertheless, issues like solar energy variability must be resolved (Ezema et al., 2022).

The design process for tall buildings should focus on active and passive energy conservation approaches, considering technological innovations and climate-responsive design to enhance energy efficiency. Overall, a holistic approach to architectural design, considering both building elements and renewable energy integration, is crucial for improving the energy efficiency of high-rise buildings.

2. Human Factor

Human factors have a major effect on high-rise structures' energy efficiency. Energy usage is influenced by occupant actions, such as using air conditioners and opening windows; as a result, lower levels have 26% greater electricity expenses than higher floors (Jia, Du. *et al.,* 2020).

Involving stakeholders such as residents, the "human dimensions" of energy usage in buildings are critical to building energy performance.

Furthermore, encouraging occupiers to embrace energy-saving practices is crucial to reaching building energy efficiency targets (Ezema. *et al.,* 2022).

High-rise office buildings can improve their energy efficiency by employing daylighting techniques and sustainable lighting systems (Verena. *et al.,* 2018).

In general, the key to minimizing energy consumption and improving occupant comfort and productivity in high-rise structures is incorporating human factors into building design and operating operations.

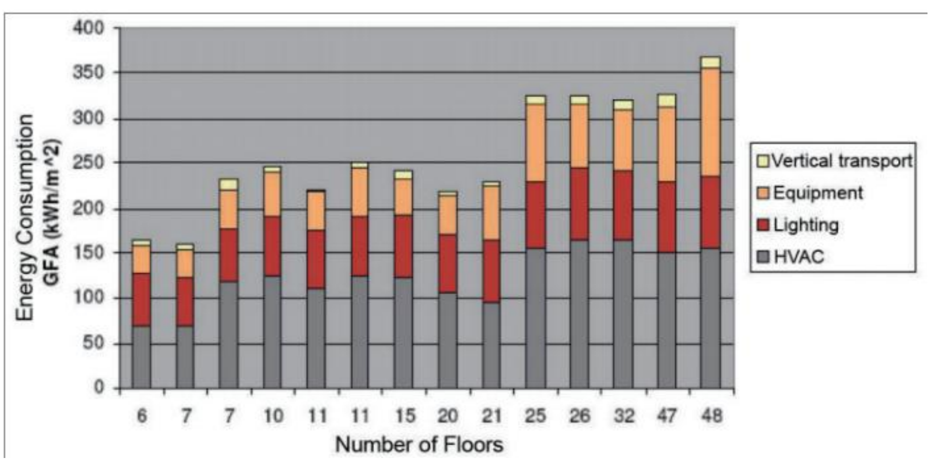


Figure 2.1: Energy consumption with a number of floors
Source-(Mohammad A)

3. Technology Factors

At different stages of construction and during the building's operation, technology has a significant impact on the building's energy efficiency. The building management system, or BMS, controls every aspect of the structure to increase efficiency while assisting with autonomous operation (Mohammad *et al.,* 2023).

The utilization of contemporary thermal insulation materials and "green" building technologies such as recuperators, solar panels, and Smart Energy Glass windows are among the technological elements that impact the energy efficiency of high-rise structures (S.G., et al 2023). Retrofitting techniques including changing the color of opaque walls, upgrading glazing, and putting in exterior shade systems can drastically lower energy use by up to 75.6% and reduce Overall Thermal Transfer Value (OTTV) (Yasser *et al.,* 2023). Reducing cooling loads and energy consumption in buildings is made possible by the analysis of window parameters made possible by Building Information Modeling (BIM) (Siti, *et al,* 2023). Standard floor area, floor height, and window wall ratio are some of the parameters that affect the total energy consumption per unit space in high-rise hotels.

4. Natural Factor

Climate and other natural elements have an effect on the building's energy efficiency and heating and cooling load. Windows that open are disturbed by wind speed at higher elevations. High-rise structures are also directly exposed to solar radiation at greater elevations, adding to the HVAC system's workload (Mohammad *et al*., 2023).

Various natural variables, such as geometric features, envelope design, natural ventilation, and vegetation systems, have an impact on the energy efficiency of high-rise structures (Ezema, *et al.,* 2022). In addition, key factors that improve natural ventilation and thermal performance in high-rise residential structures are the Window to Wall Ratio (WWR), building orientation, and courtyard corridor size (Babak 2018).

One important passive design strategy that can drastically cut down on energy use for cooling and fans in buildings while simultaneously increasing thermal comfort and indoor air quality without using electricity is natural ventilation (Loban H., at al., 2018).

The significance of incorporating natural components and design solutions to improve energy efficiency in high-rise structures across various building types and climates is highlighted by these aspects.

2.1.2.2 Energy Efficient Design Techniques

Using energy-efficient design techniques is essential to improving occupant comfort and building performance. Numerous studies demonstrate how important these tactics are for lowering greenhouse gas emissions and energy use (Ekta, *et al.,* 2023). Energy savings of up to 46% can be achieved by implementing passive design strategies such thermal insulation, green roofs, and improved building envelopes (Nedhal 2022). Achieving net zero energy usage in buildings is also made possible by technology like HVAC systems, energy-efficient lighting, and smart building automation systems. To improve human comfort while maintaining energy efficiency, architects and designers must prioritize early-stage design elements such building orientation. Buildings can achieve considerable reductions in energy consumption, expenses, and carbon emissions by efficiently integrating these measures, which will ultimately promote sustainable and efficient energy use in

The research findings indicate that there are numerous technologies available that facilitate the construction of energy-efficient buildings. The terms "energy efficiency design strategies" relate to the elements and actions included in the planning stage of a building to make it more energy-efficient. For ventilation, heating, and lighting. Energy-efficient design techniques can be used into new construction projects or into the renovation of older, already-existing structures (Emokpae *et al.,* 2021).

2.1.3 Green Infrastructure

Also, green infrastructure could foster sustainable development objectives by assisting in the management of storm water runoff, heat effects, and biodiversity loss, among other urban concerns (Samutsakhon et *al.,* 2021).

High-rise building integration of green infrastructure entails the application of several design techniques that offer several social, economic, and environmental advantages (Theingi *et al.,* 2023).

We will only talk about three of green infrastructure design in this part that will be inculcated in the high rise building design. Techniques, along with the benefits of each, such as vertical gardens, green roofs, and green terraces.

1. Green Roofs

Plant surfaces known as "green roofs" are added to buildings with the goal of lowering energy use, enhancing air quality, and lessening the impact of urban heat islands. Additionally, they can help manage storm water, offer habitat for wildlife, and improve the visual attractiveness of structures. Additionally, they can help manage storm water, offer habitat for wildlife, and improve the visual attractiveness of structures.

Plate 2.1: Green Roofs
Source-(Anna K. Cottrell)

1. Vertical Gardens

Known as living walls or vertical gardens, these plant-filled panels are erected vertically on the outside or inside of buildings.

One essential element of design plans for green infrastructure is vertical gardens. These cutting-edge solutions maximize green space in heavily populated regions to solve the problems caused by urbanization and climate change. Studies underscore the advantages of vertical gardens, including their capacity to augment urban aesthetics, ameliorate air quality, and foster biodiversity. Research demonstrates the effective culture of decorative plants in urban environments and highlights the significance of appropriate media compositions for plant growth in vertical gardens (Pavel, 2022). Additionally, the development of vertical greening systems is regarded as a sustainable development technique that offers significant benefits to the environment, society, and economy. Vertical gardens are an essential part of contemporary green infrastructure design initiatives because they allow communities to boost economic growth, improve public health, and lessen their environmental effect (Aakanksha, *et al.,* 2023).

These gardens can increase energy efficiency by lowering noise pollution, improving air quality, and providing insulation (Davis *et al.,* 2019). Vertical gardens can also support biodiversity, create aesthetically pleasing environments, and foster positive psychological effects for occupants (Oyama *et al.,* 2021)). Additionally, they can help enhance building marketability,

increase property values, and contribute to urban branding.

Plate 2.2: Vertical Garden
Source-(Erinna Giblin)

1. **Green Terraces**

With its many advantages, green terraces are crucial parts of design initiatives for green infrastructure. They aid in improving thermal comfort, reducing excessive heat gain in buildings, and advancing urban health. Terraced landscapes, which have been sustainable historically, are being brought back to life by circular economy principles, protecting natural and cultural assets and creating new economic opportunities (Chitra *et al.,* 2020). Agricultural terraces are beneficial to the environment and society at large because they offer essential ecosystem services like water conservation, erosion management, and

cultural landscape maintenance (Antonia *et al.,* 2021). Furthermore, by lowering stress levels, reviving good energy, and improving aesthetic and ecological elements in densely populated places, urban gardening on terraces and balconies improves public well-being (Antonia *et al.,* 2021). Green terraces are a great way to increase environmental sustainability and residents' quality of life when they are incorporated into urban architecture.

Plate 2.3: Green Terraces
Source-(Kelly DiNardo)

2.1.3.1 Challenges And Solutions

Integrating green infrastructure in high-rise buildings presents a variety of challenges, such as structural, maintenance, and water management issues. However, several solutions and best practices have emerged to address these challenges, including innovative materials, technologies, and design approaches.

1. **Structural Challenges**

A major structural obstacle for incorporating green infrastructure into tall structures is the extra weight that vegetation, soil, and water place on the structure. This problem is especially noticeable when upgrading already-existing structures since the structural system might not have been built to support the extra weight (Mikayel 2023).

Also, the stability and integrity of the building structure may be impacted by the wind resistance of vertical gardens and green façades (Gago *et al.,* 2013).
Innovative materials and construction techniques have been developed in response to these structural challenges. For example, lightweight growing material can be used to lessen the weight of vertical gardens, green terraces, and green roofs while yet offering sufficient support for plant growth (Abdul *et al.,* 2019).

2. **Maintenance Challenges**

Another major obstacle to incorporating green infrastructure in high-rise buildings is maintenance. Maintaining plants at high altitudes raises accessibility and safety concerns, which can result in higher maintenance expenses and possible hazards for staff members. (Conejos *et* *al.,* 2019). Furthermore, elements including air pollution, little sunshine, and sharp temperature swings might have an impact on the health and longevity of plants in an urban setting.

Researchers and practitioners have created best practices and standards for choosing plant species that are well-adapted to the unique environmental conditions of high-rise structures in order to address these maintenance problems. Moreover, automated watering systems, while maintaining the performance and health of the green infrastructure, fertilization and monitoring can lessen the requirement for manual maintenance (Theingi *et al.,* 2023).

3. Water Management Challenges

In high-rise structures, water management is a crucial component in integrating green infrastructure. Water resources in the area and urban drainage systems may be subject to additional strain due to the need for irrigation and the control of storm water runoff (Mupeta *et al.,* 2020). Additionally, for green infrastructure to be sustainable, water efficiency is essential, especially in areas where water supplies are scarce (Jemat *et al.,* 2022).

Innovative technologies and design strategies have been created to maximize the use of water in green infrastructure in order to overcome these difficulties related to water management. Rainfall harvesting systems, for instance, can gather and save rainfall for use in irrigation, lowering the need for use of drinking water (Maha *et al.,* 2023). Furthermore, studies have demonstrated the large reduction in storm water runoff that may be achieved by green roofs and other types of green infrastructure, which relieves pressure on urban drainage systems (Theingi *et al.,* 2012). These technologies can support the overall resilience and sustainability of high-rise buildings with green infrastructure, as shown in a number of recent case studies.

Furthermore, by encouraging the sustainable use and management of water resources, the incorporation of water-sensitive urban design (WSUD) concepts into green infrastructure can aid

in addressing water management concerns. For instance, terraces and green roofs can be created with specialized drainage and water storage systems to minimize runoff and maximize water consumption. To further improve the water efficiency of green infrastructure, drought-tolerant and native plant species can be used to lessen the requirement for irrigation.
In conclusion, new materials, technologies, and design strategies have been created to meet the structural, maintenance, and water management concerns associated with integrating green infrastructure in high-rise structures.
Urban planners, architects, and engineers can successfully integrate green infrastructure into high-rise buildings, leading to more resilient and sustainable urban settings, by using these solutions and best practices.

2.1.4 Sustainable Building Materials

Buildings have an environmental impact during their entire life cycle, and the materials they are made of will affect how well they function overall.
Sustainable materials and techniques in affordable high-rise buildings: Sustainability is a crucial issue since the last decade as the building sector, directly or indirectly cause a considerable portion of the annual environmental deterioration. Due to increase in houses' demand, leading to consumption of more resources, energy and raw materials which are directly responsible for the rise in carbon content in air and which are harmful to human health and environment (Kuma *et al.,* 2021)
To overcome these various environmental impacts, we need to build with more sustainable materials which will reduce the impacts on environment. Design of a building is essential and it becomes crucial when we talk about affordable housing. The green buildings design should thus

begin with the use and selection of eco-friendly materials with related or better features than traditional building materials.

Sustainable building materials have three life cycle stages: Pre-Building, Building, and Post-Building, each with specific environmental impacts.

Sustainable building construction requires careful planning, including centralized location, energy efficiency, water recycling, and the use of recycled and eco-friendly materials.

Key materials for sustainable building include Pozzolana materials, recycled steel, ferro cement, bricks from coal washery rejects, and clay tiles for insulation, selected based on local availability, benefits, cost, and durability.

Sustainable building practices aim to minimize environmental impact throughout the material life cycle, from production and construction to demolition and waste management.

Residential buildings should be centrally located for easy access to public transport, utilize energy efficiently, recycle water, use recycled materials, aerated concrete blocks for insulation, and clay for roof insulation instead of chemicals (Rajesh *et al.,* 2021).

Sustainable building materials like Pozzolana, recycled steel, ferro cement, precast components, and eco-friendly tiles are chosen based on local availability, cost, and durability. Lime is a common alternative to cement, absorbing carbon and emitting oxygen. Colored lime plaster is waterproof, washable, and maintenance-free, enhancing aesthetics over time.

Eco-friendly tiles are energy-efficient, cost-effective, and improve indoor air quality. Colored lime plaster reduces the need for repainting, is durable, and enhances aesthetics as it ages.

1. Reflectsol Glass

Reflectasol glass maintains cool temperatures, reduces energy consumption, minimizes solar heat gain, provides optimal lighting, UV protection, and enhanced privacy compared to clear glass. Reflectasol glass helps in keeping the inner temperature cool even in hotter summers, thereby reducing the need for excessive air conditioning, which in turn lowers energy consumption (R. Kuma *et al.,* 2021)

This type of glass is designed to reduce solar heat gain while allowing optimal natural lighting throughout the day, reducing the reliance on artificial lighting and associated energy consumption.

Reflectasol glass is a good UV ray resistant material, which not only protects occupants from harmful UV rays but also reduces the need for additional cooling measures that consume energy

By providing better privacy compared to normal clear glass, Reflectasol glass can reduce the need for curtains or blinds, allowing more natural light to enter the building and decreasing the need for artificial lighting during the day, thus saving energy.

Plate 2.4: Reflectasol glass

Source-(https://www.archdaily.mx/catalog/mx/products/10986/reflectasol-vidrio-reflectivo-capa-suave-vitro)

2. Eco-Friendly Tiles

Conventional flooring is replaced with eco-friendly tiles, which require less energy to produce in comparison. Cost-wise, it is less expensive than traditional tile. Additionally, these tiles enhance the quality of the indoor environment (Rajesh *et al.,* 2021).

3. Active Solar Technologies

Through the use of active solar technologies, solar energy can be directly transformed into another useful energy source, such electricity or heat conversion (Rajesh *et al.,* 2021).

A solar panel is a device that uses the photovoltaic effect, sometimes known as a photovoltaic cell or PV for short, to transform heat from sunlight into electrical energy.

Using this material is a step toward putting the Green high rise building idea into practice, which aims to have the structure generate its alternative electricity. The 'Efficiency Of Using Solar Panels as An Alternative Energy sources indicate that using solar panels for alternative electrical energy is more cost-effective than using generators, both in terms of initial investment and ongoing operating expenses (Hermawan *et al.,* 2013).

Plate 2.5: Solar Panels on High Rise Building
Source-(ar.inspiredpencil.com)

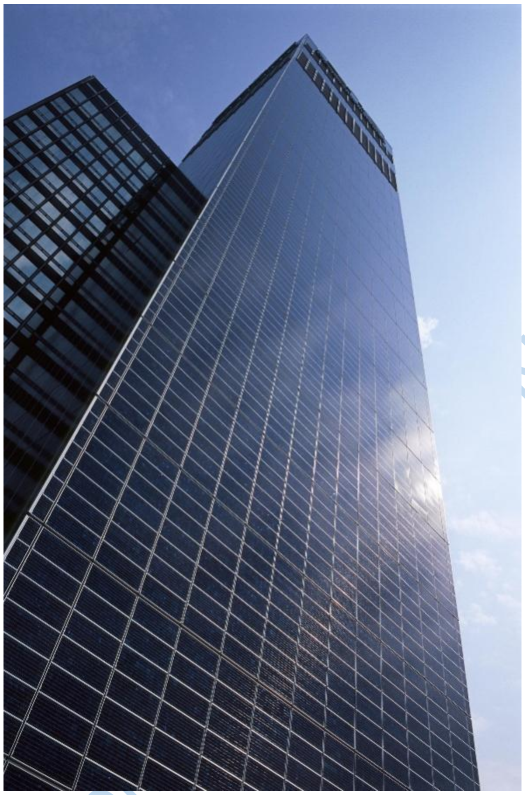


Plate 2.6: Skyscraper Covered in Solar Panels is Europe's Largest
Source-(*Flickr*)

4. Technology

Aluminum formwork technology: it is a popular in construction due to its lightweight, easy adaptability, and monolithic construction approach, requiring initial high investment but offering higher repeatability.

The 4-step cycle of aluminum formwork involves erecting vertical and horizontal formwork, reinforcing slabs, and removing vertical formwork after 24 hours.

Self-compacting concrete (SCC): is an innovative type that does not require vibration for compaction, contributing to sustainable development by incorporating recycled materials and increasing durability.

5. **Rainwater harvesting:** rain water systems reduce dependence on treated water, minimize storm water runoff, and provide chemical-free water for irrigation.
6. **Passive solar:** Building design utilizes the sun's energy for heating, cooling, and daylighting, reducing the need for additional energy sources and creating a comfortable indoor environment.

Active solar technologies, such as solar heating and cooling and solar PV systems, directly convert solar energy into heat or electricity, with smaller-scale systems on rooftops and larger-scale systems in power stations.

2.1.5 Building Impacts on Environmental Sustainability

Mixed-use tower buildings can have negative impacts on environmental sustainability due to various factors. For instance, the lack of consideration for sustainability in architectural design can lead to low standards of habitability, connectivity, and social integration, resulting in increased operational costs and health problems, especially for lower-income groups.

Additionally, the rapid development of investment in areas Ikeja, Lagos can lead to skyrocketing land values, potentially causing issues like flooding due to reduced green spaces and inadequate water flow management. Moreover, while mixed-use developments aim to be socially beneficial and environmentally sound, challenges such as equitable access to social infrastructure for residents can hinder the overall sustainability goals of these projects (Kim *et al.,* 2020). Therefore, careful planning and consideration of environmental impacts are crucial in the design and implementation of mixed-use tower buildings to mitigate negative effects on environmental sustainability.

According to (Newman *et al.,* 2021) It is clear that over the years, the construction sector has had a significant impact on the environment through both the actual building construction and building operations around the world. The following are some of the ways that the building industry affects environmental sustainability:

- **Pollution and Air Quality**: Poor air quality can be caused by building and construction operations that discharge pollutants into the atmosphere. These contaminants include building materials' volatile organic compounds (VOCs), dust, and emissions from construction equipment.
- **Environmental Degradation:** The construction of new buildings has the potential to wipe out wetlands, ecosystems, and natural habitats. The loss of natural places can have an adverse effect on ecological balance, decrease biodiversity, and disturb the habitats of species.
- **Depletion of Resources:** Building development necessitates the extraction and depletion of natural resources, including aggregates, minerals, and lumber (Adjei *et al.,* 2018). Deforestation, habitat damage, and biodiversity loss may result from this.
- **Energy Consumption:** Throughout the course of a structure's lifetime as well as during construction, the building industry is a major energy consumer. The energy required for electrical appliances, lighting, heating, and cooling systems, as well as building operations, adds to greenhouse gas emissions and climate change.
- **Carbon Emissions:** according to (Terrenoire *et al*., 2019) energy use and the burning of fossil fuels are two aspects of building operations that contribute to emissions of carbon

dioxide and other greenhouse gases. Climate change and global warming are exacerbated by these emissions

- **Waste Generation:** A lot of waste is produced during building development and destruction. This waste includes packaging materials, abandoned building components, and construction debris.

  Ineffective waste management techniques can result in resource waste and contamination in landfills.

- Water Usage: The building sector uses a lot of water for operations, maintenance, and landscaping. Increased demand for water can put a strain on available supplies, resulting in shortages and unbalanced ecosystems (Mannan *et al.,* 2020).

  Nonetheless, there are chances in the building sector to advance sustainability. Preserving the environment can be aided by designing and developing green, energy-efficient buildings with sustainable materials, effective water management, and renewable energy systems. Numerous initiatives have been implemented to lessen the damaging effects of the construction sector on the environment. These initiatives include waste management, energy-efficient design, green building certifications, sustainable practices, and ethical material sourcing. Furthermore, government rules and laws can be quite effective in encouraging environmentally friendly choices in the building industry and supporting sustainable building practices.

2.2 Design Consideration

Achieving a "green building" design for a mixed-use high-rise structure, it requires careful consideration of a number of critical variables. Here are a few important design factors to remember;

2.2.1 The Orientation of the Building

The building's orientation refers to how it is positioned in relation to the sun and wind patterns. It is one of the passive design strategies for raising interior thermal comfort levels. Early planning stage orientation with respect to climatology is crucial as it aids in optimizing the building's overall heating and cooling requirements.

Building will be positioned in a way that it will aids in optimizing the building overall heating and cooling.

2.2.2 Sustainable Building Materials

The choice of building materials has a significant influence on how the structure will affect the environment. To lessen the impact of transportation on the environment, sustainable and non-toxic materials that are readily available locally should be used in building. Utilizing recycled materials might also reduce environmental waste. On lessen the building's heat gain, apply UV-reflective paint on the outside walls. Another important factor influencing the building's energy efficiency is the material on the roof. Among the materials that can be used as roofing are polystyrene insulation, vermiculite concrete, and china mosaic white finish. The less heat gain for the building, the lighter the color of the roofing material.

2.3.3 Energy Efficient Design Techniques

Energy efficiency, which aims to lower primary energy usage, is a crucial part of the global effort to reduce CO2 emissions.

In mixed use tower, energy consumption is a big worry. Include energy-efficient design elements including renewable energy sources, insulation, lighting controls, and HVAC systems that are optimized. Reduce operational expenses and the impact on the environment by implementing green building methods.

2.3.4 Infrastructure

Energy efficiency and environmental sustainability in mixed use tower structures depend on the integration of green infrastructure. Green roofs, green walls, and hybrid wind and solar power plants are a few strategies that can improve living conditions and energy conservation in high-rise structures. Reusing resources and implementing new, energy-efficient building materials can reduce costs and advance sustainability in the building industry. Advanced technologies, local climate adaptability, and cooperative efforts throughout society to lower costs and improve environmental effect are essential for the future of high-rise green buildings. Green infrastructure can enhance ecological features, sustainability, and urban planning choices in high-rise building.

2.3.5 BIPV (Building Integrated Photovoltaics) Solar Panels

Solar panels are integrated into building structures through the use of cutting-edge technology called building-integrated photovoltaics, or BIPV systems. These systems help create net-zero energy buildings by producing sustainable energy in addition to improving the thermal comfort of the structure. Rooftop, balcony, curtain, sunshade, and wall façade BIPV systems are among the many varieties available; they are continuously being explored for increased power efficiency and decreased air conditioning use. Combining BIPV systems with hydrogen storage systems can maximize self-consumption and minimize environmental effect by storing excess electricity as hydrogen for later use. Furthermore, methods such as phase change materials, optical filters, and PV chimneys are being investigated to lower the BIPV modules' working temperatures and improve their electrical performance and dependability. All things considered, BIPV technology has enormous promise to transform building sustainability and energy efficiency.

2.4 Empirical review

2.3.2 Design Strategies for Achieving Environmental Sustainability

To achieve green architecture in high-rise buildings, several design strategies can be implemented. These include utilizing new energy-efficient building materials, incorporating recycled materials, improving air conditioning systems, implementing intelligent zone-controlled lighting systems, and ensuring a high utilization ratio of renewable energy sources (Rajesh. *et al.,* 2021). Additionally, it is essential to focus on reducing the level of load, improving material properties, and implementing supporting measures to enhance the structure's performance and fuel economy (Yuan 2023). Design concepts should also consider minimizing environmental impact, adapting to local climate and resource characteristics, and reducing construction costs through collaboration among relevant departments of society (Sophia *et al.,* 2022).

By integrating these strategies, high-rise buildings can achieve sustainability, energy efficiency, and environmental friendliness, contributing to a greener future in construction and architecture (Walnut *et al.,* 2023).

To achieve environmental sustainability, the following four crucial elements of green building design must be adopted:

1. Energy Efficiency in Building Design
2. Sustainable Materials
3. Biodiversity and Green Spaces
4. Indoor Environmental Quality

a) Energy Efficiency in Building Design:

One of the most important factors in designing environmentally friendly sustainable buildings is energy efficiency in the context of green architecture. The goal of green design is to reduce a building's environmental impact at every stage of construction, with a particular emphasis on energy efficiency. Key factors unique to energy efficiency in building design within the context of green architecture are as follows:

As the goal of green building design is to minimize environmental effect and reduce energy consumption, energy efficiency is essential. Research has demonstrated that conventional buildings contribute to carbon dioxide emissions and energy waste (Berhane, *et al.,* 2023). By optimizing building factors like glass, roof materials, and HVAC loads, simulation-assisted designs can help achieve significant energy savings of between 20–45% per year (Veena *et al.,* 2022).

Building orientation, window type, and glazing adjustments can lead to peak energy reductions in buildings, and integrating Building Information Modeling (BIM) and Building Energy Modeling (BEM) approaches can effectively minimize overall building energy usage (Mohamed *et al.,* 2021).

The term energy efficiency refers using of less energy to provide services, functionality and comfort that are the same or supersede before. A building can be made more energy efficient through:

- By using natural ventilation.
- By using a passive solar design.
- Improvement of its structure (inside and out).
- By optimizing building systems and controls.
- And by installing high-efficiency appliances and lighting.

Furthermore, integrating suitable shading and ventilation plans during the construction of green buildings can drastically cut artificial energy use, highlighting the significance of energy-efficient models in power conservation.

b) **Sustainable Materials:**

Sustainable materials and construction practices are fundamental aspects of green architecture, aiming to minimize environmental impact and promote resource efficiency throughout the building's life cycle. Here are key considerations and strategies for incorporating sustainable materials and construction practices in green architecture.

Green design relies heavily on sustainable materials and construction techniques since they lessen their negative effects on the environment and encourage sustainability. In order to reduce pollution and the depletion of natural resources, green architecture places an emphasis on the use of eco-friendly techniques and materials. To improve sustainability and lessen adverse environmental effects, this involves utilizing green construction products, such as green raw materials like wood, bamboo, and fiber cement. A more sustainable consumer and industrial economy is facilitated by the use of sustainable materials, which are distinguished by their adaptability, affordability, and environmental friendliness. These materials are used in a variety of industries, including engineering, agriculture, and healthcare.

c) Biodiversity and Green Spaces:

Numerous research studies have emphasized the critical role that biodiversity plays in urban green spaces and green design. Green infrastructures (GI) that incorporate Nature-Based Solutions (NBS) can improve ecosystem benefits and biodiversity protection (Michelle *et al.,* 2022). In urban green spaces such as green roofs, invertebrate diversity must be supported by design aspects such as variable substrate, increased plant diversity, and habitat complexity

(Tatiana. *et al.,* 2023). In order to achieve a synergy between people and nature, community-scale public open space design must prioritize maintaining and restoring urban biodiversity through green infrastructure (Cong *et al.,* 2022). Additionally, using naturally inspired modular design, like that of the Mindoro dwarf buffalo, can reduce the ecological footprint of building projects and encourage the preservation of biodiversity in constrained places (Sydney *et al.,* 2021). By integrating ecological concerns into green building design, green architecture and urban green areas can be made sustainable for the benefit of ecosystems and people alike by taking biodiversity into account.

Biodiversity and green spaces play a crucial role in green architecture, contributing to the creation of sustainable and ecologically harmonious environments. Here are key considerations and strategies for integrating biodiversity and green spaces in green architecture: Study of green roofs, vertical gardens, and other features that promote biodiversity.

d) **Indoor Environmental Quality:**

Investigation of design elements that enhance indoor air quality and occupant well-being.

Examination of the impact of natural lighting and ventilation on building occupants.

Indoor Environmental Quality (IEQ) is a crucial aspect of green architecture, focusing on creating indoor spaces that promote occupant health, comfort, and well-being. Here are key considerations and strategies for enhancing Indoor Environmental Quality in green architecture:

In green design, indoor environmental quality, or IEQ, is critical to tackling the global energy issue and advancing occupant health and well-being. Sustainable architecture methods are incorporated into green buildings to create healthier indoor environments, with an emphasis on energy efficiency and IEQ (Hirou *et al.,* 2023). Changes in behavior to improve IEQ can be driven by occupants' perceptions of IEQ, which can result in more comfortable working conditions and higher levels of satisfaction (Jeong-Taek *et al.,* 2023). Incorporating natural components like interior vertical plants, such green drapes, can greatly enhance thermal comfort and air quality in buildings, which has numerous positive effects on health and well-being. Research on LEED-certified office buildings shows that they fulfill IEQ requirements, guaranteeing inhabitants a comfortable and healthy working environment. In general, concentrating on IEQ elements such as illumination, acoustic comfort, thermal comfort, and indoor air quality in sustainable buildings not only benefits occupant health and productivity but also aligns with green building certification systems, contributing to overall IEQ improvement (Alexandre *et al.,* 2022).

Chapter Three

Research Methodology

3.1 Research Designs

This section focuses on the process for evaluating information sources and researching the means of adopting green architecture design in high rise building.

3.2 Case Study Method

The project employed case study methodology, which entails a thorough examination of a structure or project's design, construction, and performance. Techniques applied in case studies include:

- On-site observation: going to the building to see how it functions and how it is used.
- Literature review: Examining books, papers, and other published materials pertaining to the project or structure.
- Interviews: Speaking with contractors, engineers, architects, users, and other relevant parties.
- Measurements and data collection: Gathering information about the energy usage, environmental factors, and building performance.
- Photography and videography: Using images and films to record the structure.

- Diagrams and drawings: Producing diagrams and drawings to show the layout and structure of the building.
- Case study reports: Putting all of the facts and data together in one thorough report.
- Comparative analysis: This involves evaluating the building or project against benchmarks or other comparable examples.

  By using these techniques, it is possible to do thorough studies of structures and projects and obtain important knowledge about their performance, design, and construction.

3.2.1 Case Studies Selection Criteria

Four case studies in all were done, each of which represented and identified examples of situations with specific inherent characteristics related to the suggested design, such as:

- The first case study is **4 Bourdillon, located at Ikoyi, Lagos.** It's a leading architectural and design landmark in Nigeria, this iconic residential project conveys a unique lifetime experience. The 25-storey building sets new heights and standards of luxury in Lagos. Living becomes a daily bliss of peace of mind. Growing and prospering flows as smooth as the landscape itself. The Number 4 is INFINITE
- The second case study is **Gallery of WOHA**, **located at Taichung City, Taiwan (ROC).** It is renowned for its persistent innovation and progress. A continual investigation of modern architectural form-making and concepts is entwined with a thorough understanding of local environment and culture, resulting in a distinctive blend of inventiveness and pragmatism.
- The third case study is the **Milan's vertical forest, located at Milan, Italy,** and may be seen as a prototype for a completely new kind of biodiversity-inspired architecture, where other living species— plants, birds, and so on — join us in the design process rather than just humans. Above all, the Vertical Forest serves as a home for trees, which also happens to be a

home for people and birds. Large, symmetrical balconies with overhangs measuring three meters each are a structural feature of the two buildings. These prominent projections provide a place for plants, which are placed in customized tubs to allow unhindered growth.

- The fourth case study is **Shanghai Tower, located at located in lujiazui, china.** The tower are the innovative sky gardens that set the building apart from any high-rise ever built. From the point of green architecture the building's transparent second skin provides insulation, reducing the need for heating and cooling, while the use of glass limits the need for electric lighting. Meanwhile, 270 wind turbines (built into the façade at the top of the building) power the exterior lighting. Shanghai Tower also uses integrated landscaping and water conservation practices as energy-saving measures.

3.3 Case study analysis framework

This study's technique, which was taken from the body of research on design techniques, is centered on evaluating green architecture in tall structures.

Based on the following crucial elements, case studies 1-4 will be assessed using this framework:

2. **Energy Efficiency in Building Design:** This aspect of the framework examines how well the building integrates Energy efficiency in building design within the context of green architecture. It is a crucial aspect aimed at creating environmentally sustainable structures. In green architecture, the focus is on minimizing the environmental impact of buildings throughout their life cycle, with a strong emphasis on energy efficiency. Here are key considerations specific to energy efficiency in building design within the realm of green architecture.
3. **Sustainable Materials:** This section looks at the case studies' methods for choosing eco-friendly materials, cutting waste, recycling, and conserving resources. It evaluates

approaches including utilizing locally produced or recycled resources, employing effective building methods, and embracing behaviors that reduce waste production and advance the circular economy.

4. **Biodiversity and Green Spaces:** This dimension focus on the Biodiversity and green spaces as it contributes to the creation of sustainable and ecologically harmonious environments. The framework evaluates how effectively the case studies incorporate strategies for integrating biodiversity and green spaces in green architecture such as the use of green roofs, vertical gardens, and other features that promote biodiversity.
5. **Indoor Environmental Quality:** This element examines the case studies' approach to design elements that enhance indoor air quality and occupant well-being. Examination of the impact of natural lighting and ventilation on building occupants.

The study will methodically assess each case study's environmental sustainability along these four important characteristics by using this extensive methodology. The results will facilitate understanding and insights into the suggested design by offering insightful information about how well the design tactics used in the case studies worked.

3.4 Case study 1: 4 BOURDILLON

3.4.1 Description of the Building

A leading architectural and design landmark in Nigeria, this iconic residential project conveys a unique lifetime experience. The 25-storey building sets new heights and standards of luxury in Lagos. Living becomes a daily bliss of peace of mind. Growing and prospering flows as smooth as the landscape itself. The Number 4 is INFINITE.

Infinite Details

The 25-storey building offers several luxurious apartments of choice: 3-bedroom apartments of 510 sqm, 4-bedroom apartments of 584 sqm, 4-bedroom duplex apartments of 969 sqm, 4-bedroom penthouse apartments of 967 sqm, and 1,137 sqm.

The massive ground floor comprises a tennis court, a swimming pool, decorative water features along with a gym, leisure and entertainment spots and a multi-purpose club room. Underground parking is provided for all residents.

Plate 3.1: 3D View of 4 Bourdillon
Source- (orbitalq.com)

Figure3.1: 4 Bourdillon Ground Floor Plan and Site
PlanSource- (orbitalq.com)

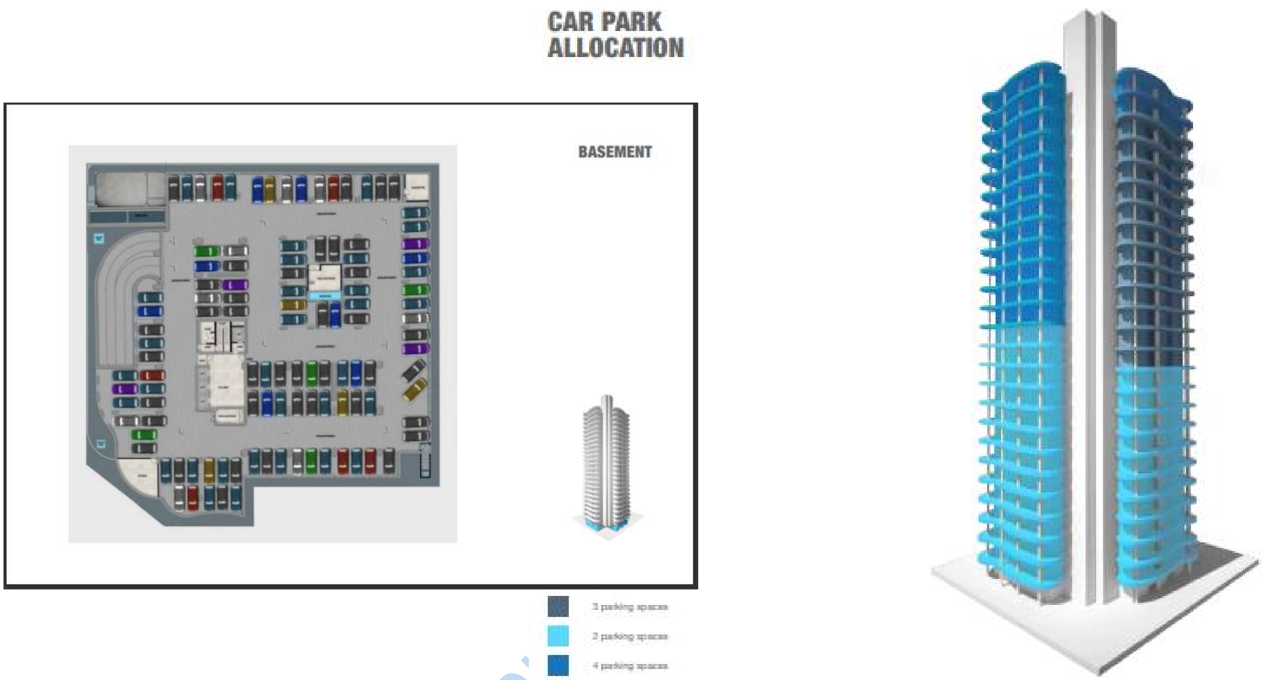


Figure 3.2: 4 Bourdillon Car Park Allocation
Source- (orbitalq.com)

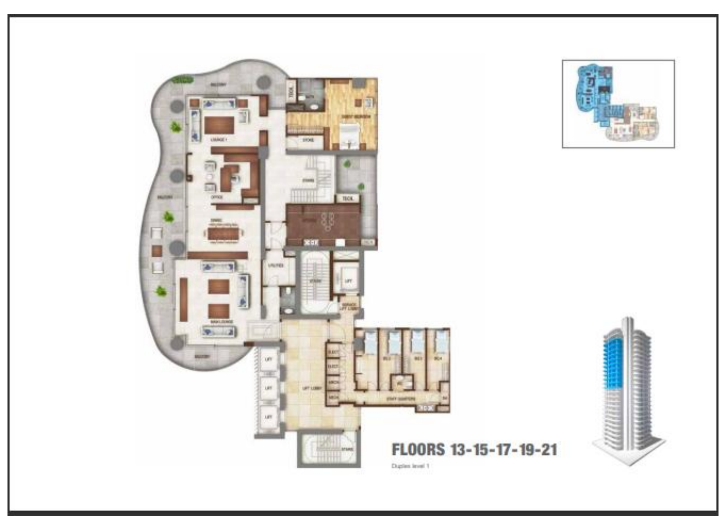


Figure 3.3: Floor Plan
Source- (orbitalq.com)

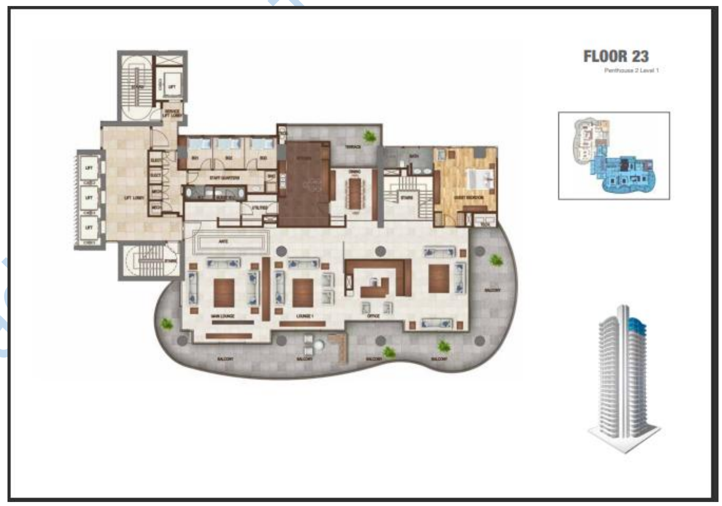


Figure 3.4: Floor Plan
Source- (orbitalq.com)

Figure 3.5: Floor Plan
Source- (orbitalq.com)

3.4.2 Framework Analysis

3.4.2.1 Energy Efficient Design Techniques

a) **Site Selection:** The choice of the site for 4 BOURDILLON involved careful consideration of environmental factors. Sustainable site planning taken into account the site's accessibility, proximity to existing infrastructure to minimize the need for new construction and reduce transportation-related emissions. And to feel the unrivalled sensation of serenity and enchanting sea views. Ikoyi is the nicest neighborhood in the city, right in the center of Lagos. The bustling uptown Bourdillon Road, the community's hub, and the perfect place to live are all under you. Nothing compares to this way of living. Here, memories are brighter and more satisfying than elsewhere.

b) Land Use Optimization: Optimizing land use efficiency is the goal of sustainable site planning. This required planning the site to optimize the building's footprint while causing the least amount of disruption to the surrounding environment. The structure layout has been carefully thought out to reduce any negative effects on the environment and maximize the utilization of available space.

c) Storm Water Management: Strategies have been implemented to collect and process rainfall locally, lessening the burden on regional drainage systems and limiting water pollution. These strategies include permeable pavement, rain gardens, and retention ponds.

The water and the ground work together to revitalize your everyday trip through every facet of this remarkable landmark.

d) Bioclimatic architecture principles: Trees, green areas, and wetlands are examples of natural characteristics that have been protected and incorporated into the architecture.

e) Outdoor Environment: Consideration of the outdoor environment is crucial in sustainable site planning. The design of 4 Bourdillon has incorporated outdoor spaces that promote occupant well-being, such as gardens, courtyards, or outdoor seating areas. These spaces provide access to nature, enhance the quality of the outdoor environment, and promote a healthier and more enjoyable workplace for employees. 4 Bourdillon Have the privilege of the ultimate uplifting walk no further than your garden, an escape oasis. The wind, the earth and the water are all united to revive your daily journey across every aspect of this outstanding landmark.

Energy Efficient Design Techniques: Enchantment Witness the sunlight reflecting on the avant-garde curves of the balconies to reveal the dynamism and elegance of the distinctive architecture.

The building features energy-efficient systems, including LED lighting, solar panels, and a rainwater harvesting system.

The project utilizes low-carbon cement, reducing greenhouse gas emissions and environmental impact.

Sustainable Materials: Four Bourdillon Tower in Ikoyi, Lagos, Nigeria, is a notable example of a sustainable building in Africa. Here are some ways it supports the use of sustainable materials: Locally sourced materials: The building's design incorporates locally sourced materials, reducing transportation costs and supporting the local economy.Recycled materials: The tower's structure uses recycled steel and reinforced concrete, minimizing waste and conserving natural resources. Sustainable wood: The interior design incorporates sustainably sourced wood, certified by organizations like the Forest Stewardship Council (FSC).

Biodiversity and Green Spaces: The tower features green spaces and gardens, enhancing biodiversity and promoting a connection to nature.

Plate 3.2: 4 Burdillon Landscape
Source- (orbitalq.com)

Indoor Environmental Quality: The building design has adopted environmental passive strategies such as natural daylight and cross ventilation to save energy and provide a healthier indoor environment. The structure has prioritized indoor environmental quality to create a healthy and comfortable working environment for occupants. Strategies include proper ventilation systems, control of indoor air quality, and the use of low-emission building materials to minimize the presence of harmful pollutants.

Plate 3.3: Interior of 4 Burdillon Tower Showing Indoor Environmental Quality
Source- (https://4bourdillon.com/public/images/uploads/project_photos/GF-garden-01.jpg)

3.5 Case study 2: Gallery of WOHA

3.5.1 Description of the Building

Gallery of WOHA is a green and sustainable mixed-use development in the heart of the city, the first of its kind in Taichung. Located in a bustling and highly built neighborhood in the center of Taichung is a mixed-use complex called Sky Green. The property is divided into two rectangular plots, one facing Daying Street, a more sedate side street, and the other toward Gongyi Road, the main highway in the city. The project consists of two 26-story residential towers that house retail establishments and apartments starting at level 4. The ground level to level three of the building is where the retail spaces are positioned in order to engage with its surroundings and the bustle of the streets. The stores' patterned glass covering is staggered, providing an urban backdrop for the pedestrian paths lined with trees and the contemporary outdoor street furniture. It has a serene landscaped courtyard. From the top of retail shops rise the two residential towers as well as generous recreation facilities for indoor and outdoor activities. The two towers have deeply recessed windows and the façades are enveloped with protruding balconies that have trees, sky gardens and mesh screens that serve as a trellis for green creeper plants. Landscaping is treated as a key material in creating the building envelope for the residential towers. The façade elements create deep sun-shading and the greenery acts as an active and living interface between the interior and exterior environment.

Housing, health facilities and social spaces are all contained within this plant-covered Singapore building by WOHA, which won World Building of the Year

Project Information:

- Apartments, Store
- **Address:** Taichung City, Taiwan (ROC) Taichung, Taiwan
- Architects: WOHA
- Area: 61027 m²
- Year: 2019

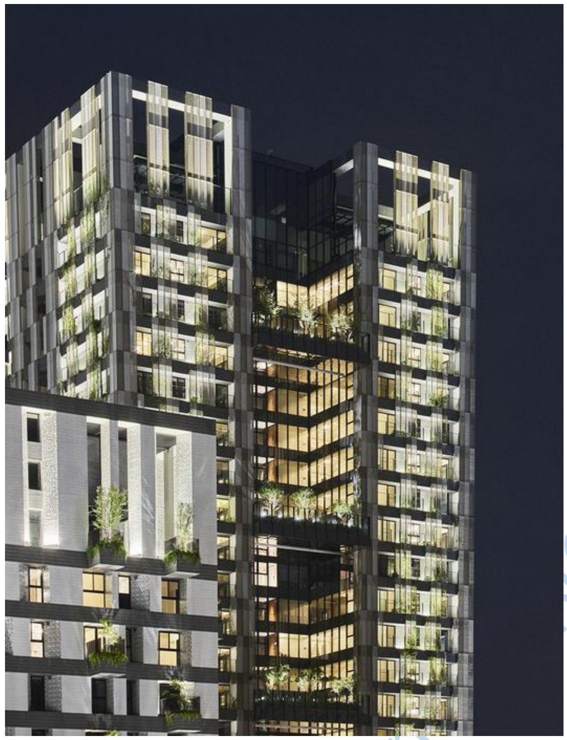


Plate 3.4: Gallery OF WOHA Elevation
Source- (Koumin Lee)

Figure 3.9: Gallery OF WOHA Floor Plan
Source- (Koumin Lee)

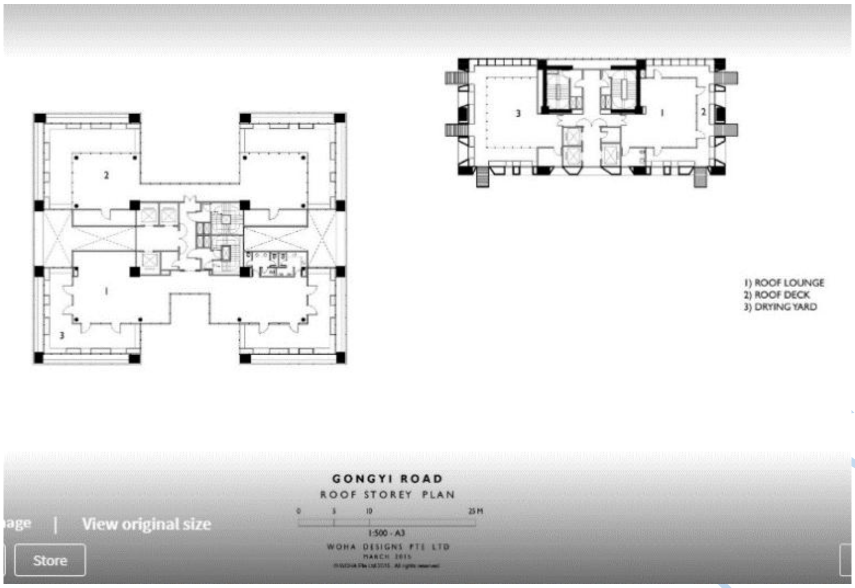


Figure 3.10: Gallery of WOHA Floor Plan

Source- (Koumin Lee)

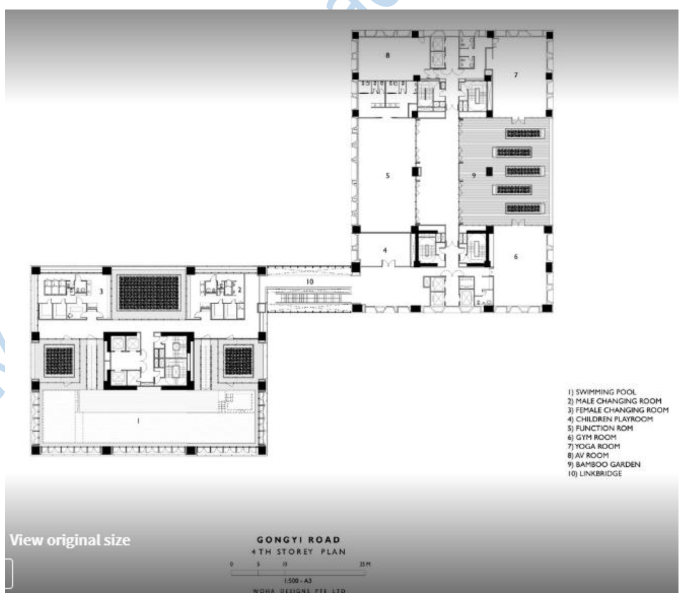


Figure 3.11: Gallery OF WOHA Floor Plan

Source- (Koumin Lee)

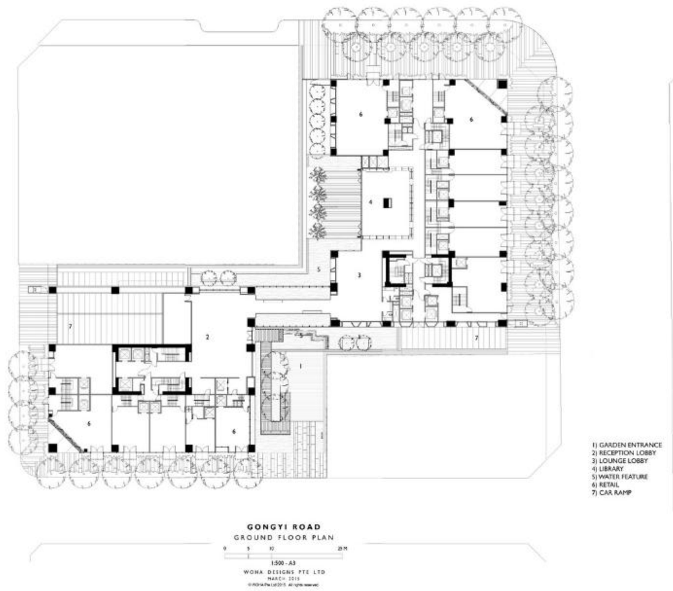


Figure 3.12: Gallery OF WOHA Floor Plan
Source- (Koumin Lee)

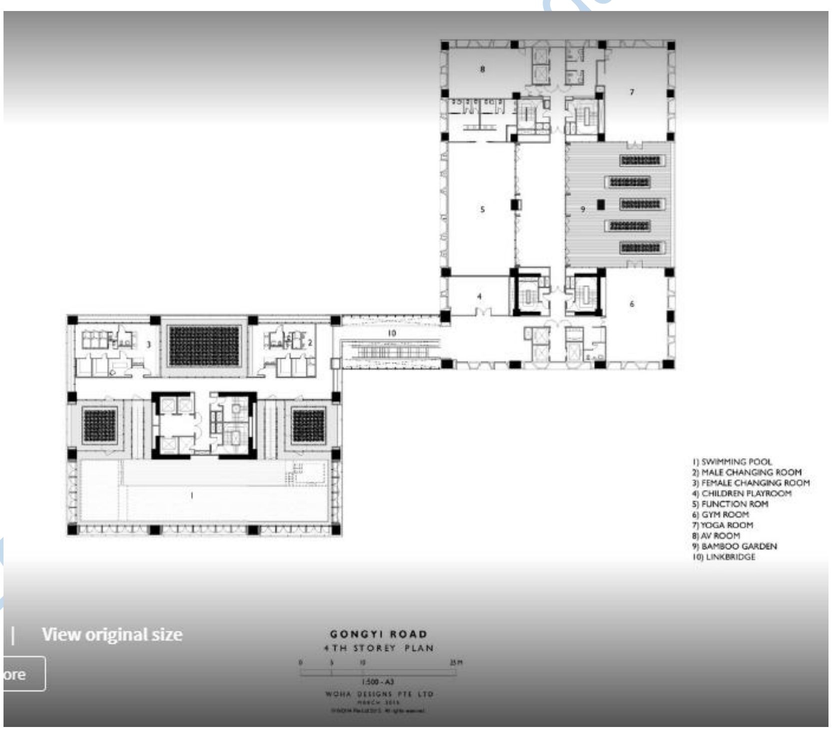


Figure 3.13: Gallery OF WOHA Floor Plan
Source- (Koumin Lee)

3.5.2 Framework Analysis

The Gallery of WOHA, a Singapore-based architecture firm, showcases their commitment to green architecture through various sustainable design elements and features.

Energy Efficiency in Building Design: The gallery uses energy-efficient systems, including LED lighting and a solar panel system. It focused on the design principles of sustainability, low carbon emissions, and smart cities.

Sustainable Materials: The gallery showcases sustainable materials and products, promoting eco-friendly design choices.

Biodiversity and Green Spaces: The building's façade is covered in lush greenery, providing natural insulation and reducing urban heat island effect, the rooftop features a lush garden, providing additional insulation and habitat for local wildlife. It features sky gardens, trees, and mesh screens that act as a trellis for green creeper vines on its projecting balconies. When constructing the residential towers' building envelope, landscaping is considered a crucial component. A biophilic atmosphere is created within a high-rise development by the expansive sky terraces that are located every five floors of the block, extending the living area of the occupants from indoors to outside. Every apartment has a clear view of the lush vegetation outside its windows. In a densely populated region, a sequence of open, yet protected, sky gardens, terraces, balconies, and planters create a breathable façade and visual interest, increasing the units' real estate value while giving apartment owners some much-needed spatial requirement.

Indoor Environmental Quality: The design maximizes natural light and ventilation, reducing the need for artificial lighting and mechanical cooling. The vegetation serves as an active and living interface between the inner and outside environments, while the façade features provide profound sun shade.

Plate 3.5: Gallery OF WOHA Terrace
Source- (Koumin Lee)

3.6 Case Study 3 - Milan's Vertical Forest

3.6.1 Description of the Building

Milan's Vertical Forest is a haven for trees that also serves as a home for people and birds. Large, symmetrical balconies with overhangs measuring three meters each are a structural feature of the two buildings. Plants are able to grow freely in these emphasized protrusions since they are planted in specific tubs. The tallest trees in the Vertical Forest reach heights of up to three stories. The facade is a three-dimensional area that is attractively mirrored by porcelain stoneware rather than a surface.

The two towers that make up the Milan Vertical Forest have varying heights—one is 112 meters above the ground, while the other is 80 meters. A total of 800 trees, about 15,000 ground cover and perennial plants, and 5,000 shrubs are housed in the two skyscrapers. The towers contain as much flora as is typically found on about 30,000 m2 of forest and undergrowth, all concentrated in about 3,000 m2 of city. The plants in the Vertical Forest not only provide oxygen, control humidity, and absorb carbon dioxide and tiny particles, but also filter sunlight to create the ideal environment. Many animal species, including at least 1,600 birds and butterflies, now call the vertical forest home.

Plate 3.6: Milan's Vertical Forest
Source- (Radu Bercan / Alamy Stock Photo)

Figure 3.16: Milan's Vertical Forest Floor Plan
Source- (Boeri Studio)

Figure 3.17: Milan's Vertical Forest Section
Source- (Boeri Studio)

Project Information

Architect: Stefano Boeri

Location: Milan, Italy

Project area: 29 300 mq; GFA: 18,200 sqm; H: 112 and 80 m

3.6.2 Framework Analysis

Energy Efficiency in Building Design: The structure is mostly self-sufficient due to its solar panels, geothermal heating, and greywater irrigation system for the surrounding vegetation

Sustainable Materials: The gallery promotes eco-friendly design choices by showcasing sustainable materials and products.

- **Recycled concrete:** utilized for the structural components and foundation of the construction.
- **Low-carbon cement:** Adds less greenhouse gas emissions to the concrete mixture.
- **FSC-certified wood**: This ensures sustainable forestry practices and is used for the building's façade and interior finishes.
- **High-recycled aluminum**: Used to construct the structural framework of the façade.
- **Double-glazed windows**: lowering heat loss and increasing energy efficiency. Materials for insulation with low environmental impact: Used to reduce energy usage.

- **Durable ceramic tiles:** Composed of recycled and natural materials, they are used for cladding and flooring.
- **Low-VOC paints and finishes:** They enhance the quality of the air indoors.
- **Recycled plastic composite and bamboo:** are used to make outdoor flooring and decking.
- **Local and regional materials**: Given top priority in order to boost local economy and lower transportation-related emissions. The sustainable kitchen facade is made entirely of glass, a precious, resistant, and eco-friendly material.

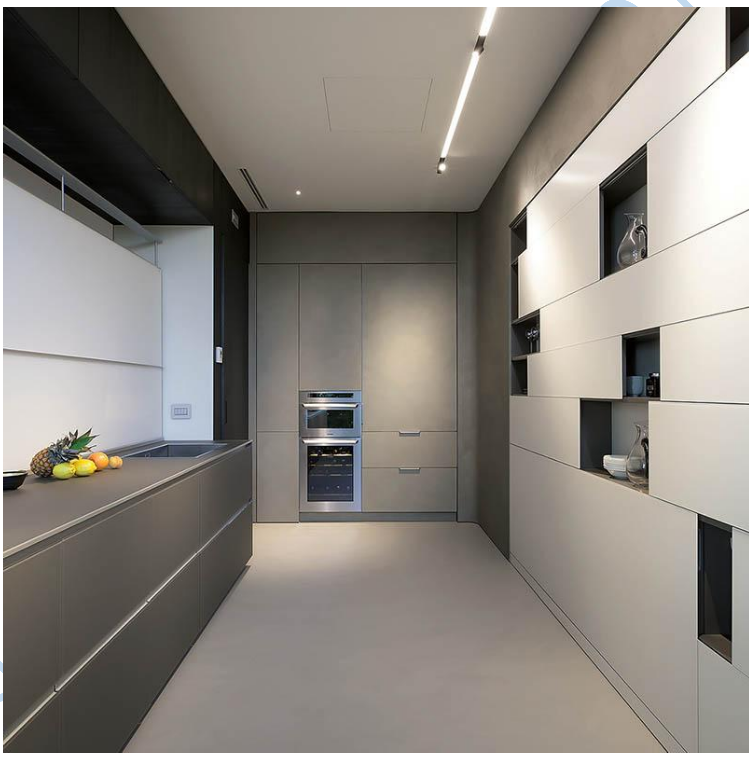


Plate 3.7: Milan's Vertical Forest Kitchen
Source- (Beppe Brancato)

Biodiversity and Green Spaces: It features 700 trees and over 20,000 different shrubs and plants. The exterior is covered in vegetation, providing insulation and reducing energy consumption. In addition to regulating summer and winter temperatures, the plant life, which is estimated to be equivalent to 3 hectares of woods (20,000 sq m), can convert up to 30 tonnes of CO_2 annually. It also acts as a dust filter, shields the occupants from noise pollution, and provides a microhabitat for birds and insects. Currently, some 20 different bird species have nests in the towers, and it is home to bumblebees, hermit wild bees, syrphidae (hoverflies), and more.

Indoor Environmental Quality: Vegetation covers the façade, which acts as insulation and lowers energy use.

Plate 3.8: Milan's Vertical Forest
Source- (Davide Piras)

Plate 3.9: Milan's Vertical Forest Bedroom Well Ventilated and with Natural Lighting
Source- (Giovanni Nardi)

3.7 Case Study 4 - Shanghai Tower, Lujiazui, China

3.7.1 Description of the Building

Shanghai Tower, Lujiazui, China the tower comprises of nine vertical zones that range between 12 and 15 stories. At the base of the structure, zone 1 contains retail and conference outlets, while zones 2-6 offer office space. Zone 7 houses a hotel, with further hotels and boutique outlets found in zone 8. Finally, observation levels are included at the peak in zone 9.

In order to withstand the typhoon-force winds that are common to the region, the architects designed an asymmetric form with a tapered profile and rounded corners — a form that reduced wind loads by 24% and saved $58 million USD in materials.

Plate 3.10: Shanghai Tower, Lujiazui, China
Source- (Beni)

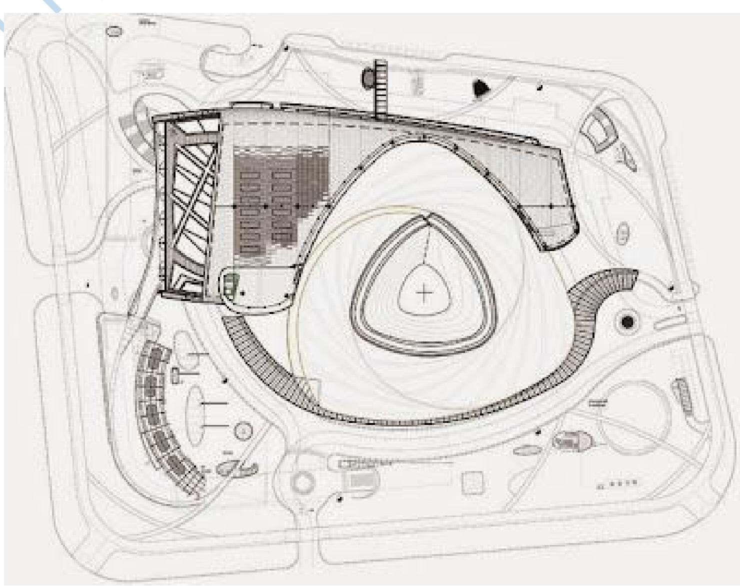


Figure 3.22: Shanghai Tower Floor Plan
Source- (architect-1.blogspot.com)

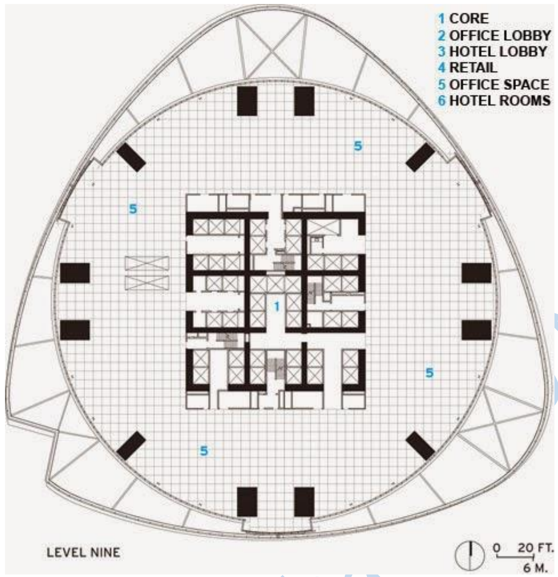
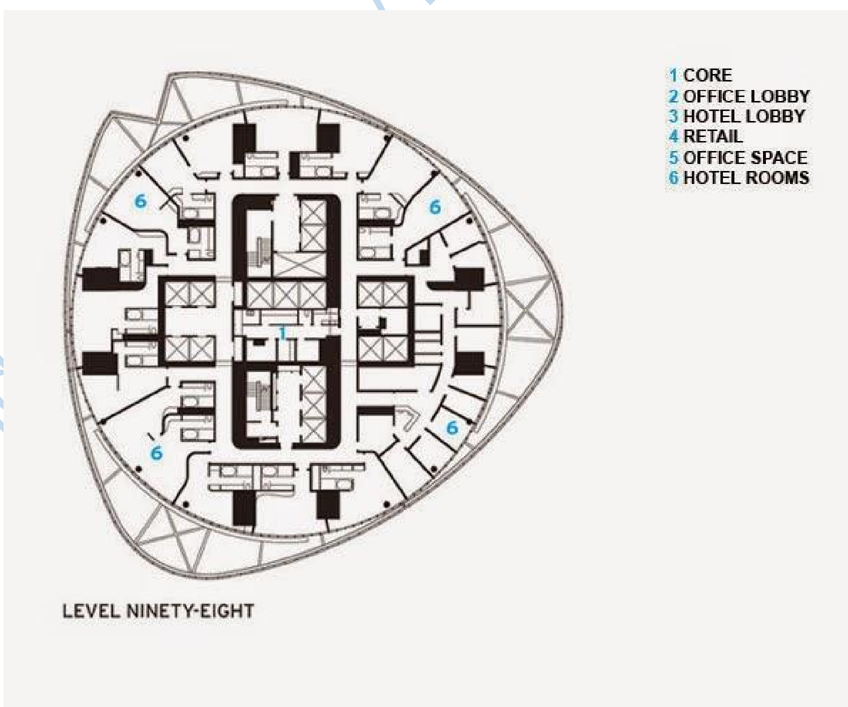


Figure 3.23: Shanghai Tower Floor Plan



Source- (architect-1.blogspot.com)

Figure 3.24: Shanghai Tower Floor Plan
Source- (architect-1.blogspot.com)

Project Information

Architect: Gensler

Location: Lujiazui, China

H: 632m and 127 floors into the air shanghai tower' is the tallest building in china and the second tallest in the world.

3.7.2 Framework Analysis

Energy Efficiency in Building Design:

Skin Façade: The exterior of the skyscraper has a double-layered façade that minimizes heat gain and energy consumption.

Geothermal Energy: Shanghai Tower lessens its dependency on fossil fuels by using geothermal energy for heating and cooling. It minimize the strength of strong winds and double skin which maintains the tower cool in summer and warm in winter and vertical wind turbines.

Wind Turbines: The structure has two wind turbines that produce power and cut down on energy use.

Energy-Efficient Systems: The tower is equipped with smart building management system and LED lighting, among other cutting-edge energy-efficient technologies.

Sustainable Materials: The structure uses environmentally friendly elements like recycled wood, low-VOC coatings, and FSC-certified timber.

Biodiversity and Green Spaces: There are more than 1,000 square meters of green space throughout the structure, including indoor and rooftop gardens.

Indoor Environmental Quality: Because of the building's architecture, less mechanical cooling is required because natural ventilation is maximized. It Minimize the strength of strong winds and double skin which maintains the tower cool in summer and warm in winter and vertical wind turbines.

The inner skin of the tower, which is an insulated glass assembly that is fire-rated in accordance with Chinese legislation. The outer skin and its inner curtain wall are separated by a number of open, garden-like areas. Shanghai Tower's double-layer design, combined with features like sophisticated lighting controls and an energy-efficient central plant, should help it consume 21%

less energy than a building that conforms to the 2004 ASHRAE 90.1 standard.

Plate 3.11: Shanghai Tower Interior

Source- (Shen Zhonghai)

Plate 3.12: Shanghai Tower Double Wall Section
Source- (Shen Zhonghai)

Round office and hotel floor slabs will support the inner facade of the Shanghai tower. A sequence of radial struts and surrounding girts will stabilize its exterior facade, which will be suspended from the building's mechanical floors (see below right). The two skins together will enclose a multistory garden-like area that building inhabitants can access (see below left). These atria will serve as buffer zones against the climate.

Shanghai Tower has been certified as a LEED Gold building, a testament to its sustainable operations and design.

3.7.2 Building Appraisal

Architecture and Design:

- Distinctive spiral pattern influenced by ancient Chinese architecture - Stylish, contemporary, and futuristic look

- Effective utilization of space, with 578,000 square meters of floor area overall

Eco-friendliness and Durability:

- LEED Gold certification - Energy-efficient double-skin façade

Rainwater collection and greywater recycling - Geothermal heating and cooling system

- Energy-producing wind turbines - Green areas, such as a rooftop garden

Construction and Engineering:

- Creative use of materials, such as steel and concrete with great strength

- Cutting-edge building methods, such the "core-wall" system

- Outstanding structural integrity and an earthquake- and wind-resistant design

3.8 Case study synthesis:

3.8.1 Common Spaces and Facilities

- Core
- International size tennis court
- Swimming pool
- Entrance cascade
- Clubhouse

- Leisure room
- Outdoor children area
- Utilities
- Reception lobby
- Panoramic lifts
- Service and goods lifts
- Gardens
- Apartments
- Office space
- Hotel
- Commercial floor
- Entertainment
- Roof garden
- Leisure area
- Changing room

3.8.2 Special Spaces and Facilities

- Gymnasium
- Link bridge
- AV Room
- Children playroom
- Function room

3.8.3 Summary of Case Studies Findings and Deductions

Buildings	**Design Consideration**	**Degree Of Adoption**			
		high Priority	Moderate Priority	Low Priority	Not a Priority

4 Bourdillon, Ikoyi Lagos	Energy Efficiency in Building Design		•		
	Sustainable Materials		•		
	Indoor Environmental Quality	•			
	Biodiversity and Green Space		•		
Gallery Of WOHA, Taichung City, Taiwan	Energy Efficiency in Building Design		•		
	Sustainable Materials		•		
	Indoor Environmental Quality	•			
	Biodiversity and Green Space	•			
Milan's Vertical	Energy Efficiency in Building Design	•			

Forest, Milan, Italy	Sustainable Materials	•			
	Indoor Environmental Quality	•			
	Biodiversity and Green Space	•			
Shanghai Tower, Lujiazui, China	Energy Efficiency in Building Design	•			
	Sustainable Materials	•			
	Indoor Environmental Quality	•			
	Biodiversity and Green Space	•			

Table 3.1: **Degree of Adoption Sustainability amongst Case Studies of Environmental**
Source (Researcher's Field Work)

Chapter Four

Site Analysis and Design Synthesis

4.1 Study Area

Lagos, one of the most famous cities in the world and the most populated city in Africa, is located in the southwest of Nigeria on the Atlantic Ocean. Referred to as a "MEGACITY" because of its population of more than twice the necessary 10 million, it is Nigeria's largest metropolis and the country's economic center. Lagos has successfully expanded its economy beyond the oil industry and now has a diverse range of industries including construction, manufacturing, transportation, wholesale, and retail.

Lagos is not just economically significant, but it also has a significant cultural and economic impact on Nigeria and the larger African continent. Its advantageous location along Nigeria's Atlantic coast makes for good commercial routes. In addition, the city has excellent rail and road links to other Nigerian cities, a major airport, and other assets that contribute to its prominence in both regional and national trade.

The network of islands, sandbars, and lagoons that make up Lagos' physical geography are its main features. The ground is low lying, and bridges connect the islands.

Figure 4.1: Map of Africa
Source- (paintmap.com)

4.1.1 Site Location

The proposed site is located at Located in Ikoyi, a prestigious residential neighborhood, Alfred Rewane Road and its surrounds have been rezoned to create a mixed-use corridor, resulting in a boom in office and hotel developments. Much of the development in Lagos, however, has a fairly anonymous character, generally following a standard commercial model with concrete slab and curtain wall facades.

Figure 4.2: Map of Lagos
Source- (mapsof.net)

4.1.2 Site Selection Criteria

The choice of site for this project is crucial since it has a big impact on how the facility can be utilized economically. To choose the site wisely, a few factors were taken into account.

4.1.2.1 Economic Focal Point

- The most populated city in Nigeria and the second most populous in all of Africa is Lagos.
- Lagos, one of Nigeria's major economic centers as a significant economic hub in Nigeria, Lagos contributes approximately 10% to the country's GDP.
- The Central Business District on the Island serves as the primary center for commercial and financial activities, housing the headquarters of numerous business headquarters in the country.

.

4.1.2.2 Land Use

In Lagos State there is strict compliance with the land use as been designed in the city ‘s master plan.

5.1.3 Accessibility

The land should be accessible easily by users of the facility through vehicle, water way and pedestrian.

4.1.4 Services

Certain utilities should be available at the location, such as electricity and water reticulation.

4.1.5 Topography

The site's topography is relatively sloppy, which improves outdoor activities.

4.1.6 Site Analysis

The location possesses certain physical attributes that require documentation to ensure appropriate and efficient design and to fully utilize the site's potential.

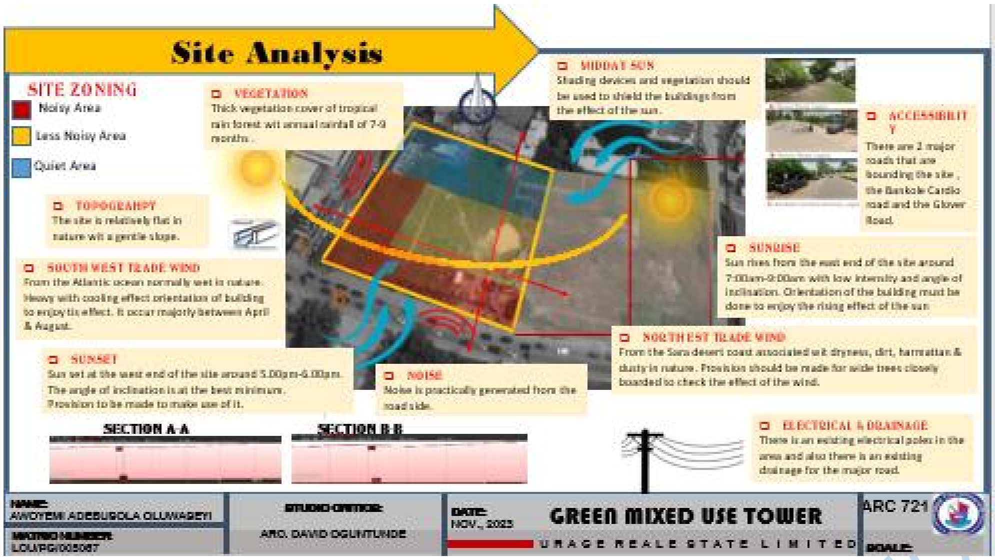


Figure 4.3: Site Analysis
Source- (Researcher's Field Work)

Figure 4.4: Site Analysis Showing Site Section
Source- (Researcher's Field Work)

4.1.6.1 Site Accessibility

The site has easy and convenient access for both vehicular Water Way and pedestrian. The site is accessible from the major road that comes from the Glover road in Lagos.

4.1.6.2 Nearness to Public Utilities

The basic infrastructures that are in place are: Good Roads, Electricity, Water, Telecommunications, and Security etc.

4.1.6.3 Drainage and Topography

The site has a gentle slope spread evenly throughout. Drainages are also in place for water collection which drains into the lagoon after the jetty terminal.

4.1.6.4 Vegetation

Lagos has two different seasons—the cold and the dry season—and is situated in a tropical region. This makes it possible for a variety of species to grow close to the site, from short grasses to evergreen trees to deep undergrowth. Oil has a low bearing capacity and is sand-filled.

4.1.6.5 Soil Condition

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

4.1.6.6 Wind Direction

The south west trade wind brings cold humidity which gives comforting effect to the people, while the north-east trade wind brings cold, dust, and harmattan, these cause discomfort

A building's effective arrangement includes proper ventilation; the building's long sides (east and west elevations) are positioned so they receive the maximum amount of air; the shorter sides of the proposed mall face the direction of the north-east trade wind.

The north-east trade wind brings cold, dust, harmattan and these cause discomfort. The south west trade wind brings cold humidity which gives comforting effect to the people. Proper ventilation is considered as part

4.2 Project Analysis and Design Synthesis

4.2.1 Brief Analysis

There is a growing demand and concerns to accommodate a growing population while preserving the communal spirit of neighborhoods and to ensure means to reduce the continuous development that has led to various harmful environmental effects such as pollution, emission of greenhouse gases, global warming, etc.

4.2.2 Brief Development

It turned out that a few spaces were shared by the four case studies that were studied and this spaces can be grouped into four. These areas were thoroughly examined to ascertain the necessary standards, the number of units per person, their capacity, and the precise role they play in the suggested design.

These areas are:

- Apartments
- Hospitality
- Offices
- Commercial

4.2.3 Design Considerations

- **Energy Efficiency in Building Design**

Energy efficiency has been incorporating into the design to achieve sustainable urban development. By utilizing concepts like solar panels for passive design, integrated renewable-storage energy systems. The solar panels have been integrated on the roof slab and all the sides of the proposed telecom building and the data center design, to generate clean and renewable electricity so as to reduce the heating and the cooling cost of running the building thereby reducing the carbon foot print of the proposed design. These solar panels have been incorporated directly into the building's design and construction, serving as both an energy-generating system and a structural element.

- **Biodiversity and Green Spaces**

Biodiversity and green spaces play crucial roles in urban areas, offering numerous benefits such as biodiversity conservation, climate change mitigation, and ecosystem services. Urban green spaces (UGSs) have been shown to harbor a diverse range of plant species, including endemic, exotic, and indigenous ones, contributing significantly to carbon sequestration and biodiversity conservation.

The proposed green mixed use tower has been designed to house vertical green garden, roof garden.

- **Indoor Environmental Quality**

Indoor environmental quality is critical to tackling the global energy issue and advancing occupant health and well-being. IEQ can be driven by occupants' perceptions of IEQ, which can result in more comfortable working conditions and higher levels of satisfaction. Natural components like interior vertical plants, such green drapes, has been incorporated in the design in order to enhance thermal comfort and air quality in buildings, which has numerous positive effects on health and well-being. Also to achieve IEQ natural ventilation is ensure it is achieved for most of the spaces that are not commercial for the comfort of the users.

- **Sustainability**

In order to reduce the building's environmental impact, sustainable design concepts have been used. These principles include the use of renewable resources, waste management system optimization, water conservation, and the use of energy-efficient materials.

- **Aesthetics**

For the green mixed use tower design, it is ensured that the structure is aesthetically pleasing to promote sales and to attract users.

4.2.4 Conceptual Development

The architectural conceptual development for the green mixed use tower in Glova Street, Lagos, prioritizes green architecture. The primary objective of this study was to create a facility that is environmentally friendly and reduces its impact on the environment.

To achieve this, several design strategies were carefully integrated during the planning stage. The first key approach involves the implementation of ensuring that the building is cross ventilated, especially at the apartment and hospitality area, this brought up the idea of making use of recessed rectangular box shape to achieve it .

Another important aspect of the design to achieve green building is introducing green vertical walls, green terraces, green gardens and green roof top.

The combination of these green architecture design strategies ensures that the proposed green mixed use tower will have a minimal carbon footprint. By prioritizing environmental sustainability, the building will serve as a model for responsible construction and contribute positively to the surrounding ecosystem and community.

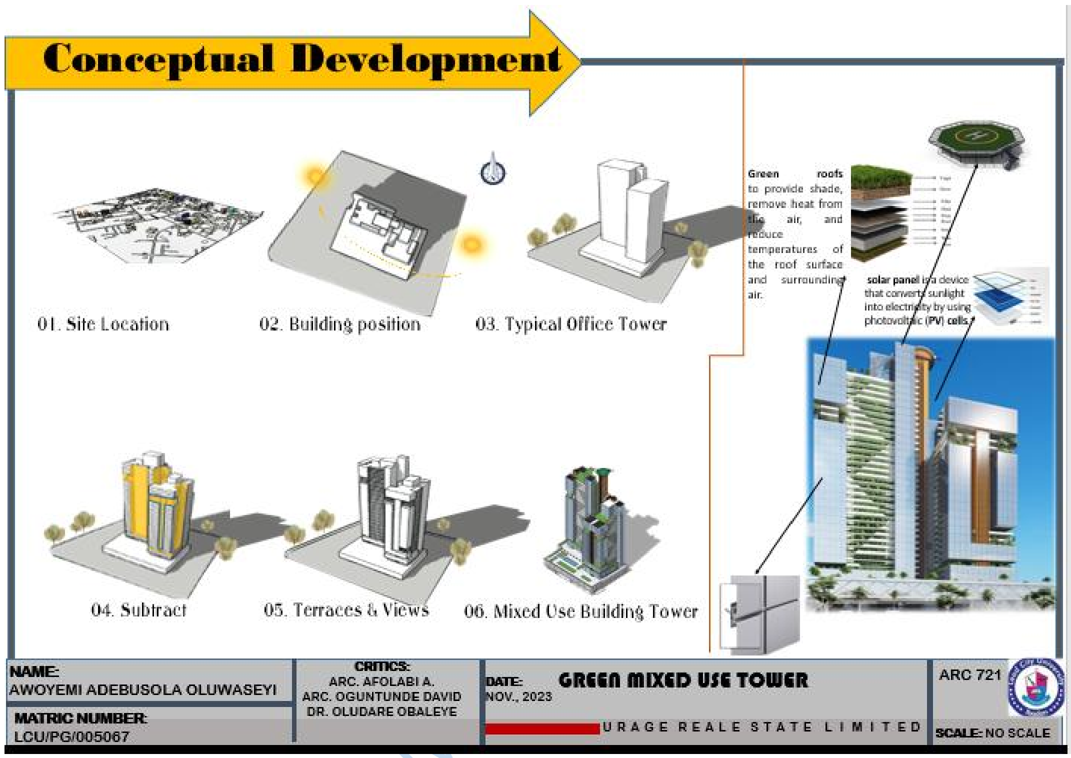


Figure 4.6: Conceptual Development of the Proposed Green Mixed Use Tower
Source- (Researcher's Field Work)

4.2.5 Functional Relationship

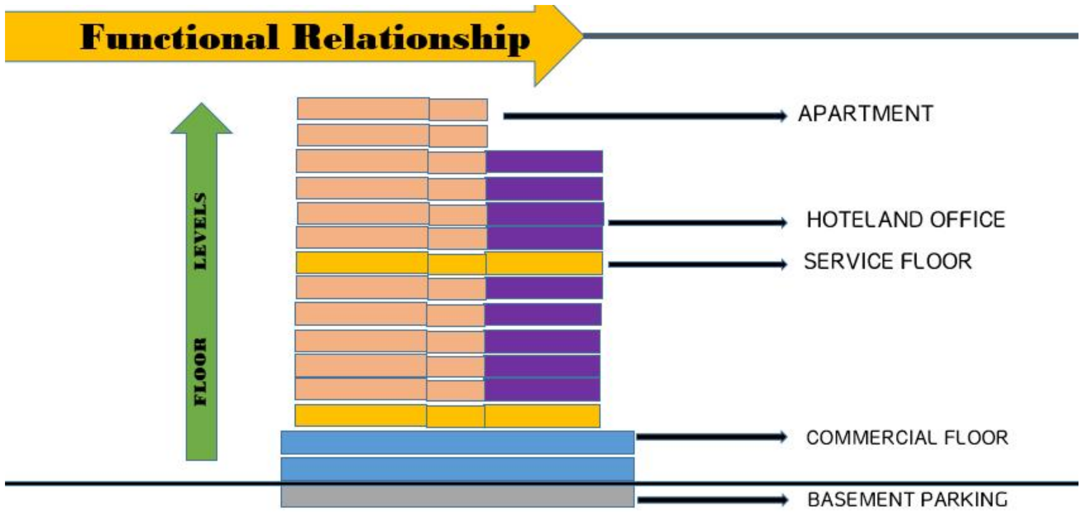


Figure 4.5: Floor Zoning Development of the Proposed Green Mixed Use Tower Source- (Researcher's Field Work)

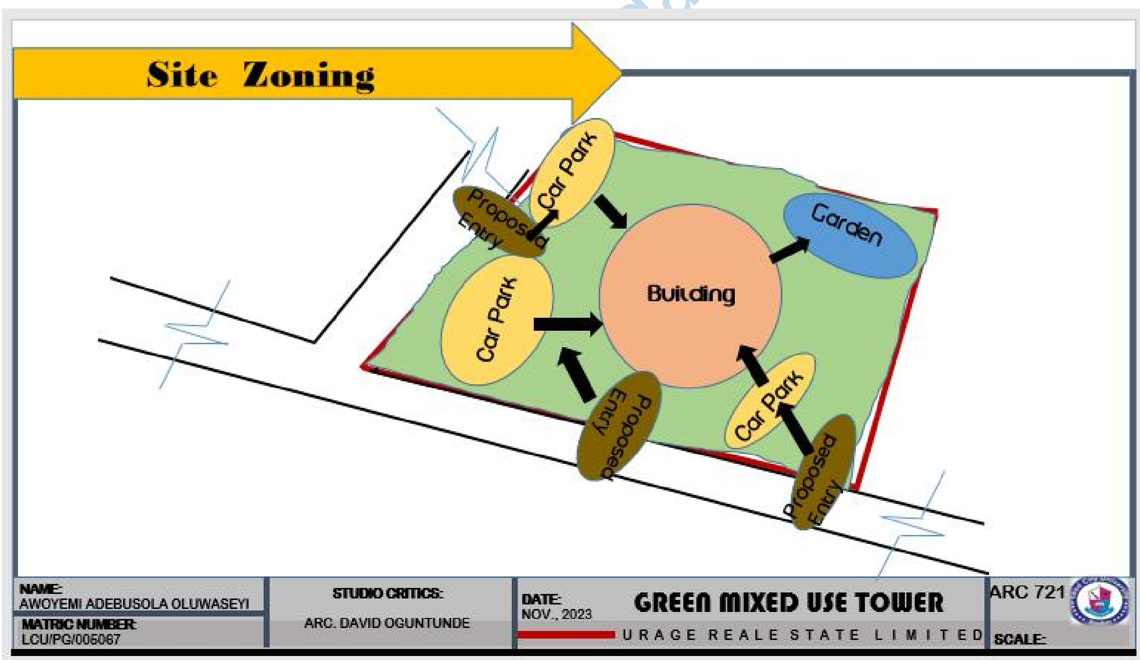


Figure 4.6: Site Zoning Development of the Proposed Green Mixed Use Tower
Source- (Researcher's Field Work)

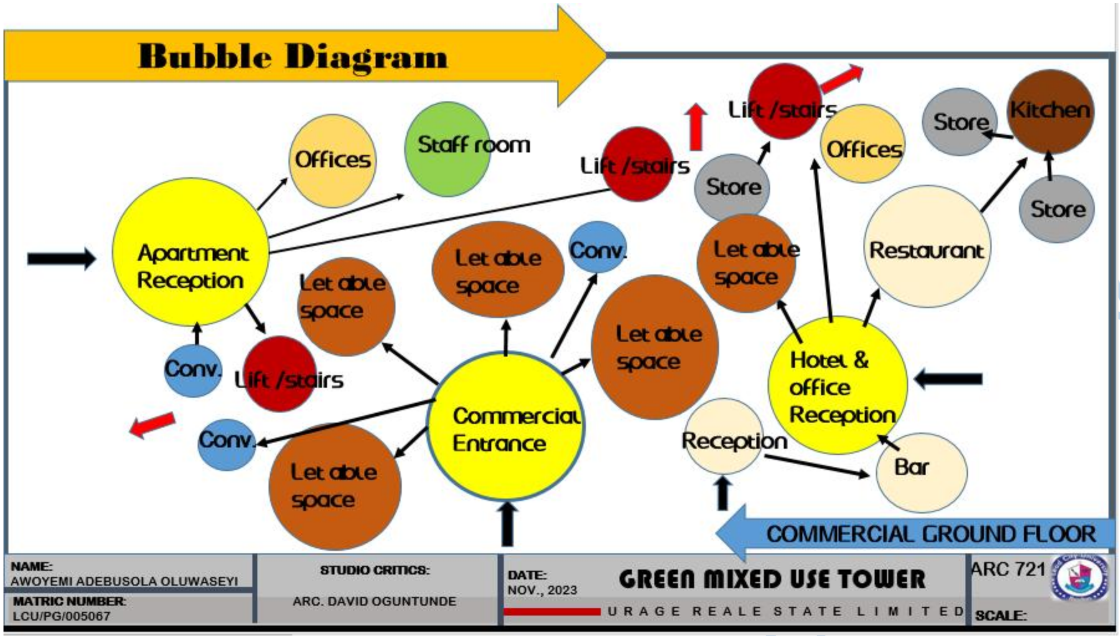


Figure 4.7: Bubble Diagram of the Proposed Green Mixed Use Tower
Source- (Researcher's Field Work)

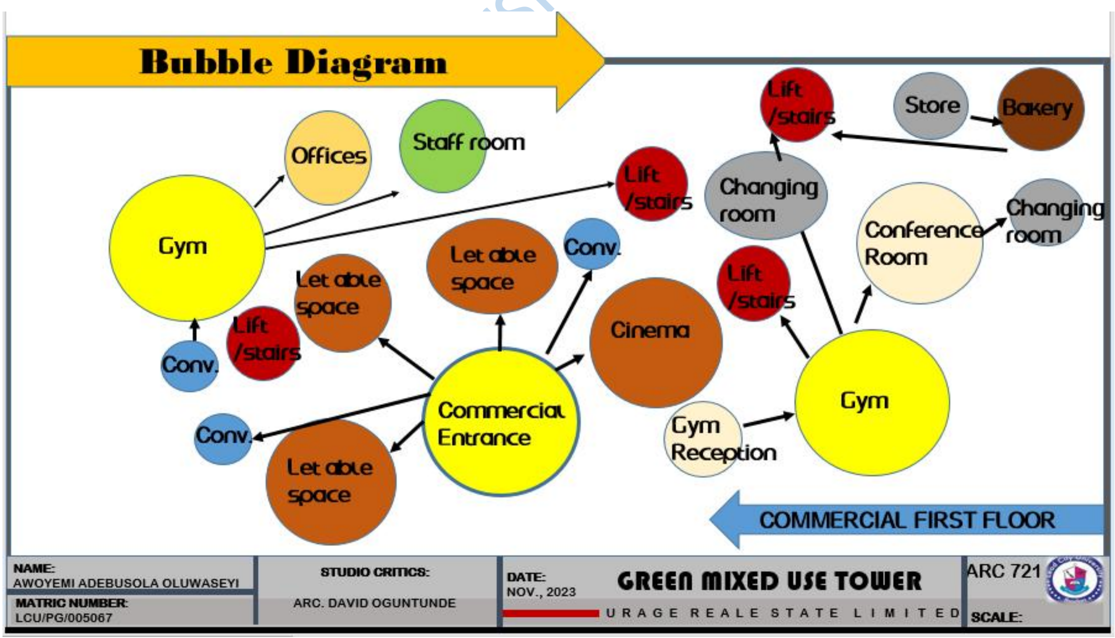


Figure 4.8: Bubble Diagram of the Proposed Green Mixed Use Tower

Source- (Researcher's Field Work)

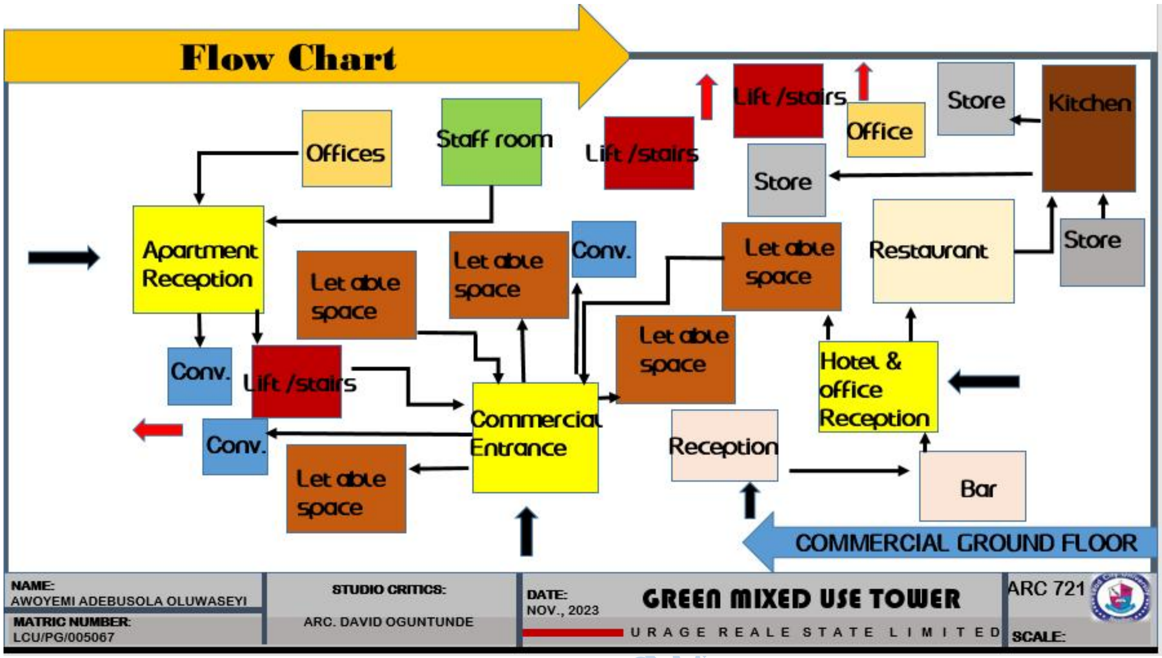


Figure 4.9: Flow Chart of the Proposed Green Mixed Use Tower
Source- (Researcher's Field Work)

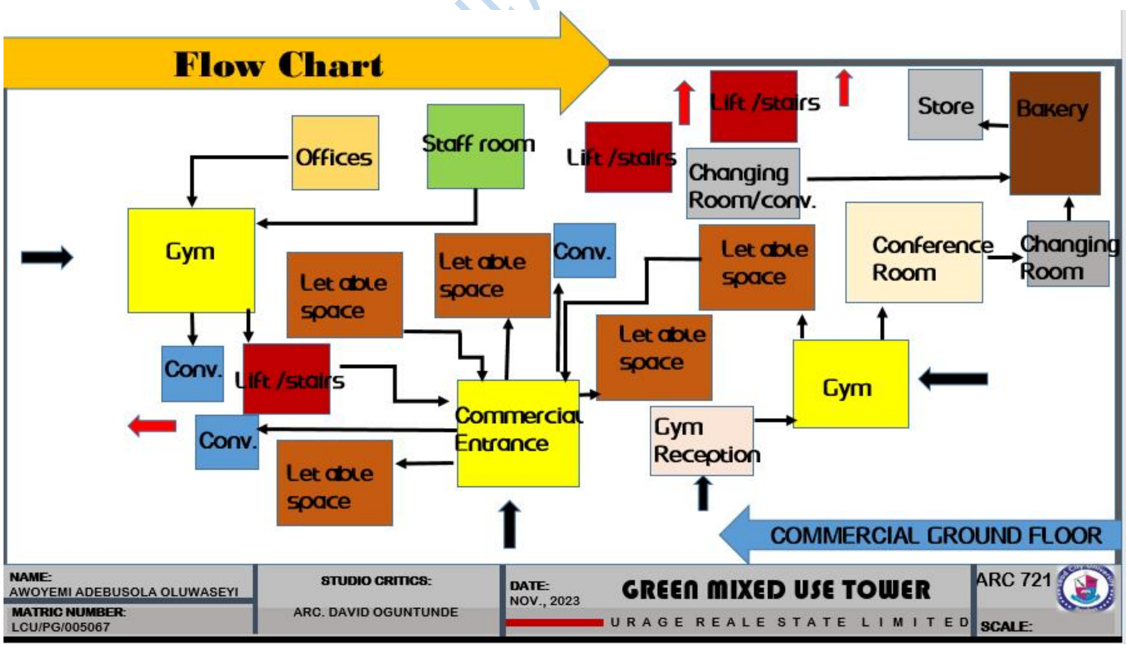


Figure 4.10: Flow Chart of the Proposed Green Mixed Use Tower
Source- (Researcher's Field Work)

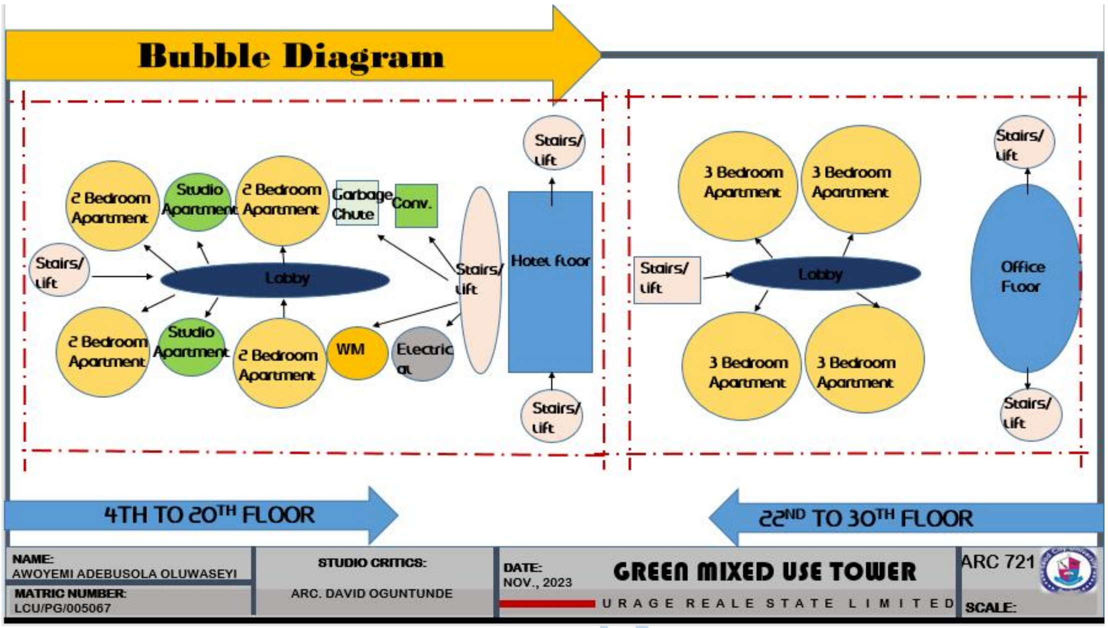


Figure 4.11: Bubble Diagram of the Proposed Green Mixed Use Tower
Source- (Researcher's Field Work)

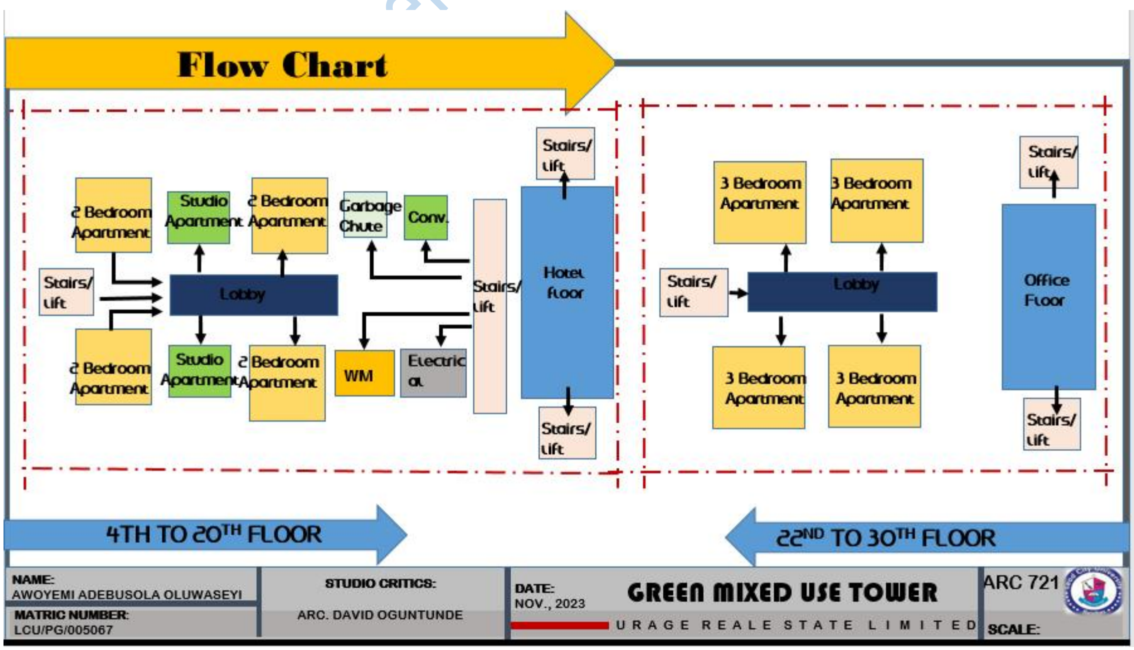


Figure 4.12: Flow Chart of the Proposed Green Mixed Use Tower
Source- (Researcher's Field Work)

4.2.6 Space Allocation/ Schedule of Accommodation

Spatial Requirement

S/N	SPACE	NO	SQUARE METER
	Apartments		
1	Reception lobby	1	16.2
2	Offices	2	188.4
3	Female staff room	2	26.6
4	Male staff room	2	20.5
5	Gym	1	19.6
6	Male locker	1	7.6
7	Female locker	1	10.6
8	Conveniences 1	4	2.0
9	Service floor	2	854.1
10	Studio apartments	60	54.23
11	2 bedroom apartments	60	129.01
12	3 bedroom apartments	56	289.8
13	Utilities	30	9.4

S/N	SPACE	NO	SQUARE METER
	Apartments		
14	lifts	4	2.26
15	Staircase	2	7.2
16	Service and goods lifts/Stairs	1	9.46
17	Garden	2	347
18	Conveniences 2	30	2.1
19	Laundry	30	4.3
20	Basement parking	1	2231.4

NAME: AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER: LCU/PG/005067
STUDIO CRITICS: ARC. DAVID OGUNTUNDE
DATE: NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE:

Figure 4.13: Spatial Requirement of the Proposed Green Mixed Use Tower Source-

(Researcher's Field Work)

Spatial Requirement

S/N	SPACE	NO	SQUARE METER
	Hotel and Office		
1	Reception lobby	1	49.61
2	Restaurant	1	484.3
3	Conference room	1	491.47
4	Dressing Room	2	22.5
5	Bar	1	261. 80
6	Executive suites	20	50.6
7	Presidential suites	40	54.4
8	Single suites	40	20.1
9	Office floor	30	420.5
10	Service floor	2	780.34
11	Gym	1	477.5
12	Service and goods lifts	1	15.84

S/N141 16	SPACE	NO	SQUARE METER
	Hotel and Office		
12	Mini-mart	1	29.48
13	Kitchen	1	59.13
14	Wet Store	1	22.63
15	Dry store	2	24.87
16	Office	1	24.71
17	Staff Conveniences	2	6.3
18	Female changing room	1	35.67
19	Male changing room	1	24.16
20	Staircase & lift	2	16.12
21	Basement parking	2	4085.9
21	Roof top garden	1	788.61

NAME: AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER: LCU/PG/005067
STUDIO CRITICS: ARC. DAVID OGUNTUNDE
DATE: NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE:

Figure 4.14: Spatial Requirement of the Proposed Green Mixed Use Tower
Source- (Researcher's Field Work)

4.2.7 Construction Methods and Materials

The frame system has been selected as the building method for the civil work. The majority of the other parts, however, will be assembled on location and placed appropriately. On-site installation of prefabricated steel work is planned.
A pile foundation with deep piling columns will be used to support the building due to the characteristics of the site's soil. All plumbing and electrical will be carried through conduits for safety and durability, and the water supply pipes will be composed of PPR (Polypropylene Random), which has fewer joints to reduce the possibility of leaks. The exterior work will be completed with great care, and trees that will be carefully tended to encourage strong growth will be planted. In addition, walkways will be constructed using concrete paving stones. Concrete, steel, and glass will be the main building materials.

4.2.8 Building Services

4.2.8.1 Water Supply

Although the location has access to a lagoon for water supply, there will be provisions for overhead and ground water tanks for storage. Near the building's moist sections are where the ducts are situated. The ducts are sufficiently broad to provide for easy maintenance access from every floor.

4.2.8.2 Power Supply

Power will come from the national grid of the Power Holding Company of Nigeria (PHCN), but the design will also provide for the site's power needs because integrated BIPV solar panels reduce cooling and power costs. A transformer will also be installed on the site due to the facility's power requirements. The site has access to water from the lagoon, but there will be provisions for overhead and ground water tanks for storage. Ducts are close to the building's wet areas, and they are wide enough to be easily accessible from each floor for convenient maintenance.

4.2.8.3 Refuse Disposal

The rear side of the building's main area of services will be used to collect the building's rubbish, which will then be stored in the waste disposal area where the disposal agency will be collecting and disposing the waste.

4.2.8.4 Waste Water and Sewage Disposal

Water closet waste should be drained via the central sewer line, treated at the sewage treatment plant, and then disposed of in an environmentally safe manner.

4.2.8.5 Firefighting System

Water sprinklers should be installed in every room and corridor, fire hydrants should be placed strategically for fire fighters to easily gather water, and smoke detectors should be installed.

Chapter Five

Conclusion and Recommendation

5.4 Project Appraisal

The focus of this study was to design a green mixed use tower, focusing on design strategies of achieving green building to reduce environmental impacts and create a cleaner, healthier environment for residents. To achieve this, various design strategies were integrated during the design stage. These strategies include the introducing of energy efficiency in building design, sustainable materials, biodiversity and green spaces, and considering indoor environmental quality.

Using a passive solar design to reduce reliance on fossil fuels and natural gas. Careful analysis of by using natural ventilation, improvement of its structure (inside and out), optimizing building systems and controls, installing high-efficiency appliances and lighting, and also using of green spaces(green terraces, green roofs and vertical green walls).

All these design strategies and measures have significantly reduced the carbon footprint of the proposed building.

5.5 Conclusion

Mixed use tower In However, while they contribute significantly to development, telecommunications also contribute to growing concerns about greenhouse gas (GHG) emissions due to their reliance on non-renewable energy sources in telecommunication facilities. These strategies includes energy efficiency in building design, sustainable materials, biodiversity and green spaces, indoor environmental quality Green mixed-use towers provide many advantages, including bettering biodiversity, lowering air pollution, fostering sustainable architecture, generating microclimates, and boosting the quality of urban life. . This study has identified several design strategies that can promote environmental sustainability and reduce carbon emissions which includes vegetation into their construction, which lessens the effects of flooding in metropolitan settings, promotes city development, and lessens excessive heat, Energy Efficiency in Building Design, use of Sustainable Materials, Biodiversity and Green Spaces Indoor Environmental Quality Furthermore, green mixed-use structures, maximizing spatial use and design to improve the performance of green buildings. Additionally, including sustainable layers within mixed-use complexes such as green towers offers a tactical ecological intervention opportunity that fosters fundamental eco-values within a framework for quick realization. All things considered, green mixed-use buildings offer a viable way to solve environmental and health concerns in crowded cities while improving the overall urban environment.

5.6 Recommendation.

I. **Energy Efficiency in Building Design:** Energy efficiency in green mixed-use tower design is essential. Cities can lower household energy consumption and greenhouse gas emissions by giving priority to low-rise, integrated mixed-use buildings. Mix-use building models that incorporate energy conservation ideas, including using solar panels for passive design, will fulfill the principles of energy conservation in urban environments and improve energy efficiency even more. Overall, green buildings can approach NetZero energy use and aid in international efforts to reduce carbon emissions by achieving large energy savings through thorough design, modeling, and simulation.

II. **Sustainable Materials:** sustainable materials for environmentally friendly mixed-use tower architecture; several creative strategies have been investigated. Utilizing waste materials such as recycled aggregate concrete (RAC), which is derived from construction and demolition debris, has been the subject of research in an effort to create concrete mix designs that improve mechanical performance while having a less environmental impact.

III. **Biodiversity and Green Spaces:** It is essential to encourage widespread adoption of Biodiversity and Green Spaces design strategies in green mixed use tower.

IV. **Indoor Environmental Quality:** It is essential to encourage widespread adoption of sustainable site design strategies using indoor environmental quality by using natural ventilation, improvement of its structure (inside and out), optimizing building systems and controls, and by installing high-efficiency appliances and lighting.

References

A., Salman, Tuqa, Mahmood, Hameed. (2023). the impact of investment renewable energies sources in green architecture applications. Nucleation and Atmospheric Aerosols, doi: 10.1063/5.0107138

Aakanksha, Tiwari. D., R., Singh. Urfi, Fatmi., C., John, Wesley. (2023). A Study on vertical gardens in urban areas under agro climatic conditions of Prayagraj, India. International Journal of Enviornment and Climate Change, doi: 10.9734/ijecc/2023/v13i92282

Abdul, M., Muslimsyah, Mochammad, A., & Mahlil. Banda Aceh. (2019). Application of precast foamed concrete panels for the structural deck of green roof system. IOP Conference Series: Materials Science and Engineering,The 9th AIC 2019 on Sciences & Engineering (9thAIC-SE). pp. 18-20. DOI 10.1088/1757-899X/796/1/012039.

Alexandre, Disser, Bing, Ye. (2022). Indoor environmental quality in green certified office buildings. IOP conference series, doi: 10.1088/1757-899x/1252/1/012054

Antonia, Gravagnuolo., Mauro, Varotto. (2021). Terraced Landscapes Regeneration in the Perspective of the Circular Economy. Sustainability, doi: 10.3390/SU13084347

B., Yuan. (2023). Analysis and Prospects on the Construction of High-Rise Green Buildings. Highlights in Science, Engineering and Technology, doi: 10.54097/hset.v51i.8256

Chitra Chidambaram, Surabhi S. Nath, Pranjali Varshney, Sakshi Kumar. (2022). Assessment of terrace gardens as modifiers of building microclimate. Energy and built environment, doi: 10.1016/j.enbenv.2020.11.003

Conejos, S., Chew, M.Y.L. & Azril, (2019). F.H.B. Green maintainability assessment of high-rise vertical greenery systems. Facilities, 37 (13/14), pp. 1008-1047. https://doi.org/10.1108/F-09-2018-0107.

Cong, Gong, Chang-Ching, Hu. (2022). Community Public Open Space Planning Based on Green Infrastructure with the Priority of Biodiversity. IOP Conference Series: Earth and Environmental Science, doi: 10.1088/1755-1315/994/1/012002

Davis, M.M., Vallejo Espinosa, A.L., & Ramirez, F.R. (2019). Beyond green façades: active air-cooling vertical gardens, Smart and Sustainable Built Environment, 8 (3), pp. 243-252. https://doi.org/10.1108/SASBE-05-2018-0026.

Davis, M.M., Vallejo Espinosa, A.L., & Ramirez, F.R. (2019). Beyond green façades: active air-cooling vertical gardens, Smart and Sustainable Built Environment, 8(3), pp. 243-252. https://doi.org/10.1108/SASBE-05-2018-0026.

Ekta, Dwivedi., Ravinder, Kumar. (2023). Evaluating the Effectiveness of Energy-Efficient Design Strategies in Achieving Net Zero Energy Building through Reduced Energy Consumption. International Journal for Science Technology and Engineering, doi: 10.22214/ijraset.2023.49774

Ezema, I., C., Maha. S. A., (2022). Energy Efficiency in High-rise Office Buildings: An Appraisal of its Adoption in Lagos, Nigeria. IOP Conference Series: Earth and Environmental Science, doi: 10.1088/1755-1315/1054/1/012037

FayazAhmad, Sofi. (2022). Research on Renewable Energy Architectural Integration Technology and Building Form. doi: 10.3233/atde220903

Gago, E. J., Roldan, J., Pacheco-Torres, R., & Ordóñez, J. (2013). The city and urban heat islands: A review of strategies to mitigate adverse effects. Renewable and Sustainable Energy Reviews, 25, pp. 749-758. https://doi.org/10.1016/j.rser.2013.05.057.

Hermawan, H., Fiyantoro, D., Svajlenka, J., & Arrizq, A. N. (2023). Green Architecture of Nahdlatul Ulama Yogyakarta University Campus Building from Material and Energy Aspects. 5(2), 229–238. https://doi.org/DOI:https://doi.org/10.17509/jare.v5i1. 62912

Hirou, Karimi., M., Adibhesami., Hassan, Bazazzadeh. (2023). Green Buildings: Human-Centered and Energy Efficiency Optimization Strategies. Energies, doi: 10.3390/en16093681

I., C., Ezema S., A., Maha. (2022). Energy Efficiency in High-rise Office Buildings: An Appraisal of its Adoption in Lagos, Nigeria. IOP Conference Series: Earth and Environmental Science. doi: 10.1088/1755-1315/1054/1/012037

Jemat, A.H., Kamal, N.A. (2022). Evaluation of Parameters for Sustainability Assessment of Green Infrastructure in the Urban Water System. [Book auth.] H., Nor, H. A. H., Ahmad, K. A., Anizahyati, A., Muhd Norhasri, M. S., Norshariza, M.B., & Ekarizan, S. Rohana. Green Infrastructure. Singapore: Springer. pp. 263-284.

Jeong-Taek, Oh, Wing-gun, Wong, Daniel, Castro-Lacouture., Jeehee, Lee, Choongwan, Koo. (2023). Indoor environmental quality improvement in green building: Occupant perception and behavioral impact. Journal of building engineering, doi: 10.1016/j.jobe.2023.106314

Jia, Du., Cong, Yu., Wei, Pan. (2020). Multiple influencing factors analysis of household energy consumption in high-rise residential buildings: Evidence from Hong Kong. Building Simulation, doi: 10.1007/S12273-020-0630-5

Kim, Tai, Up. (2020). Multipurpose air cleaning tower and mixed use buildings with it.

Krivenko, O. P., Oleksandra, Synhayivska. (2022). Optimization of the design process of high-rise buildings with integrated solar systems. Містобудування та територіальне планування, doi: 10.32347/2076-815x.2022.81.208-218

L, Khalvati., Afshin, Balal. (2023). Boosting Solar Energy Production of a Building using New Architectural Design. doi: 10.1109/CISES58720.2023.10183527

Li, X., Li, Q., Qiu, Z., Zhao, L., & Chen, S. (2023). Study on Influencing Factors of Energy Consumption Building Characteristics of High-rise Hotel Standard Floor. 2468. https://doi.org/10.1088/1742-6596/2468/1/012148

Lobna, Hassan, Ali, Hassan, Elgheriani., Parid, Wardi., AbdulBasit, Ali, Ali, Ahmed. (2018). Thermal Performance of a High-Rise Residential Building with Internal Courtyard in Tropical Climate. doi: 10.21834/E-BPJ.V3I7.1240

Maha Abdel, S.A. R. (2023). Green Infrastructure as an Effective Rainwater Management Approach in Cities. Journal of AI-Azhar University Engineering Sector, 18(66), pp. 278-303. doi: 10.21608/AUEJ.2023.283070.

Michelle, D., Enriquez, Dominic, R., Trinidad. (2022). A Biodiversity Conservation Area Using Holistic and Modular Architecture. Civil Engineering and Architecture, doi: 10.13189/cea.2022.100702

Mikayel, G. M. (2023). Base isolation retrofitting design for the existing 2-story stone building and its Conversion into a 3-Story kindergarten. World Journal of Advanced Engineering Technology and Sciences, 08(01), pp. 187-200. https://doi.org/10.30574/wjaets.2023.8.1.0023.

Milosevic, D., Pucher, B., Savic, S., Dunjic, J., & Langergraber, G. (2023). Evaluating the cooling potential of green walls and green roofs in Central European cities. EGU General Assembly 2023, pp. EGU23-9050. https://doi.org/10.5194/egusphere-egu23-9050.

Mohamed, K., Watfa., Amal, E., Hawash., Kamal, Jaafar. (2021). Using Building Information & Energy Modelling for Energy Efficient Designs. Journal of Information Technology in Construction, doi: 10.36680/J.ITCON.2021.023

Mohanad, El-Agami., Gehad, Hanafy., Medhat, M., A., Osman. (2021). Investigating the Effect of High-Rise Buildings' Mass Geometry on Energy Efficiency within the Climatic Variation of Egypt. Sustainability, doi: 10.3390/SU131910529

Mupeta, M., Kuntashula, E., & Kalinda, T. (2020). Impact of Urban Agriculture on Household Income in Zambia: An Economic Analysis, Asian Journal of Agriculture and Rural Development, 10(2), pp. 550–562. https://doi.org/10.18488/journal.ajard.2020.102.550.562.

Nakhara. Khongouan, W., & Khamwachirapithak, P. (2021). Green Infrastructure Development in Urban Areas: Case Studies of Samutsakhon, Krathumbaen and Banphaeo Municipalities in

Samut Sakhon Province., Journal of Environmental Design and Planning, 20(3), p. 119. https://doi.org/10.54028/NJ202120119.

Nedhal, Al-Tamimi. (2022). Passive Design Strategies for Energy Efficient Buildings in the Arabian Desert. Frontiers in Built Environment, doi: 10.3389/fbuil.2021.805603

Oyama, L. S., Pagliarini, M. K. ., Buschieri, C. M., Santos, P. L. F. dos. & Castilho, R. M. M. de. (2021). Research, Society and Development, 10(7), pp.e41510716709. https://doi.org/10.33448/rsd-v10i7.16709

Pavel, Kopecký. (2022). Hygric performance of new building components for vertical green gardens. Acta Polytechnica CTU Proceedings, doi: 10.14311/app.2022.38.0228

Rajesh, Kumar, Vanita, Aggarwal, M., Gupta, Surinder. (2021). Sustainable materials and techniques in affordable high-rise buildings - A case study. doi: 10.1051/E3SCONF/202130901080

S.G., Sheina., Lidia, Girya., N., S., Larin. (2022). Methods of Enhancing Energy Efficiency at the Stage of Construction of High-Rise Residential Buildings. doi: 10.23947/2949-1835-2022-1-1-17-23

Siti, Birkha, Mohd, Ali., Amirhossein, Mehdipoor., Noora, Samsina, Johari., Md., Hasanuzzaman., Nasrudin, Abd, Rahim. (2022). Modeling and Performance Analysis for High-Rise Building Using ArchiCAD: Initiatives towards Energy-Efficient Building. Sustainability, doi: 10.3390/su14159780

Siti, Birkha, Mohd, Ali., Amirhossein, Mehdipoor., Noora, Samsina, Johari., Md., Hasanuzzaman., Nasrudin, Abd, Rahim. (2022). Modeling and Performance Analysis for High-Rise Building Using ArchiCAD: Initiatives towards Energy-Efficient Building. Sustainability, doi: 10.3390/su14159780

Sophia, Harris, G., Ryan, M., Mariño., Koorosh, Gharehbaghi. (2022). The green design of high-rise buildings: how is the construction industry evolving. Technological sustainability, doi: 10.1108/techs-04-2022-0017

Sydney, Gonsalves., Olyssa, Starry., Alexander, Szallies., Stephan, Brenneisen. (2021). The effect of urban green roof design on beetle biodiversity. Urban Ecosystems, doi: 10.21203/RS.3.RS-164289/V1

Szdgmfpe, Siti, Erma, Maemunah. (2023). Study on Influencing Factors of Energy Consumption Building Characteristics of High-rise Hotel Standard Floor. Journal of physics, doi: 10.1088/1742-6596/2468/1/012148

Szdgmfpe., Siti, Erma, Maemunah. (2023). Study on Influencing Factors of Energy Consumption Building Characteristics of High-rise Hotel Standard Floor. Journal of physics, doi: 10.1088/1742-6596/2468/1/012148

Tatiana, Chalkidou. (2023). Biodiversity, Greens and Cultural Spaces. doi: 10.1007/978-981-99-0216-3_8

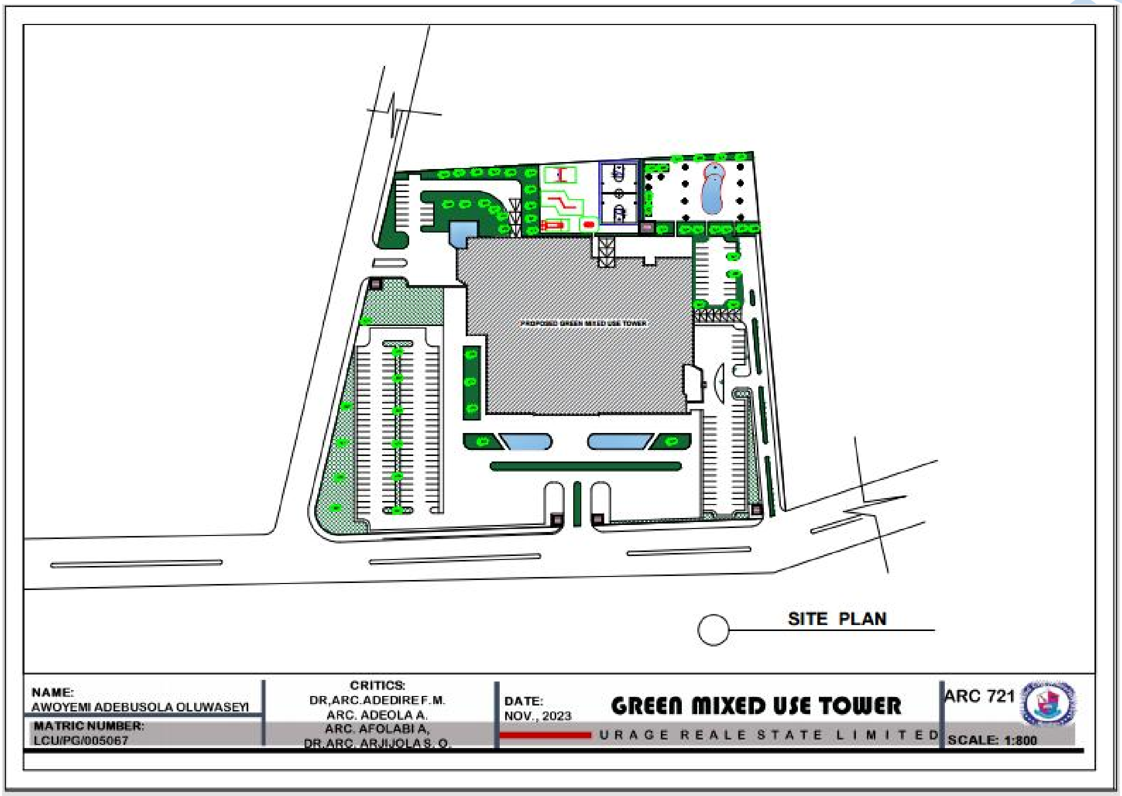
Veena, Mathew, Ciji, Pearl, Kurian, Aravind, Babu. (2022). Simulation-Based Design for an Energy-Efficient Building. doi: 10.1007/978-981-16-1642-6_31

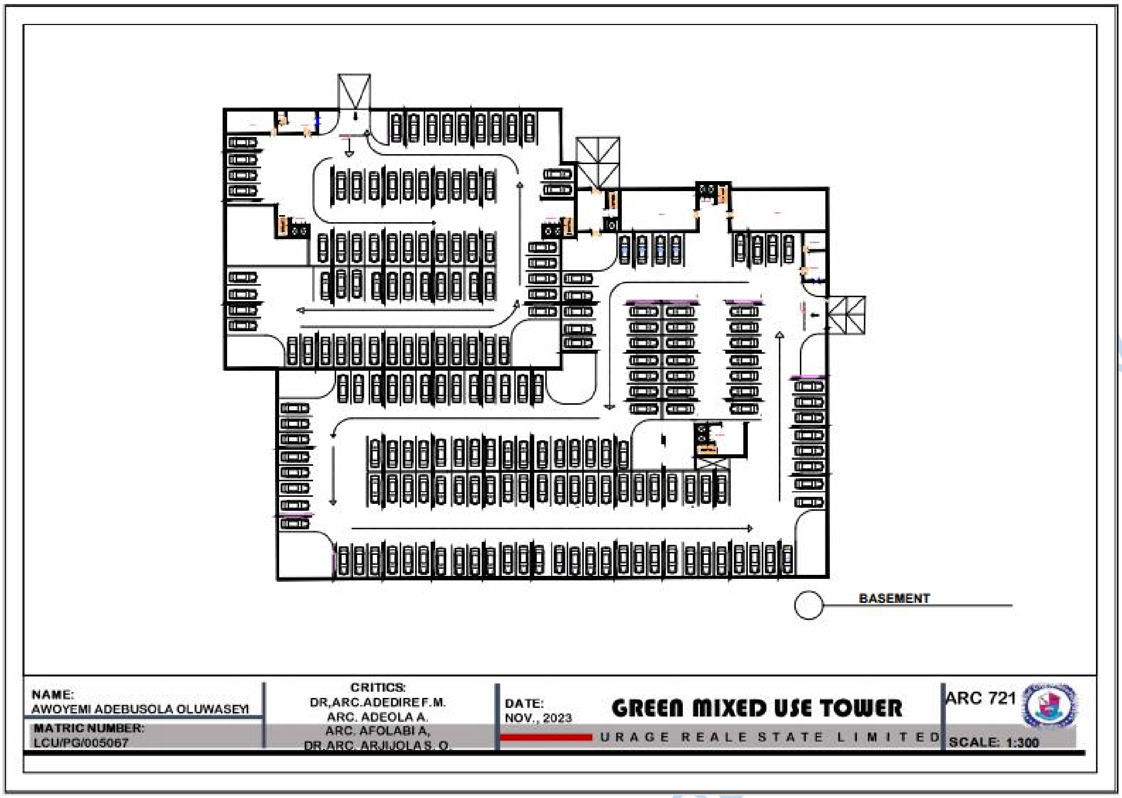
Verena, Marie, Barthelmes., Valentina, Fabi., Stefano, Paolo, Corgnati., Valentina, Serra. (2018). Human Factor and Energy Efficiency in Buildings: Motivating End-Users Behavioural Change. Advances in intelligent systems and computing, doi: 10.1007/978-3-319-96068-5_58

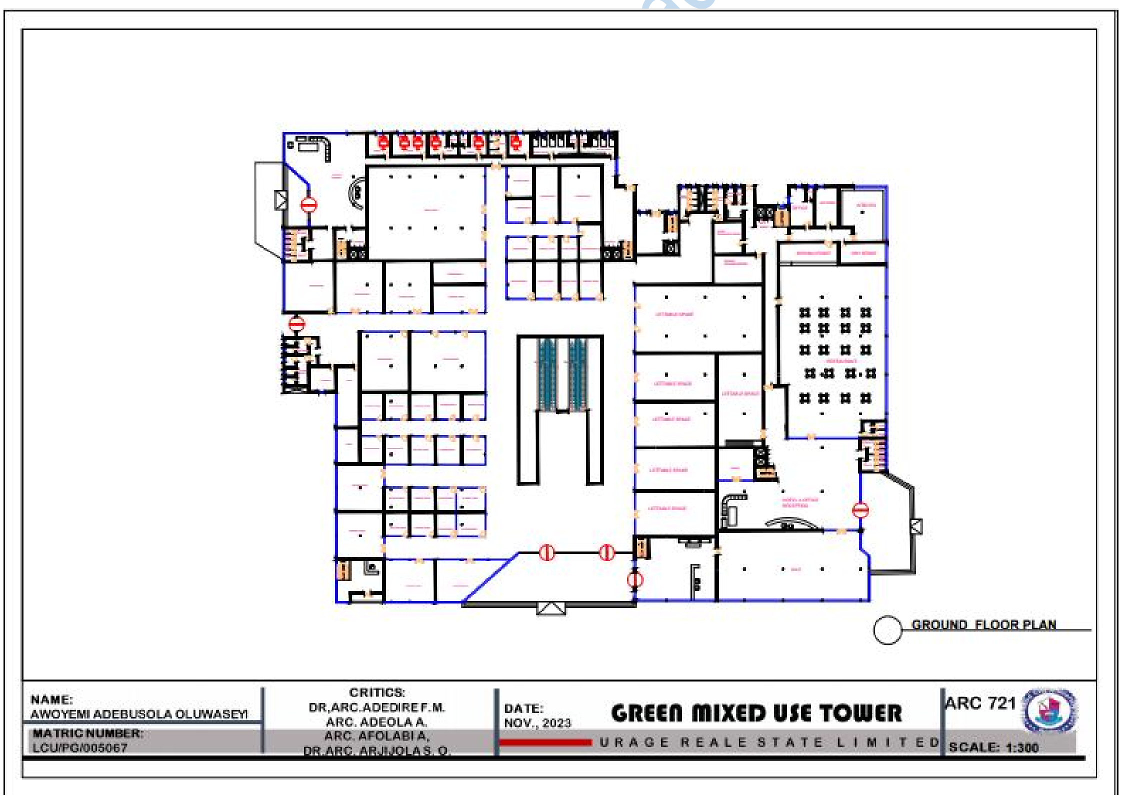
Wanlu, Wang. (2023). The Role in Tall Building Design in Greening the City. Academic Journal of Architecture and Geotechnical Engineering, doi: 10.25236/ajage.2023.050403

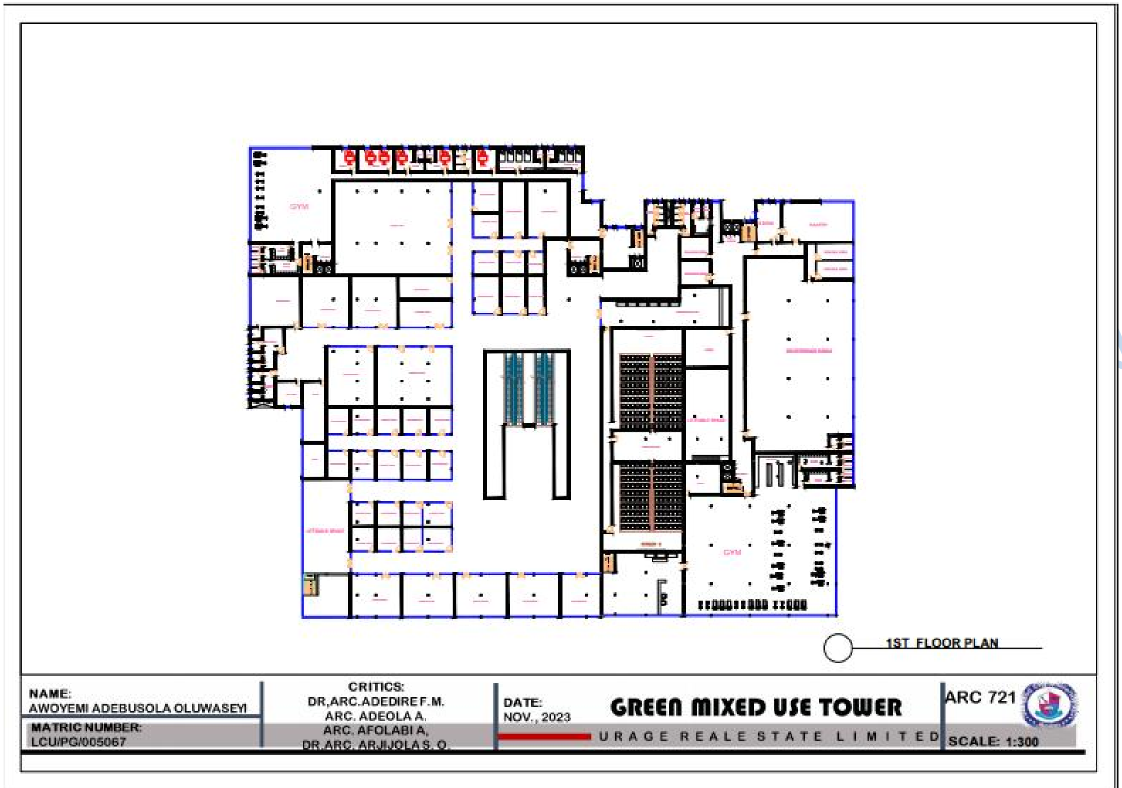
Yasser, Arab., Ahmad, Sanusi, Hassan., Zeyad, Amin, Al-Absi., Hussam, Achour., Boonsap, Witchayangkoon., Bushra, Qanaa. (2023). Retrofitting of a High-Rise Residential Building for Energy Efficiency with OTTV as an Assessment Tool. Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, doi: 10.37934/arfmts.102.2.110119

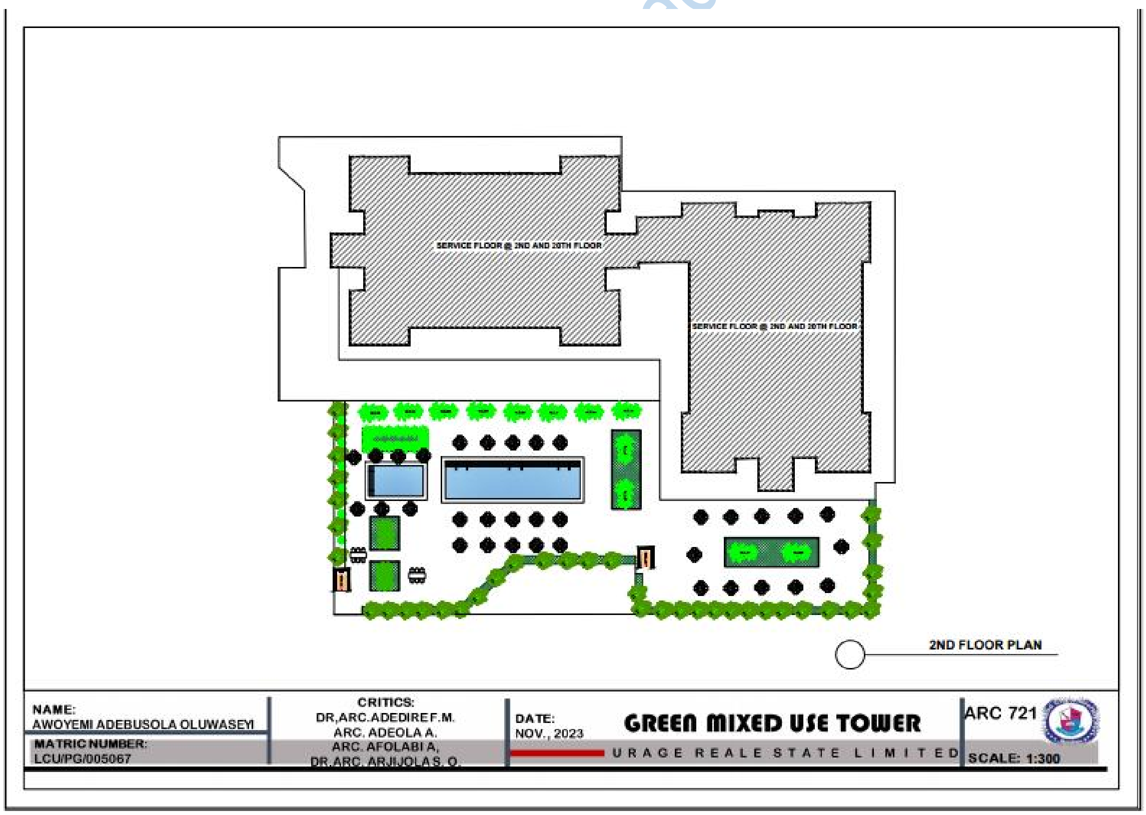
Appendices-Appendix 1- Presentation Drawings

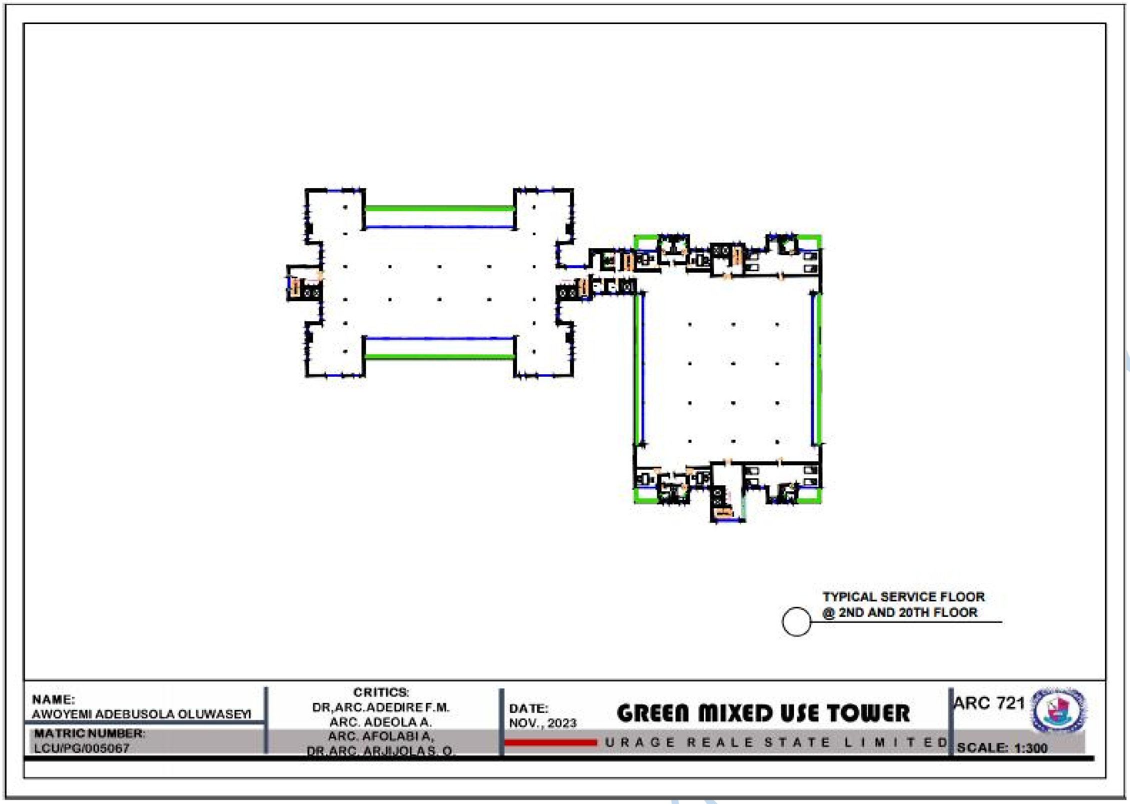


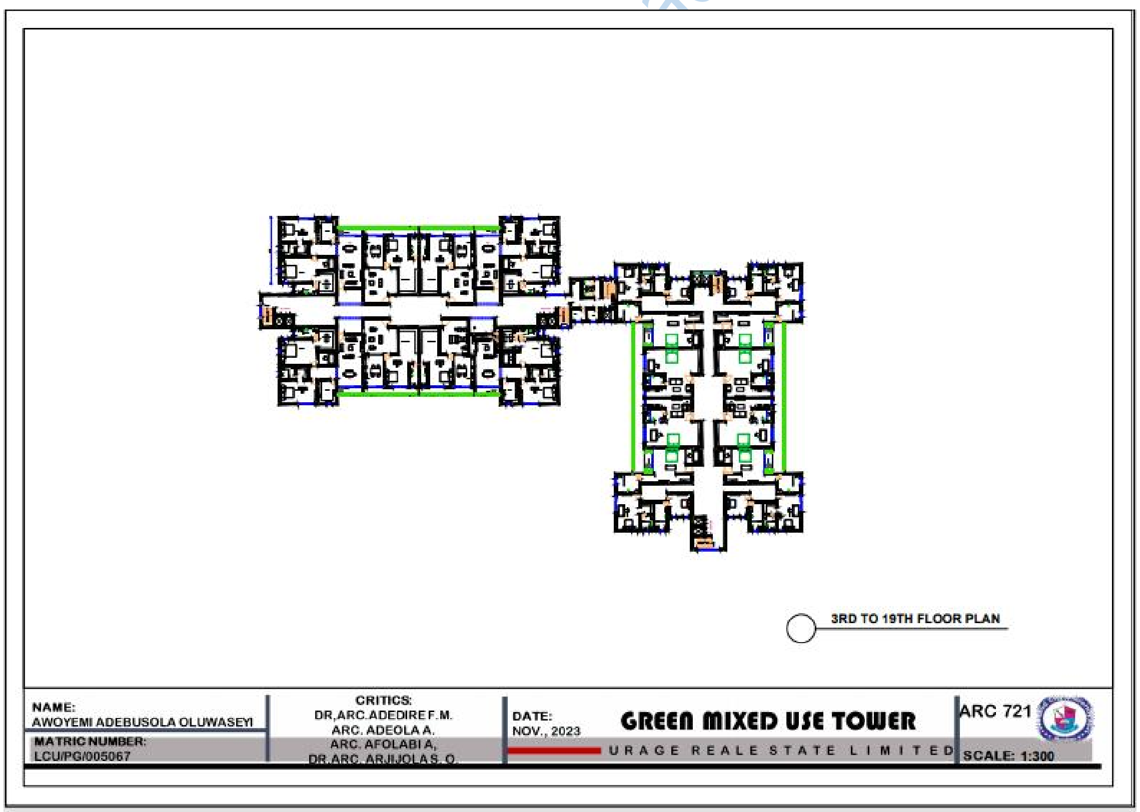

BASEMENT
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
U R A G E R E A L E S T A T E L I M I T E D
ARC 721
SCALE: 1:300

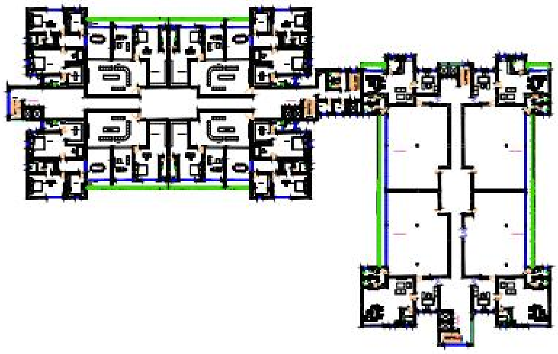

GROUND FLOOR PLAN
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
U R A G E R E A L E S T A T E L I M I T E D
ARC 721
SCALE: 1:300


GYM
GYM
1ST FLOOR PLAN
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:300


SERVICE FLOOR @ 2ND AND 20TH FLOOR
SERVICE FLOOR @ 2ND AND 20TH FLOOR
2ND FLOOR PLAN
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:300


TYPICAL SERVICE FLOOR
@ 2ND AND 20TH FLOOR
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:300


3RD TO 19TH FLOOR PLAN
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:300



21ST TO 25TH FLOOR PLAN

NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067

CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.

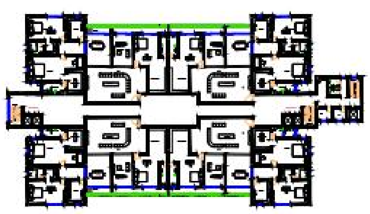
DATE:
NOV., 2023

GREEN MIXED USE TOWER

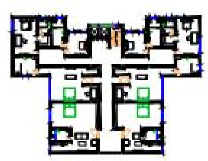
URAGE REALE STATE LIMITED

ARC 721

SCALE: 1:300



26ST TO 31ST FLOOR PLAN



32ND TO 36TH FLOOR PLAN

NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067

CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.

DATE:
NOV., 2023

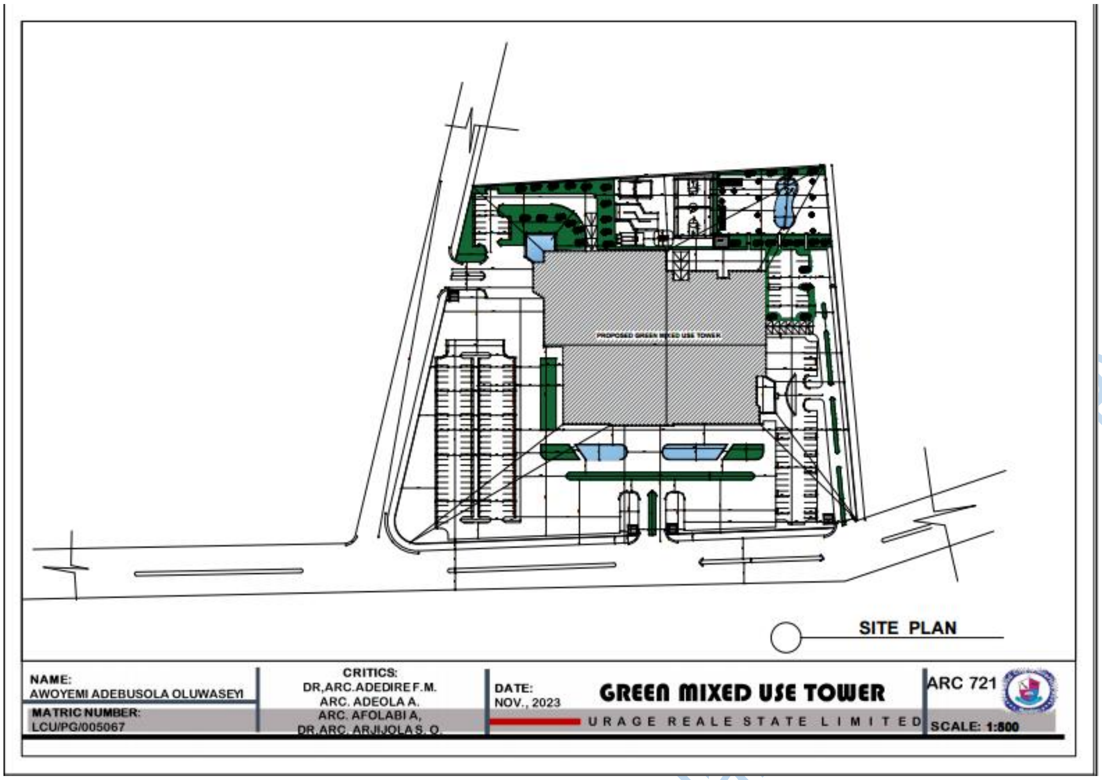
GREEN MIXED USE TOWER

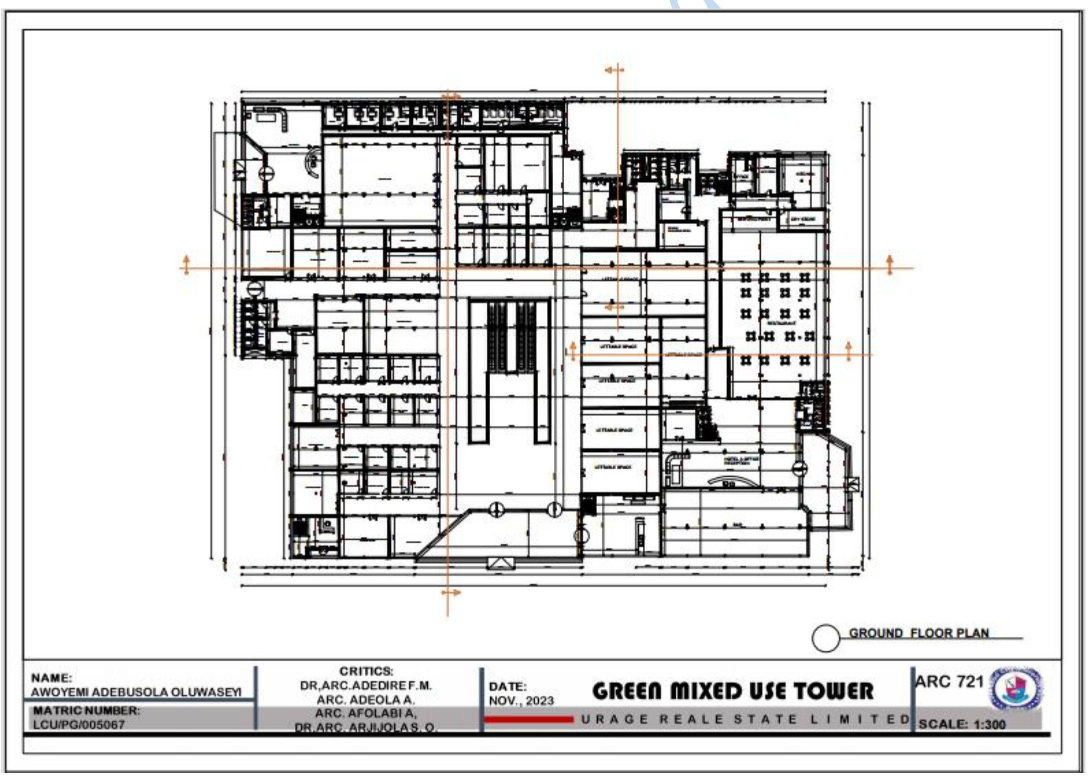
URAGE REALE STATE LIMITED

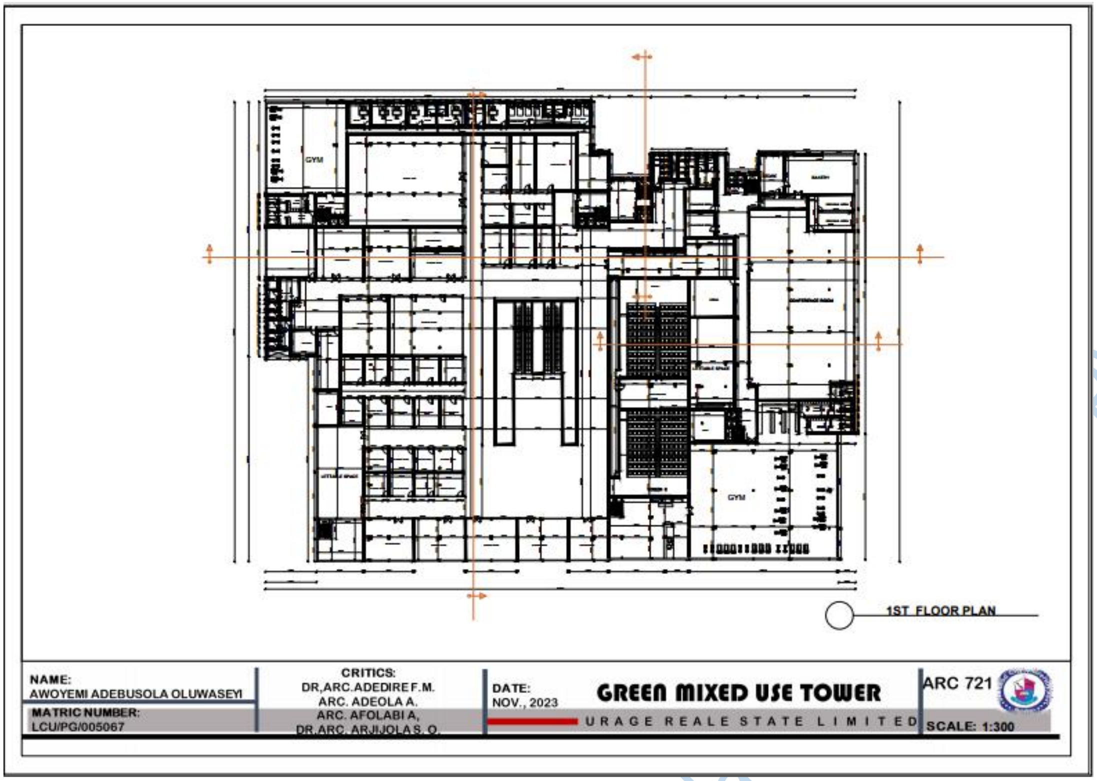
ARC 721

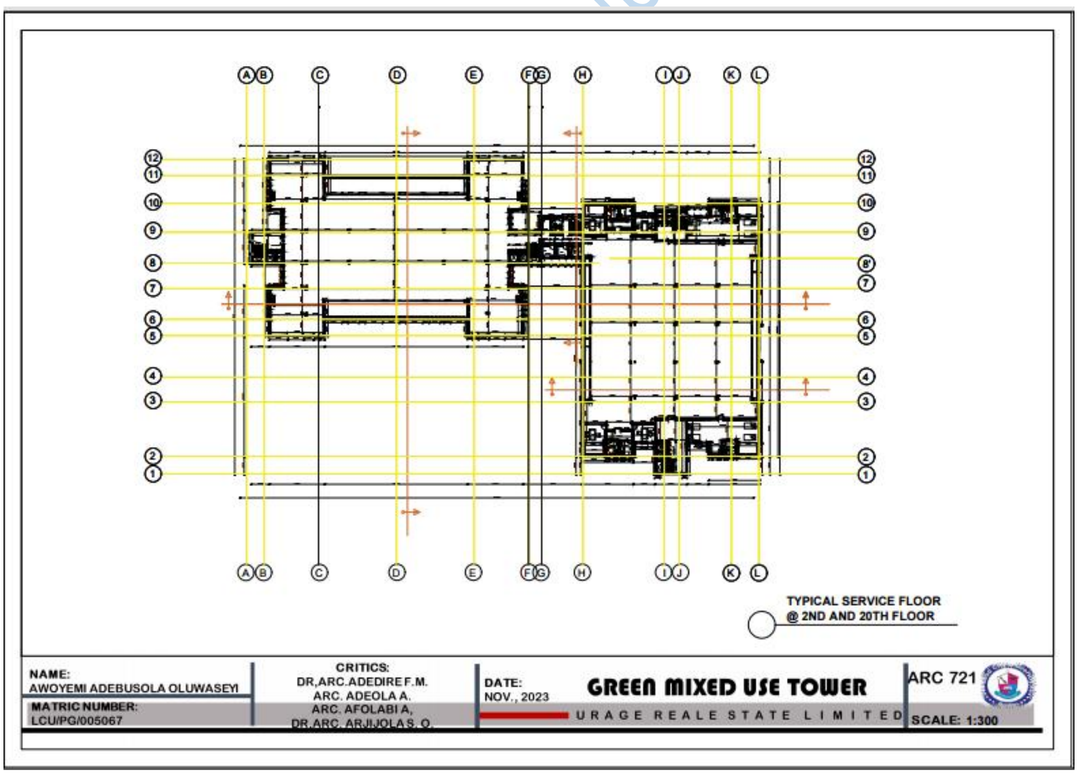
SCALE: 1:300

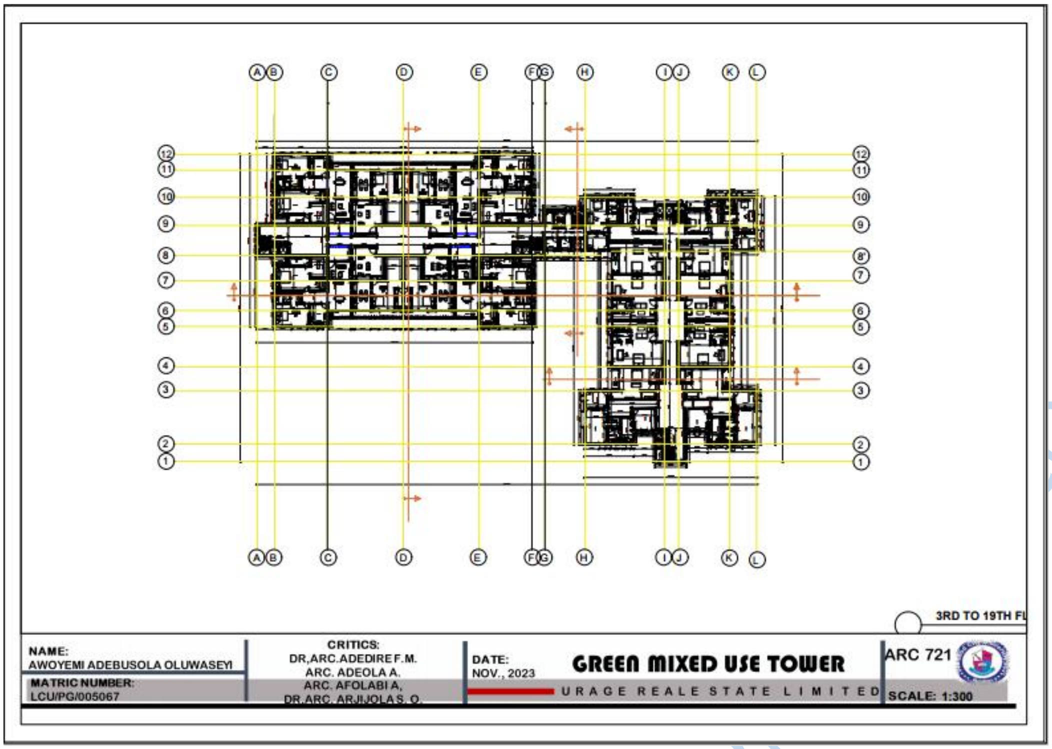
Appendices-Appendix 2- Working Drawings

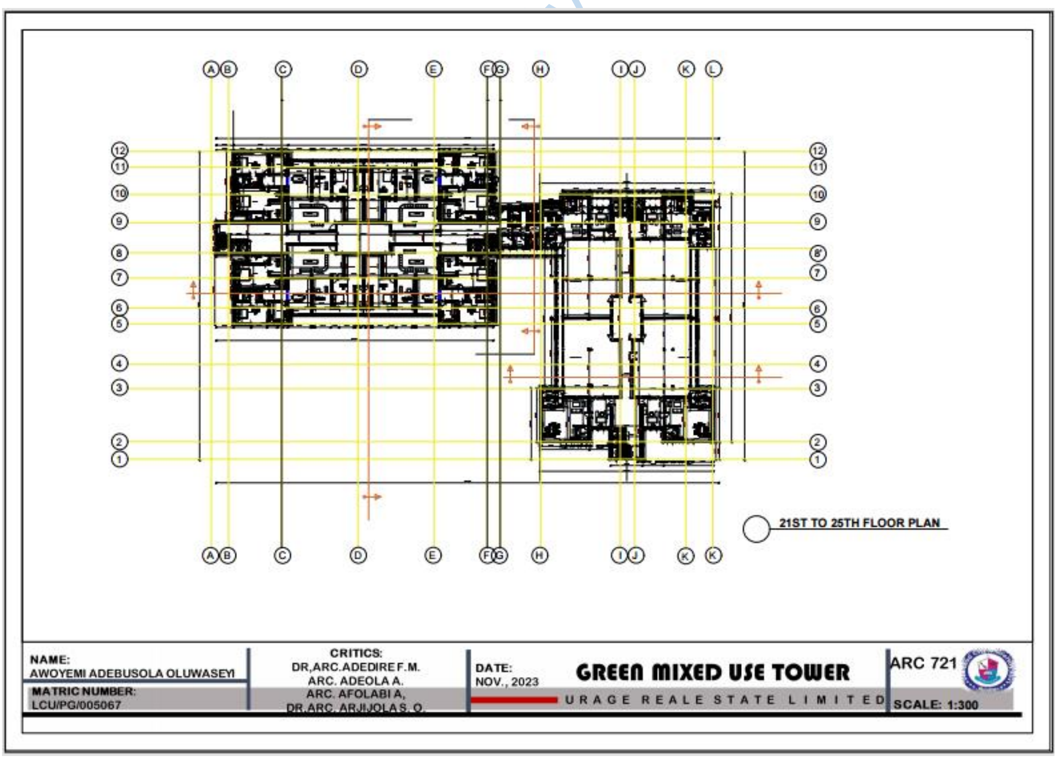

PROPOSED GREEN MIXED USE TOWER
SITE PLAN
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:800

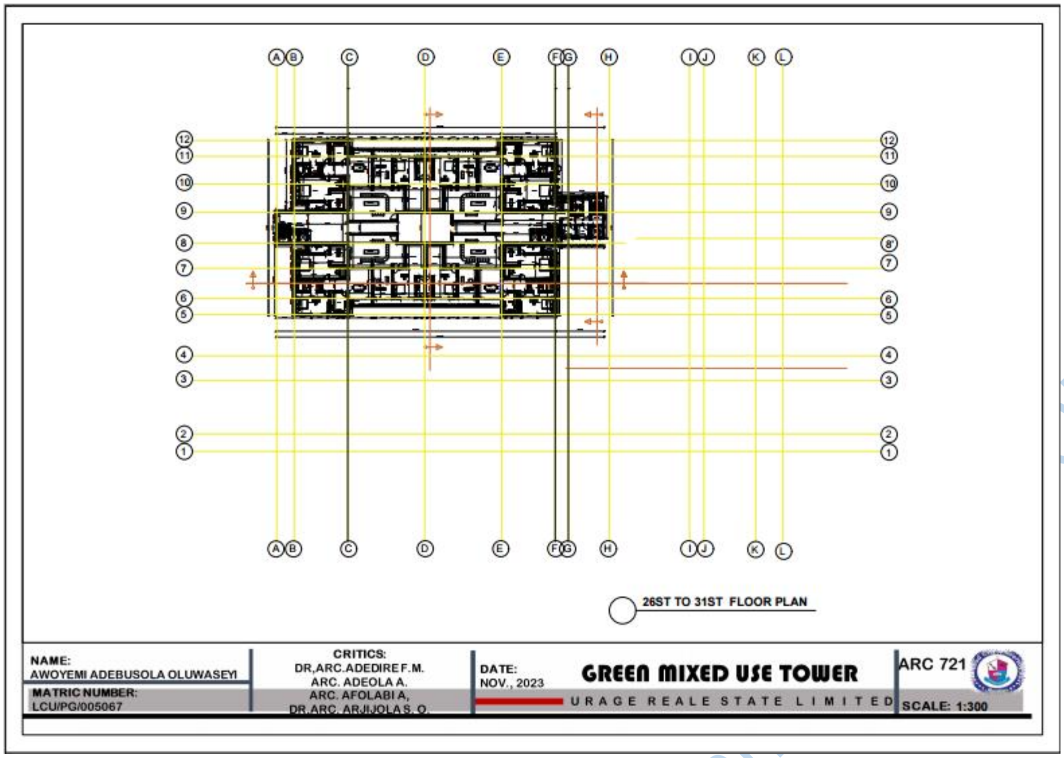

GROUND FLOOR PLAN
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:300

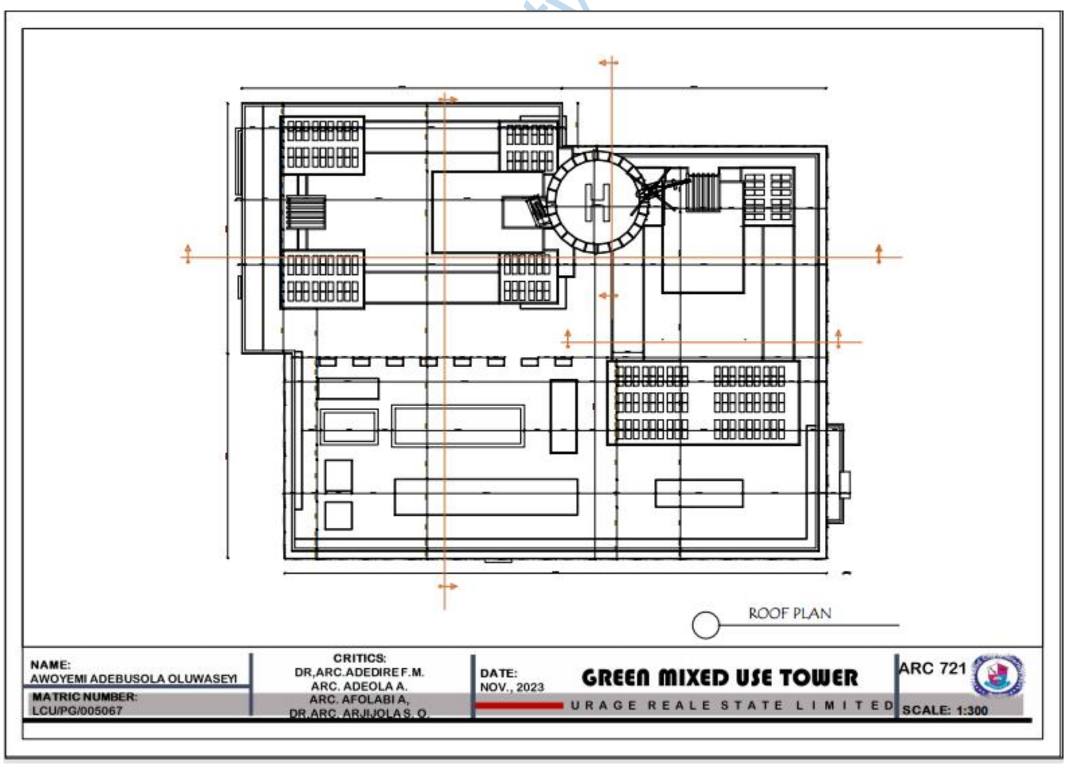

GYM
GYM
1ST FLOOR PLAN
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:300

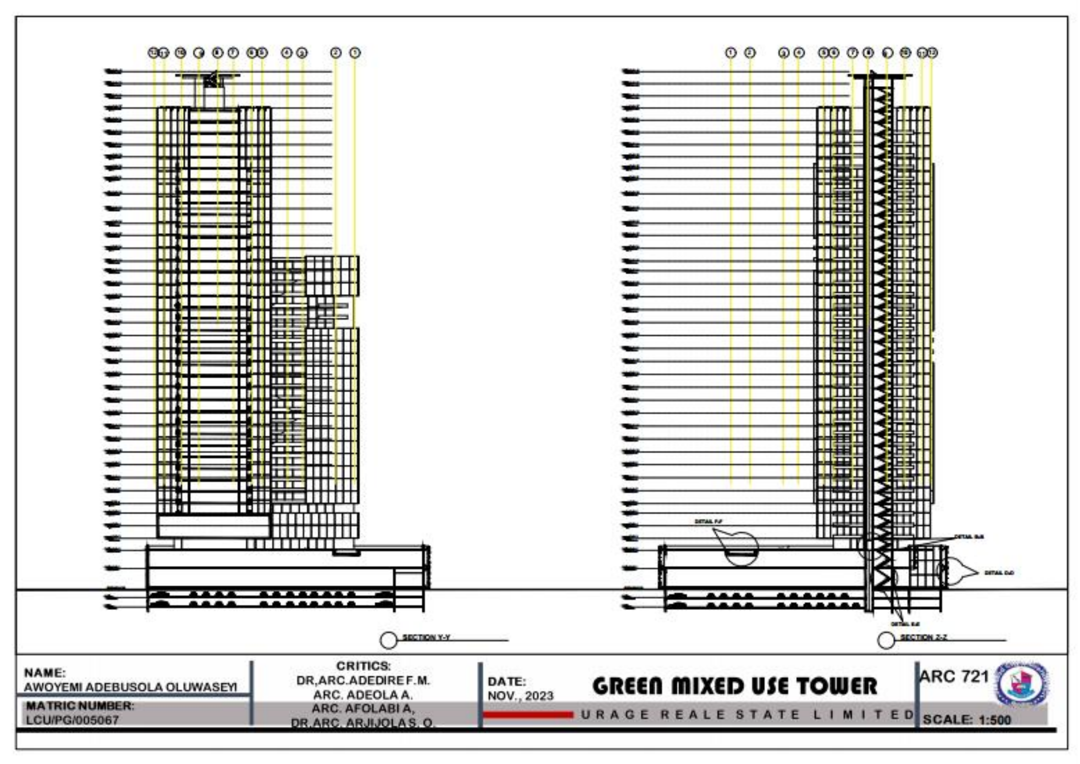

TYPICAL SERVICE FLOOR
@ 2ND AND 20TH FLOOR
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:300

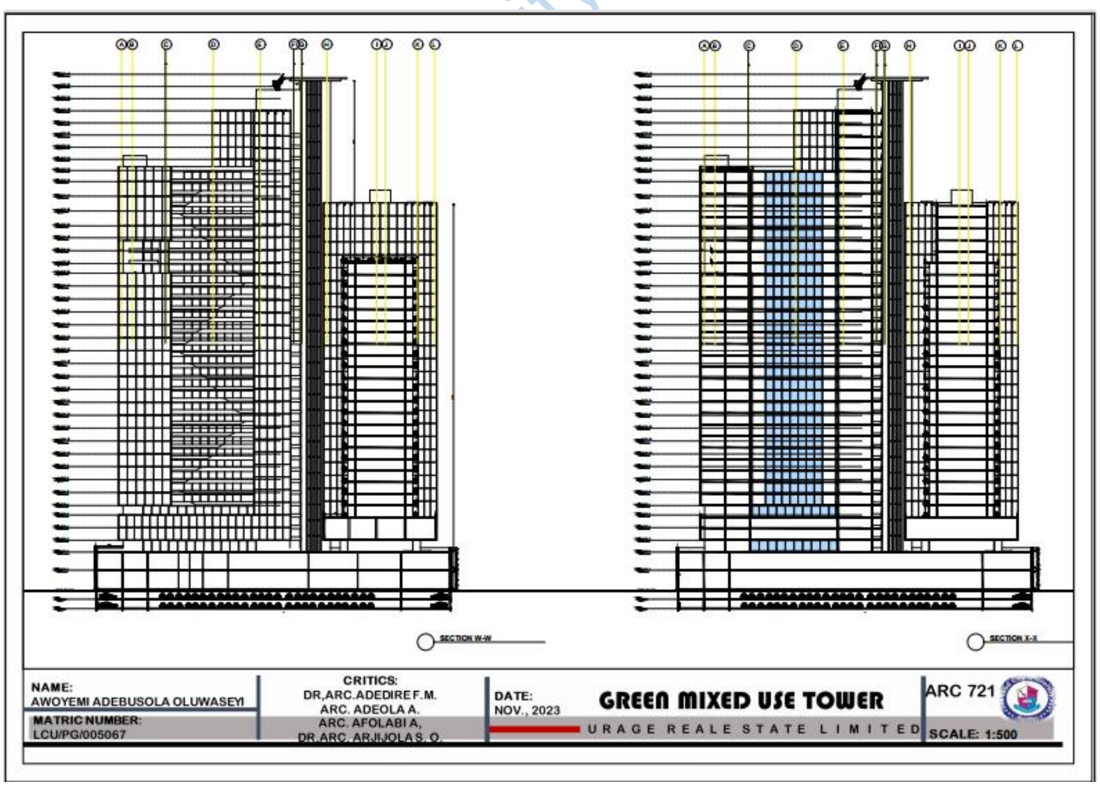

3RD TO 19TH FL
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:300

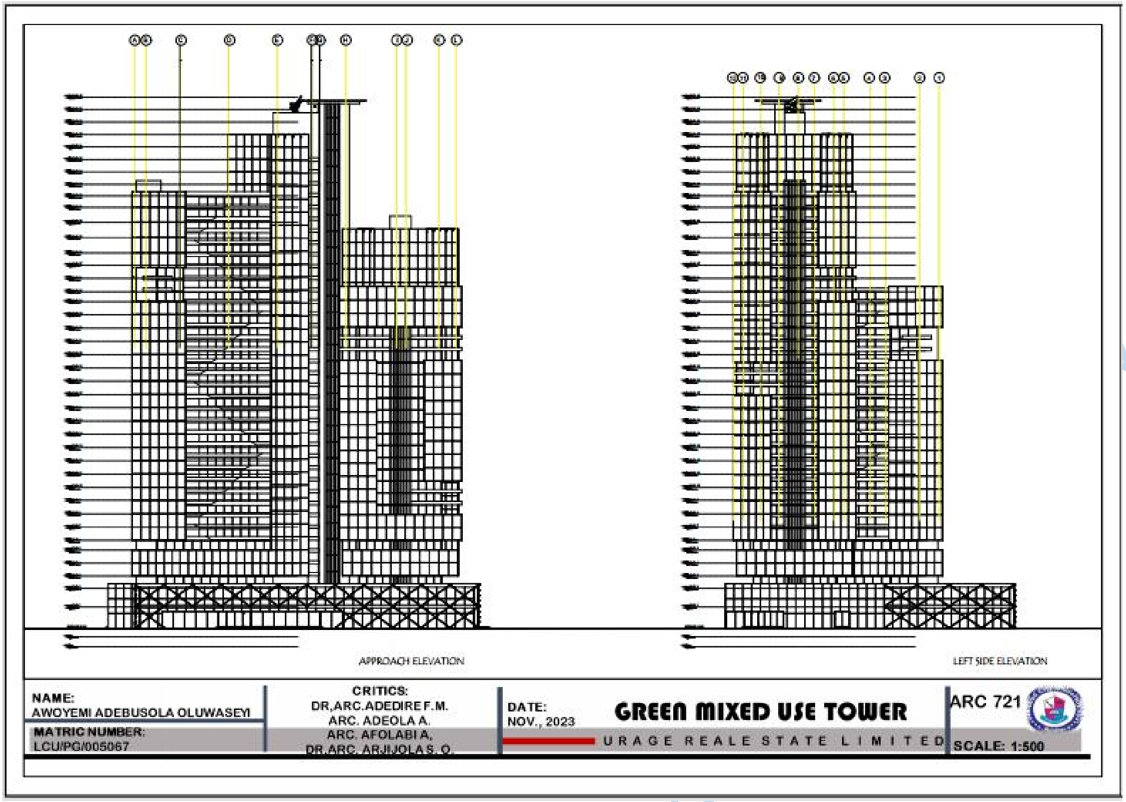

21ST TO 25TH FLOOR PLAN
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:300


26ST TO 31ST FLOOR PLAN
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:300


ROOF PLAN
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:300


SECTION Y-Y
SECTION Z-Z
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:500


SECTION W-W
SECTION X-X
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARJIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:500


APPROACH ELEVATION
LEFT SIDE ELEVATION
NAME:
AWOYEMI ADEBUSOLA OLUWASEYI
MATRIC NUMBER:
LCU/PG/005067
CRITICS:
DR,ARC.ADEDIRE F.M.
ARC. ADEOLA A.
ARC. AFOLABI A,
DR.ARC. ARIJOLA S. O.
DATE:
NOV., 2023
GREEN MIXED USE TOWER
URAGE REALE STATE LIMITED
ARC 721
SCALE: 1:500

Bio-data A

A. Personal Data

1. Full Name:	**AWOYEMI Adebusola Oluwaseyi**
2. Address:	27, Iludun Street, off Testing Ground, Osogbo, Osun State.
3. Email Adress:	awoyemiadebusola@gmail.com, awoyemi.adebusola@lcu.edu.ng
4. Phone Number:	08138031686
5. Date of Birth:	21st July, 1989
6. Place of Birth:	Ile-oluji, Ondo State
7. Nationality:	Nigerian
8. Marital Status:	Married
9. Name and Address of Next of Kin:	Awoyemi Olaoluwa Abimbola, 08060260480

B. Educational Background

1. Educational Institutions Attended with Dates and Qualification:

Qualifications	Institution	Date
MSc Architecture (Ongoing)	Institution Lead City University, Ibadan, Oyo State	2022-Date
BSc. Architecture	Institution Lead City University, Ibadan, Oyo State	2020-2022
HND	Ado Ekiti Polytechnic	2014-2016
ND	Rufus Giwa Polytechnic	2010-2012
Secondary School Certificate	Toluwani Secondry School, Igbaraodo, Ondo State.	2010
Primary Certificate School leaving	New Era Primary School, Ileoluji, Ondo State.	2001

C. Awards and Fellowships:

I. Vice President at the Department of Architectural Technology, Rufus Giwa 2011

D. Work Experience: With Dates

Company	Description	Date
Avidgrip Concept (Ongoing)	design, site supervision Procurements of Building Materials	2019-Date
Boldform Construction Company, Ibadan	Site Supervision	2018
Durklad Design Concept	site supervision, Designing	2016
Multimix Construction Company, Akure	6 months internship	2010
Ondo State Ministry of Works, Akure	A year internship	2012

....

Signature Date

The University Compliance Certification

This is to certify that the Thesis by Adebusola Oluwaseyi **AWOYEMI**, with the matriculation number LCU/PG/0005069 in the Department of Architecture, Faculty of Environmental Design and Management Lead City University, Ibadan, is in full compliance with the University format and style of Thesis

....

Signature Date

Lcu Library

Awoyemi_Adebusosla LCU Library

Quick Submit

Quick Submit

Lead City University

Document Details

Submission ID

trn:oid:::[illegible]

Submission Date

Oct [illegible], 2024, [illegible] PM GMT+1

Download Date

Oct [illegible], 2024, [illegible] PM GMT+1

File Name

[illegible]_Awoyemi_Adebusosla_D.docx

File Size

2.[illegible] MB

[illegible] Pages

[illegible] Words

[illegible],140 Characters

turnitin Page 1 of 127 · Cover Page Submission ID trn:oid:::[illegible]

18% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Match Groups

- **16 Not Cited or Quoted 16%**
  Matches with neither in-text citation nor quotation marks
- **18 Missing Quotations 1%**
  Matches that are still very similar to source material
- **6 Missing Citation 1%**
  Matches that have quotation marks, but no in-text citation
- **0 Cited and Quoted 0%**
  Matches with in-text citation present, but no quotation marks

Top Sources

- **12%** Internet sources
- **7%** Publications
- **6%** Submitted works (Student Papers)

Integrity Flags

0 Integrity Flags for Review

No suspicious text manipulations found.

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.