Energy Efficiency and Sustainability in A Mixed-Use Building

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Certification

This is to certify that Ayoola Emmanuel AJIFERUKE, with matriculation number LCU/PG/002824 carried out this research work titled "Energy Efficiency and Sustainability in A Mixed-Use Building" in the Department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, for the award of Master Degree (M.Sc) in Architecture and this has not been previously submitted.

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Dedication

This research is dedicated to God Almighty.

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Abstract

The energy consumption patterns within mixed-use buildings remain largely uncharted territory, despite the advantages of integrating residential and non-residential functions in urban development. These advantages include reducing transportation energy usage and optimizing land utilization. This research project aims to investigate how the consumption of gas and electricity in mixed-use properties is influenced by factors such as the building's immediate surroundings and its inherent characteristics. The objective is to uncover the connections between the built environment and energy consumption and to identify effective strategies for energy conservation. The thesis also provides an overview of methods for constructing energy-efficient buildings, with a focus on examining how building development can be enhanced from an energy-saving standpoint. Building development is a complex process involving the interests of various stakeholders, and many developed nations have conducted extensive research in this field over the years. In essence, energy-saving strategies can be implemented at three levels: administrative, construction-related, and architectural. Stricter building regulations are continually being introduced and enforced. Additionally, numerous research organizations have devised Building Environmental Assessment (BEA) techniques, which incorporate energy efficiency as a vital component. Furthermore, various technical approaches to enhancing energy efficiency are in development. The thesis aims to explore the theoretical framework for achieving energy-efficient buildings. Ultimately, national laws and policies will play a crucial role in ensuring that every project prioritizes energy efficiency. Technical approaches involve fundamental research that presents proven feasible concepts, while BEA encourages developers to create more energy-efficient buildings for economic gain, serving as exemplary models for the broader market. As the current cycle of standardization and regulation reaches completion, a new one will emerge, incorporating more advanced methodologies.

Keyword: Mixed Housing, Urban Planning, Built Environment

Word Count: 271

Table of Content

List of Tables

List of Figures

List of Plates

Chapter One

Introduction

1.1 Background of the Study

In recent decades, the world has grappled with numerous issues related to global warming and climate change, and Nigeria has played a significant role in exacerbating this problem as one of the leading greenhouse gas emitters. The construction industry, encompassing land use and building construction, has emerged as a major consumer of energy, thereby contributing to climate change impacts (Granqvist, 2014). Approximately 38% and 32% of the nation's total emissions originate from these two sectors, respectively. In response to the government's commitment to reduce emissions by 20% by 2030 (Granqvist, 2014), architects and industry professionals have become more innovative in developing building design concepts.

Buildings serve as the essential infrastructure for human life, housing various necessities. Unfortunately, due to insufficient emphasis on energy management during the design and planning stages, residential buildings stand out as the highest energy consumers (Granqvist, 2014). Residential usage alone accounts for 77.9% of energy consumption (Granqvist, 2014). Despite some regulations aimed at curbing energy consumption in buildings, these measures primarily focus on controlling energy use within the building envelope and often disregard human comfort (Lawrence & Keime, 2016).

Mixed-use building design strives to accommodate a variety of functions within a single structure, considering both the needs of the surrounding area and the building's occupants. With over 50% of the population now residing in cities and climate change intensifying extreme weather events like heatwaves and floods (Alfonsin et al., 2018), urban areas are particularly vulnerable. Technological advancements play a role in enhancing cities' preparedness and adaptation capabilities. Initiatives like the use of sustainable building

materials and ensuring good thermal comfort and indoor air quality, as highlighted by Yong et al. in 2021 (Yong et al.), are essential for human comfort, health, and productivity in buildings.

Designing energy-efficient mixed-use buildings presents challenges, especially because one of the key components for ensuring human comfort (heating, ventilation, and air conditioning systems) requires a significant amount of energy to operate effectively. In this context, energy conservation principles are applied to mixed-use building design to address user comfort and meet human needs.

The escalating global temperatures negatively impact both human comfort and energy consumption. Designing a conducive living environment that enhances productivity while minimizing energy usage has become a primary concern. Thus, creating an energy-efficient mixed-use building design that also provides high levels of human comfort has become the solution to crafting livable spaces today. Building holistically is challenging due to the substantial influence of climatic conditions on both comfort and energy efficiency requirements. To ensure effective working conditions in office buildings and comfortable living spaces in residential structures, interior design must receive attention (Erebor et al., 2018). Architects strive to achieve this level of comfort through architectural designs while minimizing the reliance on fossil fuels.

Developing sustainable future designs necessitates an understanding of how energy-efficient design solutions impact user comfort. Energy poses one of the most significant challenges for the future, demanding a harmonious integration of sustainable development and operational efficiency in buildings. Given the rising cost of energy and the depletion of natural resources, it is imperative to prioritize energy efficiency throughout the entire building lifecycle, from planning and construction to daily use. Enhancing energy efficiency is a method that

optimizes existing resources and carefully plans investments in new technologies, benefiting both the environment and risk management, while better serving occupants and controlling operational costs.

To achieve energy efficiency in buildings, it is imperative to adopt energy-efficient strategies throughout the building process, spanning from planning to operation. Incorporating solar passive measures during the design phase, such as passive solar heating and cooling, building daylighting, and rainwater collection provisions, can lead to nearly energy-neutral buildings. During construction, low-energy building materials and less energy-intensive construction methods should be employed, and renewable energy systems like solar panels and solar water heaters can be integrated into the building.

Therefore, this study aims to investigate energy efficiency and sustainability in mixed-use buildings and its impact on user comfort. It will also explore various strategies that can be implemented to achieve energy efficiency and sustainability in mixed-use buildings in Nigeria.

1.2 Statement of Research Problem

Research indicates that buildings are significant energy consumers, leading to higher greenhouse gas concentrations in the atmosphere, which contribute to global warming. Consequently, there is a growing need for energy-efficient practices. To create a zero-energy building, it is imperative to employ energy-efficient techniques that minimize the structure's energy demands (Shehadi, M. 2020). By optimizing space, resources, materials, and technologies, energy-efficient buildings enhance efficiency, comfort, functionality, and stability. Achieving these objectives often involves collaboration with fields such as telecommunications, building automation, system integration, and office automation. The

overarching goal is to promote a more environmentally friendly environment through increased energy efficiency (Buckman, A., Mayfield, M., & Beck, S. 2014).

The comfort of occupants is directly linked to energy efficiency, and a building is considered "energy efficient" if it can reduce energy consumption while still providing an acceptable level of comfort to its occupants (Borgstein, E., Lamberts, R., & Hensen, J. 2016). Passive and active energy conservation techniques are two general categories used to classify these strategies (Shehadi, M. 2020). Passive methods emphasize optimizing solutions during the design phase to reduce a building's energy demand from the outset. These strategies leverage natural energy sources like water or wind power instead of conventional sources like fossil fuels or electricity. Some researchers emphasize the importance of employing passive energy design principles when creating sustainable and energy-efficient mixed-use structures.

Researchers such as Altan et al. (Altan, H., Aoul, K., Hajibandeh, M., & Deep, A. 2016), Adebisi et al. (Adebisi, I., Ayinla, A., & Okeyinka, R. Y. 2018), and Rattanongphisat & Rordprapat (Rattanongphisat, W., & Rordprapat, W. 2014) have underscored the significance of building orientation. They assert that, for energy efficiency, floor plans should be oriented so that most rooms have windows facing the equator, which affects solar radiation levels. Building orientation also influences wind patterns and natural ventilation, impacting heat loss by convection. Olsson (Olsson, M. 2016) suggests a connection between a building's shape and its overall energy performance.

Recent studies have revealed a positive relationship between higher ventilation rates and increased productivity (McArthur, J., Jofeh, C., & Aguilar, A. 2015). Occupants who are satisfied with the indoor environmental quality of mixed-use buildings tend to adapt and feel comfortable in their surroundings. In developed regions, individuals spend up to 90% of their time indoors, making the indoor environment, whether residential or work-related, crucial for

comfort and health. Research findings indicate that the absence of suitable workplace conditions negatively impacts comfort, worker productivity, performance, and morale (Stephen, H., Maina, J., Chinonso, A., & Ohambele. 2016). Inefficient visual, acoustic, and thermal conditions in the built environment often hinder residents' ability to perform their tasks efficiently, leading to tardiness, missed deadlines, and other disruptive behaviors at work.

Based on multiple case studies, Mirzaei et al. (Mirzaei, M., Yazdanfar, S.-A., & Khakzand, M. 2016) have identified several benefits of mixed-use buildings, including reduced energy consumption when appropriate construction techniques are employed. These buildings also contribute to lower vehicle trips, reduced fuel consumption, and reduced dependence on cars, all of which enhance overall energy efficiency. The above review highlights that Lawrence & Keime's (Lawrence, R., & Keime, C. 2016) research primarily focused on energy efficiency in buildings without considering human comfort, a critical factor for habitability. Therefore, this study evaluates energy-saving strategies and their impact on human comfort to discover new ways to enhance energy efficiency and sustainability.

1.3 Aim and Objectives of Study

The aim of the study is to identify critical indicators/factors responsible for a sustainable mixed-use development and provide strategies for its enhancement in Nigeria.

The objectives are to:

1. Examine the problems facing the sustainability of mixed-use development in Nigeria.
2. Identify the environmental factors influencing sustainable mixed-use development in Nigeria.
3. Analyse the strategies enhancing or promoting sustainable designs in mixed use buildings.

1.4 Research Questions

1. What are the problems facing sustainable mixed-use development in Nigeria?
2. What are the environmental factors influencing sustainable mixed-use buildings in Nigeria?
3. What are the strategies enhancing the sustainability of a mixed-use buildings?

1.5 Scope of the Study

Using case studies from actual mixed-use buildings, a thorough examination of early mixed-use building design technology will be contrasted with modern designs. The study will then examine various difficulties and contributing environmental factors. Similar to this, a survey of existing mixed-use buildings will be carried out in order to gather crucial data regarding the technology used in enhancing the sustainability and adaptability of buildings both locally and globally.

1.6 Significance of the Study

This research will offer valuable insights to architects, serving as a valuable resource for enhancing specific aspects of design. Additionally, it holds significance for various stakeholders, including building industry professionals, students, researchers, educators, and policymakers. It aids in comprehending and tackling challenges associated with creating comfortable and sustainable environments, particularly in the context of energy-efficient buildings.

1.7 Operational Definition of Terms

i. Climate change: Prolonged changes in temperature and weather patterns are known as climate change. These changes may be a result of human activity or natural causes due to the production of heat-trapping gases during the combustion of fossil fuels (such as coal, oil, and gas).

ii. Energy efficiency: Energy efficiency refers to the use of less energy to complete an activity. Energy-efficient homes, buildings, manufacturing facilities, and gadgets use less energy to manufacture things and less energy to heat, cool, and operate appliances and devices. To prevent climate change and lower consumer energy bills, energy efficiency is one of the simplest and most economically available strategies. Achieving net-zero carbon dioxide emissions through decarbonization depends on energy efficiency also.

ii. Mixed-use building: Buildings that integrate three or more dwelling kinds, such as residential, hotel, retail, parking, transportation, cultural, and entertainment under one roof are known as mixed-use buildings. Any combination employed combines a multitude of uses into a single structure or a little space. Because more people live in a given amount of space, this form of building design gives a suburban area the feel of an urban neighbourhood while also raising property taxes for local governments.

iii. Sustainable: The capacity to keep an object's utility and ecological balance is known as sustainability. It refers to a building's ability to be maintained for little to no expense in this context. (2009 Microsoft Encarta)

Chapter Two

Literature Review

2.1 Conceptual Review

2.1.1 The Concept of Mixed Use

Alan Rowley (Rowley, 1996) defines mixed use as a concept integral to the internal structure of settlements. This settlement texture is characterized by three key features: grain, density, and permeability, collectively shaping the nature and quality of an area (Rowley, 1996). Eric Hoppen Brouwer and Erik Louw (2005) build upon Rowley's definition by introducing an additional dimension. According to Hoppen Brouwer and Louw (2005), urban mixed-use typology encompasses a temporal aspect where the overarching theme of an entire building or premises undergoes transformation or transition to another theme. In their explanation, the functional aspect of mixed-use developments involves distinct land uses that combine residential and office spaces, allowing for easy expansion and integration of other uses.

Mixed-use developments amalgamate residential, cultural, commercial, office, and entertainment functions within a single building, structure, or group of structures. These activities and functions contribute to creating comprehensive pedestrian networks and seamless integration (Grant, 2002). According to the mixed-use development handbook, such developments involve the combination of commercial elements like retail, office, and entertainment with non-commercial aspects like residential, both vertically and horizontally. Furthermore, a mixed-use development typically features three or more significant revenue-generating uses, promotes integration, land use density, and compatibility, and fosters a walkable community with continuous pedestrian connections (Levit and Schwanke, 2003).

Mixed land use enables the integration of residential, commercial, and industrial functions within a single building or area. This can encompass a single structure, a cluster of buildings, or an entire neighbourhood development incorporating retail establishments, indoor and outdoor dining options, as well as apartments and condominiums. Such arrangements facilitate higher population density while enlivening urban corners. They allow people to live, work, and relax within the same vicinity, typically found in urban centers. Proximity to workplaces and recreational amenities reduces the reliance on cars, resulting in fewer vehicles on the road and more walkable or bike-friendly environments.

A mixed-use development can take four general forms (Rabianski J. S & Clement J. S 2007).

1. A mixed-use development is firstly represented by a single high-rise building that is located on a single site and has two or more uses integrated into it. This type of mixed-use development has retail on the ground floor, offices above the offices, and either apartments or hotels above the offices.
2. A mixed-use development could also consist of two or more high-rise buildings on a single site, each of which has a distinct use. The most frequent integrations involve an office building, a residential building, and a hotel. On the ground levels of each use, various types of retail may also be present.
3. The mixed-use development can also consist of a number of low-rise buildings on a single site, each of which has office space or residential units above it and retail space on the ground level.
4. A single midrise building on a single site, especially in an urban setting, can be a mixed-use development with residential or office space above and retail on the ground floor. Each of the four types of mixed-use developments can be constructed in a city or a suburb and could be viewed as an expansion or infill project.

Therefore, it is worthy of note that a mixed-use development is identified as being a popular scheme because it provides the following benefits:(American Planning Association, "Planning and Community Health Research Centre).

- Decreasing traffic bottlenecks.
- A wider housing variety and mass
- Reduced driving and walking distances between residential, businesses, and leisure activities
- More compact development
- Stronger neighbourhood character
- Pedestrian-friendly landscaped environments and greenery

The main benefit of mixed-use developments is that they put residents closer to the necessities of daily life. Both residents and employees have more options thanks to it. If properly planned, mixed-use developments can significantly improve daily convenience and enjoyment for residents. Additionally, mixed-use developments can utilize public infrastructure and land more effectively. Utilizing resources like roads, parking, water, and even sewer can be done in a very efficient manner with the right mix of uses.

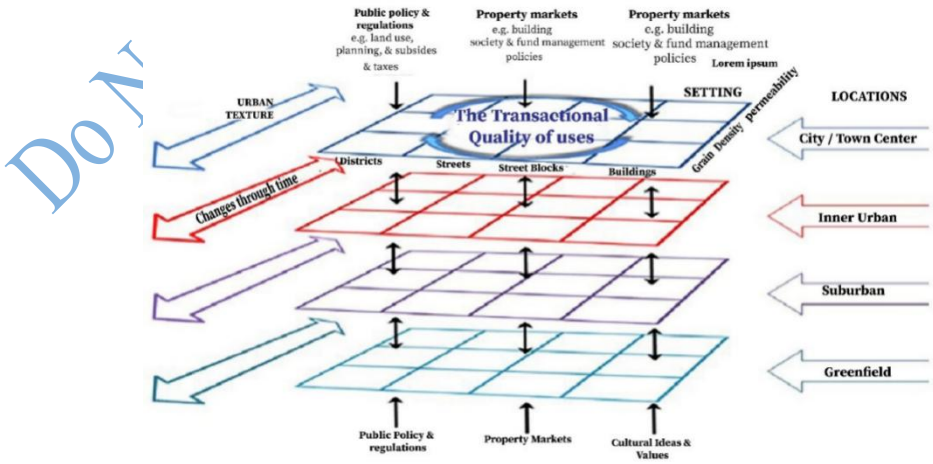

Figure 2.1: Influences on Mixed-use Development
Source - (Rabianski & Clement 2007)

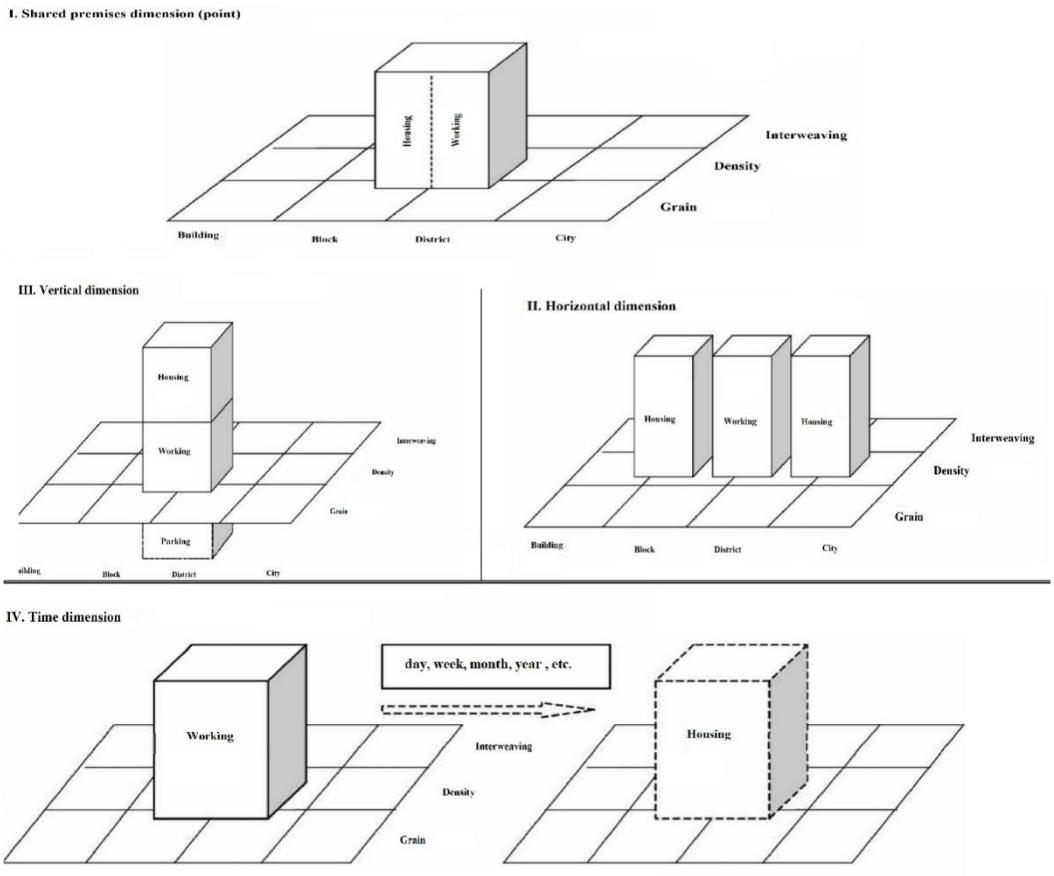

Figure 2.2 : Different mixed-use building pattern
Source - (Rowley, 1996)

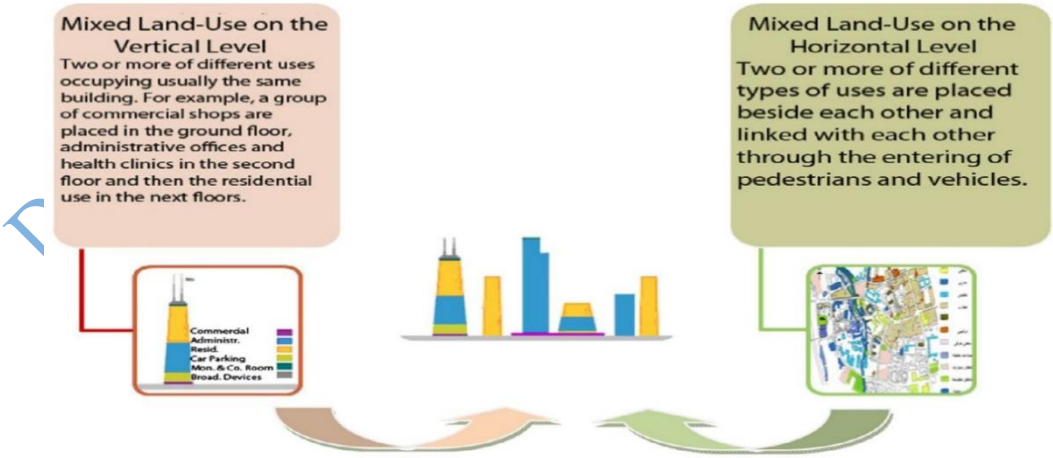

Figure 2.3: Mixed land-use on different levels
Source - (Grant, 2002).

2.1.1.1 The Necessity and Advantages of Mixed-use

A successful combination of uses happens when they work well together, interact favorably, and independently help to create a society that is balanced and offers a wide range of services. Additionally, buildings with various dimensions enable various uses to work together effectively. Government houses should not be distinguishable from private and corporate ones, enjoying equal conditions in terms of their location and ground quality, in order for social groups to have a stronger presence in society (The Commission for Architecture and the Built Environment, 2008). The provision of a building's various uses and activities by mixed-use development promotes the use of centers during workdays and animates streets. Additionally, it results in the best use of the building being made at the same time, with residential uses taking place on higher floors where it is possible to achieve greater privacy and safety and retail business activities taking place at first floor levels to make streets more active (Ku-ring Council, 2013). Social interaction and a rise in mixed-use development result from higher density combinations (Frank, Engelke & Schmid, 2003). In turn, it results in enhancements to social, mental, and physical health.

Table 2.1: Advantages of Mixed-use on Environmental, Social and Economic Factors

Advantages of Mixed-Uses	
Environmental Effects	Reduction in vehicle journeys (multi-purpose journeys), decrease in fuel consumption, less dependence on cars
	Reduction in energy consumption in buildings
Social Effects	Higher availability and use, creating opportunities to use public transport
	Higher safety and lower crime rate
	Rise in quality of life, urban centers, and more attraction
Economic Effects	Production chain and balanced supply
	Regulations on effective use of infrastructures and buildings
	Higher interest rate and economic productivity

Source - (Frank, Engelke & Schmid, 2003)

2.2 Sustainability

The Brandt Land Commission utilized the concept of sustainability to define what has become the most widely accepted interpretation of sustainable development, signifying the fulfillment of community needs. Sustainability represents a path to maintaining progress in a responsible manner, aligning the use of resources, assumptions, technological changes, and economic adjustments while renewing existing and future assets to address human issues and goals (Smith, Charles, and Rees, Gareth, 1998). Sustainable development encompasses three subcategories: social, economic, and environmental sustainability. It underscores sustainability as a concept that encompasses environmental, economic, and social development, as well as justice, all while acknowledging the constraints imposed by the Earth's natural resources. This highlights the fact that sustainable development spans various industries (Daly, 1973).

Social sustainability aims to safeguard social capital by investing in and enhancing societal infrastructure. It involves protecting future generations and recognizing that our actions affect others and the broader world. Social sustainability emphasizes the importance of interpersonal relationships and upholding and improving social quality through concepts like cohesion, reciprocity, and honesty.

Economic sustainability strives to preserve capital. It seeks to elevate the standard of living, while social sustainability concentrates on enhancing social equality. In a business context, economic sustainability pertains to the efficient use of resources to ensure long-term business profitability, as articulated by the UK government.

Environmental sustainability pursues the betterment of human welfare through the conservation of natural resources, such as minerals, air, and water. Initiatives and programs

are deemed environmentally sustainable when they ensure that the needs of the present population are met without jeopardizing the needs of future generations.

Human sustainability endeavours to safeguard and nurture society's human capital. Programs falling under the purview of human sustainability include investments in health and education systems, as well as ensuring access to services, nutrition, knowledge, and skills. Given the scarcity of natural resources and space, striking a balance between ongoing development and universal economic prosperity is crucial. In the realm of business, organizations that respect human capital and view themselves as members of society promote business values aligned with human sustainability.

One of the significant challenges in Nigeria, as in many other developing nations, pertains to housing, particularly in rapidly expanding urban areas. According to data from the UN Population Fund, since 2010, more people worldwide reside in urban areas than in rural ones, with urban areas accounting for 56.2% of the global population in 2020. However, they also represent over 60% of resource utilization and about 70% of global carbon emissions. Achieving sustainable development with this level of urbanization requires fundamental changes in the way we design and maintain urban spaces. In Nigeria, residents share a common desire for access to clean air and water, a secure and healthy environment, and the ability to participate in decisions that impact their lives. Sustainable community development forms the foundation for addressing these aspirations. Nigeria should aspire to high levels of development, but without a sustainability plan, these efforts may prove ineffective or transitory. The success of various community projects plays a pivotal role in realizing sustainable community development. Given the environmental effects of heavy reliance on fossil fuels, researchers must now seek remedies for global warming's consequences. The adoption of low-carbon economic practices is one of the proposed solutions, combining

cleaner and more efficient energy sources to reduce greenhouse gas emissions into the atmosphere.

In the United States, residential, commercial, and industrial buildings account for 40% of carbon dioxide (CO2) emissions, according to the Environmental and Energy Study Institute, which focuses on real estate. These buildings contribute to CO2 and other greenhouse gas (GHG) emissions due to their substantial use of natural resources and waste generation. The real estate industry is responsible for over 40% of annual global energy consumption, 30% of raw material usage, and 12% of water consumption. A 2016 research study by the World Economic Forum predicted a rise in emissions from new constructions and development. By 2030, the largest cities are expected to require 540 million square meters of office space and 260 million new houses, driven by the anticipated global population increase. According to Oxford Economics' Global Cities 2030 study, Lagos is poised to surpass Cairo as Africa's largest metropolis in terms of GDP and become the 114th largest city in the world. However, building resilient societies and economies, offering business opportunities, ensuring safe and affordable housing, and creating sustainable cities are essential objectives. Achieving these goals involves investing in green public spaces, enhancing inclusive and participatory urban planning and management, with the real estate sector playing a critical role.

Promoting the adoption of eco-friendly, sustainable alternatives in real estate development in Nigeria requires strong motivation and dedicated platforms for fostering discussions on the subject. The real estate sector is vital for meeting development needs and enhancing community living standards. However, the quality of community development is no longer solely determined by the size, shape, and construction of buildings; it now depends on the sustainability of structures within their social, economic, and environmental contexts.

Challenges:

In Nigeria, successive government regimes have established various development commissions, agencies, and departments to promote development at the local, regional, and national levels. However, these government strategies have often fallen short due to a lack of integration of crucial factors like culture or a lack of coordination among community development initiatives. One of the challenges in creating sustainable mixed-use buildings in communities has once again been government rhetoric. Property developers, on the other hand, are primarily concerned with profit-making, and they may not be fully committed to meeting a significant portion of all communities' development needs in Nigeria due to concerns about profitability. This hesitancy may be driven by the risks associated with venturing into unfamiliar territory, similar to the relatively new concept of creating sustainability-compliant buildings in Nigeria. There is ample evidence to demonstrate that environmentally friendly mixed-use building projects are not always prohibitively expensive. There are many cost-effective methods to make mixed-use buildings more conducive to living and working. All aspects of real estate development must be evaluated to improve construction in a socially, economically, and environmentally sustainable manner.

The government should develop long-term sustainability plans that identify demographic trends, anticipate construction requirements, and establish environmental objectives. The planning process should consider a range of inputs from users, residents, and other stakeholders. Plans should be regularly updated and made accessible for public scrutiny. While the private sector plays a significant role in implementing green policies, the government must also step up and fulfill its share of the work. Any government should prioritize the creation of sustainable buildings and support relevant policies. Cooperation from the private sector is more easily secured when the government demonstrates its commitment to integrating sustainable practices into its projects. However, without adopting

a sustainable approach to real estate development, sustainable building development will remain an unattainable goal.

Industry experts should educate themselves and their clients about the benefits of proactively investing in sustainability during building projects. This aims to have a positive impact on the environment and the building's users, while also substantially reducing operating costs over the building's lifespan.

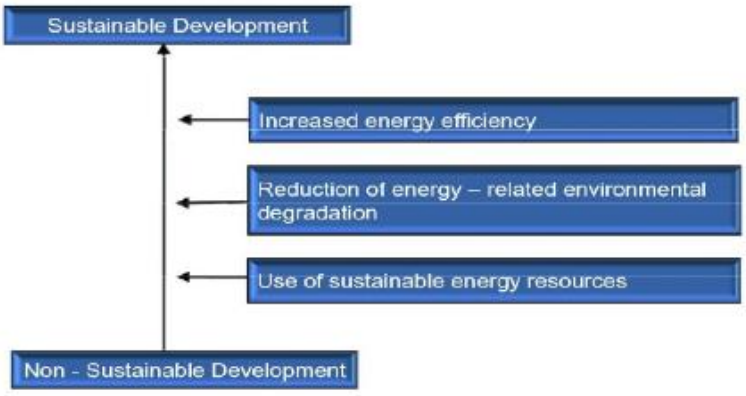

Figure 2.4: Difference between sustainable development and non-sustainable development
Source - (Dwaikat and Ali, 2016; Wang et al., 2010)

The government also needs to take a holistic approach to tackle these challenges by developing an innovative, long-term vision for their buildings to thrive.

2.2.1 Sustainability Issues with Mixed-Use Structures

After conducting a thorough literature review, the potential difficulties in the design of sustainable buildings were identified. The cost of using sustainable building methods and materials is higher. Other significant issues include the technicalities of the construction process, the length of bureaucratic procedures, the lack of knowledge about sustainable technology, the lack of awareness, and the lack of information on sustainable products.

2.2.1.1 High Costs of Sustainable Building Processes and Materials

According to estimates from Dwaikat and Ali (2016) and Wang et al. (2010), sustainable construction costs somewhere between 1% and 25% more than conventional construction. Due to the intricacy of the design layout, modelling, and green practices, the cost is higher (Wu et al., 2019). According to Zhang et al. (2011a, 2011b), utilizing sustainable building materials is 3–4% more expensive than using conventional building materials. The project management team is impacted by the excessive costs of sustainable building because they are responsible for handling and completing their projects within a predetermined budget.

2.2.1.2 Intricacies Of the Construction Process

The design and construction of sustainable buildings may involve overly complex processes due to the probable use of complex technologies and construction methods (Wu et al., 2019). If the complex nature of the building procedures is not promptly conveyed, the project management team's performance as a whole may be compromised. However, in order for project management teams to achieve the designated project objectives, efficient project management system implementation is a necessity (Robichaud and Anantatmula, 2011).

2.2.1.3 Long Administrative Procedures

According to Graeber (2015), the lengthy administrative process for approving the use of cutting-edge technologies in construction projects may extend project completion times. The drawn-out approval procedures that management must go through to get approval of the construction processes for their projects were also described by Zhang et al. in 2011a and 2011b. Numerous difficulties are presented by this drawn-out approval, particularly for the project's management.

2.2.1.4 Lack of acquaintance with sustainable technology

According to Silvius et al. (2012), project management teams seem to know very little about environmentally friendly building practices and materials. The overall project outcome and performance are negatively impacted by a lack of familiarity with sustainable technologies, according to Darko et al. (2018). Teams in charge of project management should make sure that actual performance stays consistent with what was anticipated (Barbosa et al., 2021).

2.2.1.5 Insufficient awareness

The traditional idea of how a building should be built does exist, but due to the perceived risks, many builders do not want to engage in sustainable construction (Kibert, 2016). A lack of understanding prevents many people from adopting environmental auditing, a useful sustainable building practice (Agyekum et al., 2019). Due to a lack of sustainability research, particularly on topics related to indoor environmental quality, productivity, and occupant health, there is also insufficient public education regarding the benefits of sustainable construction (Darko, 2019). According to Opoku et al. (2019b), a significant obstacle to using sustainable building techniques is this lack of awareness.

2.2.1.6 Unavailability of knowledge about sustainable products

The lack of knowledge on sustainable products, such as sustainable materials and the sustainable construction process that must be understood in sustainable buildings, is an obstruction to project management teams Häkkinen and Belloni (2011); Schoggl et al. (2017).. Developers need to connect with professionals who have this information on an ongoing basis. Potential hazards linked to different project delivery contract types, issues with communication, clashing project team member interests, and the need for more time to

implement sustainable building practices on construction sites are some additional challenges (Koolwijk et al., 2018).

2.2.2 Strategies Enhancing or Promoting Sustainable Designs in Mixed Use Buildings

For a number of very significant reasons, sustainable buildings, also referred to as high-performance buildings, are currently in the spotlight. They minimize negative effects on the planet and uphold environmental responsibility and resource efficiency. To do this, strategies must be developed to lower the consumption of energy, water, and materials in general. Minimizing the detrimental effects of the built environment on occupant health is another responsibility of designers and other professionals, including those who provide mechanical engineering services. One of the most important considerations is that structures must be sustainable from their inception until demolition, when and if that occurs. These indicate that every element of the built environment, including:

- Siting
- Design
- Construction
- Operation
- Maintenance
- Renovation
- Deconstruction

When you consider how the building's lifecycle, from conception to "deconstruction," contributes to the success of the sustainability concept, it makes perfect sense that sustainable architecture depends on both the design and construction processes to be significant. Keeping this in mind, the top 10 architectural techniques for green buildings are as follows:

- Site planning and analysis, as well as building orientation

- Passive and active sustainable design
- Recycled content and eco-friendly, high-quality building materials
- Energy-saving and renewable energy sources
- Excellent indoor air quality
- Daylighting and energy-efficient lighting
- Reducing waste during construction and building operation; - Rainwater collection and water conservation;
- Stormwater management
- Native landscaping, which uses trees and bushes for windbreaks and shade.

Site Planning

Given that every site is unique, it is crucial for architects and designers to understand the situation they are in. Ultimately, minimizing factors that might have a negative effect on the environment and on those who will live or work in the building is the goal. Another crucial factor is the building's placement in relation to the site's layout. Correct building orientation can lead to up to 25% energy savings. The busiest areas of the structure should face north or south, depending on which hemisphere it is in, to take full advantage of daylighting. East and west facing windows are not ideal.

Sustainable Design

Active design should also be sustainable, even though passive design will be emphasized. The building's careful orientation and use of the sun's and prevailing winds' advantages are key components of the passive design. The right size and placement of windows will heat the thermal mass, which stores heat, allowing temperatures to be maintained without the use of energy. Concrete, bricks, and various types of tiles are among the substances with a high thermal mass.

Natural ventilation is a key component of passive cooling, and low-emissivity window coatings shield the interior from excessive sunlight during the summer and on extremely hot days. For heating and/or cooling, sustainable active design systems generate or use renewable electricity.

Sustainable Building Materials

Sustainable energy systems should generate electricity on-site utilizing photovoltaic panels or another active solar power generation technology. Renewable energy sources used in these systems often include solar, wind, or biofuels. Energy efficiency is largely dependent on effective insulation, and an airtight building envelope will be achieved through integrated design.

The ultimate goal is for the system to outperform current fossil fuel-based systems in terms of energy efficiency, financial cost, and environmental damage. Computerized energy management systems make energy efficiency maintenance easier.

Indoor Air Quality

Achieving the highest degree of indoor air quality goes hand in hand with the long-term advantage of building durability and energy efficiency. Maximizing residents' comfort and health depends on it. Avoiding items like paint and flooring that are high in volatile organic compounds (VOCs) can enhance the quality of indoor air. The air quality will also be improved by the inclusion of highly efficient HVAC systems and HVAC components. In order to prevent mold from forming, which poses a major health concern in and of itself, moisture control is essential.

Lighting Priorities

Goals such as daylighting and energy conservation are crucial. Passive architecture practice known as "daylighting" entails allowing the sun to heat and illuminate interior areas. In the southern hemisphere, the living room windows should face north, and in the northern hemisphere, south. Naturally, artificial lighting will be necessary; however, make sure that the bulbs used are either light-emitting diodes (LEDs) or compact fluorescent lamps (CFLs).

Water Conservation

Water efficiency starts with the very simple step of installing and using water-efficient appliances, plumbing fixtures, and fittings. Water conservation, including rainwater harvesting and recycling of greywater from showers and appliances, is essential. These include appliances with an energy star rating for refrigerators, washers, and dishwashers, as well as water-saving faucets and showerheads.

Management of Stormwater

Harvesting rainwater will aid in reducing the amount of water entering the local authority's installed and maintained stormwater system. Installing rain barrels that are joined to gutters by drainpipe spouts is a simple place to start.

In addition to absorbing rainwater, a green roof will also lessen stormwater runoff. Storage systems can be created to treat rainwater and let it seep into the ground, which is a more difficult feat. An experienced mechanical, electrical, and plumbing (MEP) or stormwater consultant will be able to provide guidance or even model flows to ensure that an onsite system can handle typical stormwater runoff.

Reduction of Waste

When waste is generated on-site, recycling is frequently an option rather than disposing of it in a landfill. When done properly, architects can significantly reduce waste. Generally speaking, they can reduce waste simply by selecting materials that don't require on-site finishing. Pre-cut and pre-assembled materials must be specified, which has a significant impact. Waste reduction includes operating finished buildings where residents can recycle a significant portion of their trash, including bottles, plastic, metal (in the form of cans and other containers), and paper.

Native Landscaping

The microclimate around a building can be altered by good landscape design, which will help to balance the airflow inside the building. Native trees and shrubs can be strategically placed in landscaping designs to provide shade, which helps with a sustainable cooling plan. They may also aid in reducing the impact of wind.

According to IBI's (International Biochar Initiative), additional design strategies for achieving sustainable results include the following:

As suitable for the project type, working with clients to guarantee sustainable building certification to BREEAM, LEED, Passive House, WELL, and other standards.

- Collaborating with the building sector to develop Modern Methods of Construction (MMCs).
- Local off-site fabrication solutions lessen the effects of development on the environment.
- Using local labour and materials during construction helps the local economy and reduces carbon emissions.

- Requesting that manufacturers of building supplies submit the Environmental Product Declaration (EPD) data required for accurate lifespan evaluations.
- Incorporating plants into our designs, which have positive effects on biodiversity and well-being and trap carbon through photosynthesis.
- Supporting vertical greening systems and green infrastructure in urban areas to boost biodiversity there and slow down the treatment and retention of rainfall. The demand for carbon-intensive infrastructure declines as a result of these biological systems.
- Giving daylighting top consideration when designing buildings, which will enhance wellbeing and consume less energy for artificial lighting.
- Facilitating rapid decision-making to offer targeted, economical solutions.
- Promoting the adaptation and reuse of existing structures as opposed to their demolition and construction. We demonstrate the possible financial and carbon benefits while minimizing the impact on people through phased reconstruction.

Making use of the site's advantages in a triple-bottom-line strategy to develop site-specific designs that adapt to the environment and climate while taking into account social, economic, and climatic aspects.

2.2.2.1 Benefits of Sustainable Building Strategies

The advantages of sustainable construction methods and how to apply them to mixed-use designs are becoming increasingly important. Mixed-use designs encourage the integration and density of two or more residential, commercial, institutional, cultural, and/or industrial purposes. Effective construction methods are ones that make very good use of natural resources and benefit the city and its people.

i. Efficient Use of Space

Sustainable building design enhances efficiency in the use of energy, space and materials. For mixed-use buildings, space efficiency is a key component in sustainable building strategies. The efficient use of space translates into saving energy and reducing waste over the lifecycle of a building.

ii. Environmental Impacts

Energy-efficient equipment is used in sustainable building design to maximize energy performance and savings, and design strategies are employed to reduce reliance on high-use power systems. This results in a more effective use of energy and lessens the negative effects on the environment. By lowering cities' carbon footprints, mixed-use buildings also encourage walkability and contribute to positive environmental effects. People are more likely to explore the area on foot or by public transportation than by cab or car because a wider range of uses are available in a smaller footprint.

iii. Health Benefits

Designing for pedestrians is encouraged by the use of mixed-use developments and other smart growth techniques. We can encourage more active lifestyles, a deeper sense of community, and a stronger sense of place by developing mixed-use zones. Sustainable construction methods also improve the quality of the air and maximize natural light, which benefits those who live there.

iv. Social Stimulation

Donald Appleyard, a professor of urban design at UCal Berkeley, spent his entire career researching how to make cities and neighbourhoods safe and liveable as well as the social and psychological effects of traffic and neighbourhood layout. His study revealed that the

amount of traffic on a street had a significant impact on the residents' quality of life. People tended to rate their neighbourhoods higher if they were close to activity, sidewalks, and transit corridors.

v. Sustainability

All of these characteristics of mixed-use landscapes contribute to increased neighbourhood productivity, vitality, and variety, with a growing emphasis on promoting sustainability. For a large portion of the world, the sprawling suburban model that the invention of the automobile encouraged is simply unworkable (is this relevant?). The city is constantly changing, so mixed-use design takes this into account and offers opportunities for innovative sustainable building. Mixed-use development makes cities more vibrant by fostering the well-being, economy, efficiency, productivity, sustainability, and social interaction of its citizens.

2.2.3 Environmental Factors influencing Sustainable Mixed-use Development in Nigeria.

Buildings play a significant role in limiting the effects of climate change because they produce 39% of the world's energy-related CO2 emissions (Global Status Report, Global Alliance for Buildings and Construction & International Energy Agency 2018). We base our assessment of a building's environmental impact on two main pillars: operational energy use and whole-life carbon emissions.

Operational Energy

In the strict, internationally renowned Passive House standard for low energy consumption in buildings, which IBI Group is presently certifying numerous projects to, operational energy is also measured. These "envelope first" solutions for lowering operating energy are integrated

into our design methodology as we innovate globally. These include airtight building envelopes, high performance glazing, appropriate window-to-wall ratios, careful detailing and construction techniques, and well insulated components that prevent thermal bridging.

To design healthy, cozy, and effective buildings, we make use of strong technology and construction methods in addition to the high-performance building envelope.

We may prevent the use of fossil fuels, take advantage of renewable energy sources when we can, and decrease wasted energy thanks to technologies and practices including highly efficient mechanical and electrical systems, heat recovery, and optimum glazing.

Whole Life Assessment of Carbon

The topic of environmental sustainability is currently being discussed on a global scale using a comprehensive method for life cycle carbon modeling of buildings. Buildings can achieve a true net zero lifecycle thanks to whole life carbon assessment (WLCA), which measures all carbon-related building stages.

The construction industry in the UK and around the world is currently at a turning point where the WLCA framework is being defined and benchmarked, emerging standards and targets are being outlined, and best practice is being implemented in accordance with RICS WLCA guidance.

IBI Group is creating solutions that link our BIM processes to the carbon counting process; as an integrated design and technology company, we are ideally situated to be at the forefront of the anticipated widespread adoption of WLCA in international building practice.

2.3 Design Consideration

Basic planning considerations for mixed use developments include the following parameters:

- The cultural, political, and social aspects of the city where the building will be located.
- A strong relationship within the city
- Sustainability
- Safety and security issues

In establishing an effective mixed-use structure, the following must be taken full consideration in order to ensure safety, functionality and aesthetic appeal of the spaces.

Integrated Theme

The mixed-use development should have an integrated architectural theme that includes complementary materials, colours, and design details. The site should exhibit a unified theme that includes landscaping, amenities, signage and lighting.

Aesthetics And Architectural Enhancements

The design of the structure should complement and enhance the design of the surrounding buildings and neighbourhood. This architectural continuity is critical to the success of the design.

Effective Functional Design

It must incorporate an efficient functional layout that best utilizes structural systems to reduce costs while providing a pleasant patron experience.

Vehicular Parking

The function of a parking structure is critical to its success. It must have parking efficiency, entrance/exit locations, turning radii must be efficient and good traffic/ pedestrian circulation.

Safety And Security

Today, safety is a top priority everywhere, but it's especially important in parking lots where individuals frequently stroll alone or late at night. The highest level of security elements must therefore be incorporated into every aspect of planning and design. Here are a few of the most widely used tactics.

Passive Security Measures

- Maximize visibility and openness
- Increased lighting levels
- Floor to ceiling heights
- Access control
- Safe and inviting appearance

Building Design

For a mixed-use development, the following architectural principles should be considered and incorporated in the overall design of buildings:

- Scale
- Visual order

- Balance
- Rhythm
- Proportion
- Colour and light

Chapter Three

Research Methodology

3.1 Introduction

According to Walliman and Walliman (2011), research is "an activity that involves learning new things in a more or less systematic way." The philosophical framework or foundation within which research is carried out is referred to as methodology (Brown, 2006).

This chapter describes research methods, approaches, and designs in detail, emphasizing those that were used throughout the study. I defend my choice by outlining the benefits and drawbacks of each approach and design while also considering how well they would actually work for the research. The research's methodology should be most effective at achieving its goals, and it should be possible to replicate the methodology in other similar studies.

3.2 Case Study

A case study is an empirical investigation that looks at a current phenomenon within its actual setting, particularly when the distinctions between phenomenon and setting are hazy. It aims to shed light on a decision or set of decisions, explaining why they were made, how they were carried out, and what the outcome was. An initial evaluation of the current building typology would need to be completed in order to fully comprehend the principle behind designing any building typology. The documented buildings were initially evaluated in terms of space, functionality, equipment, and operational standards, which informs the necessary preparations for potential future needs in this building typology

3.3 List of Selected Case Studies

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

1) Maitama Mixed Use Development, Maitama Mall

2) Kingsway Tower, Lagos

3) The MayFair on Jaspe, Edmonton Canada

4) Funan Mixed Use, Singapore

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

3.3.1 Case Study 1 (Local)

Maitama Mixed Use Development, Maitama Mall

Location – Abuja, Nigeria

Year Built – 2017 to 2019

Architect - Boogertman and Partners;

3.3.1.1 Description

The Maitama Mall is a renowned mixed-use development with a gross construction area of 82,000 m2 that is situated at the intersection of Shehu Shagari Way and Ibrahim Babangida Way in Abuja's upscale Maitama neighbourhood. Since Maitama serves as the headquarters for numerous embassies and is generally home to a very rich population, it has significant diplomatic significance in Abuja. The mall is anticipated to cater to the residents of Maitama as well as the nearby communities of Asokoro, Wuse I & II, Katampe, Gwarimpa, and Kukwaba. Eris Property Group is the development partner and advisor, and the Momentum Africa Real Estate Fund and Imani & Sons are the sponsors. The complex was planned by Boogertman and Partners in the same manner as their prior projects, and it will provide exceptional parking ratios at 4 bays per 100 for retail and 3 bays per 100 for the office segment.

There will be 23,855 square meters of gross lettable shop space at the Maitama Mall. It takes up the most space in this mixed-use complex. According to the tenant mix, the high-end luxury fashion merchants, European, Middle Eastern, and American fashion and cosmetic retailers, local retailers, fine dining restaurants, a food court, and a movie theatre all appeal to the Nigerian consumer. The office portion of the Maitama Mall will include 6,494 sq m of gross lettable space distributed across 6 levels with 1,000 sq m floor plates.

The Maitama Mall will also include a 5-star Radisson Blu hotel. It will be finished in April 2019 and will be similar to the office component. This hotel will cost $80 million ($320,000 per key) with 250 keys.

The Mixed used development consists of 3 parts;

- Retail
- Office
- Hotel

3.3.1.2 Building Appraisal

The project is currently still under construction.

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

PLATE 1: Approach view of Maitama Mall
Source - (Google search)

PLATE 2: Aerial view of Maitama Mall
Source - (Google search)

PLATE 3: Side view of Maitama Mall
Source - (Google search)

3.3.2 Case Study 2 (Local)

Kinsway Tower, Lagos

Location – Lagos, Nigeria

Year Built – 2019

Architect - SAOTA

3.3.2.1 Description

A notable mixed-use structure, Kingsway Tower is located in the Ikoyi neighbourhood of Lagos, Nigeria. Alfred Rewane Road cuts through the neighbourhood, running north to the airport and south to Victoria Island. SAOTA, a South African architectural firm, created the 15-story Kingsway Tower. It has a basement, a parking podium, a two-level retail podium, and 12 stories of office space.

The Kingsway Tower's design not only brings fresh architectural concepts to Lagos, Nigeria's economic hub and one of the world's fastest growing cities, but it also exemplifies the significance of this developing market on a global scale with unwaveringly top-notch quality and execution.

Alfred Rewane Road and its surroundings, which are part of the upscale residential community of Ikoyi, were rezoned to form a mixed-use corridor, which has caused a boom in office and hotel construction. However, much of the construction in Lagos has a rather anonymous appearance, often adopting a conventional commercial style with concrete slab and curtain wall facades.

3.3.2.2 Building Appraisal

Merits

- Natural ventilation: wide and enough windows
- Good entry points and exits
- The use of passive security system, thermal and acoustic insulation to improve building performances and increase its comfort standard

Demerits

- Insufficient parking lots
- No consideration for the environment
- Less storage space/area

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

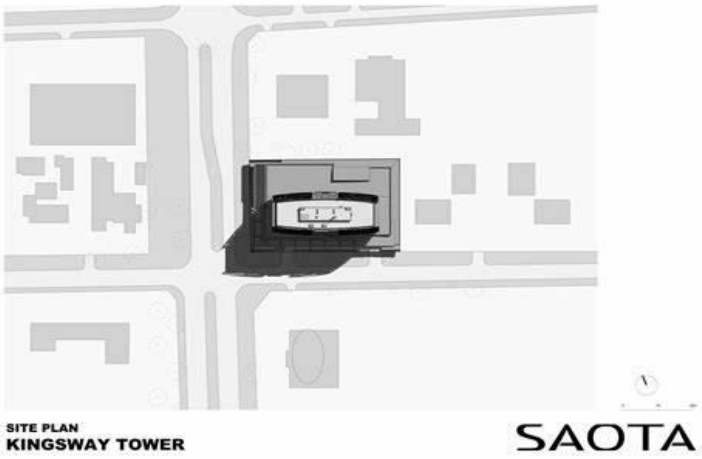

PLATE 4: Site Layout of Kingsway Tower
Source - (Google search)

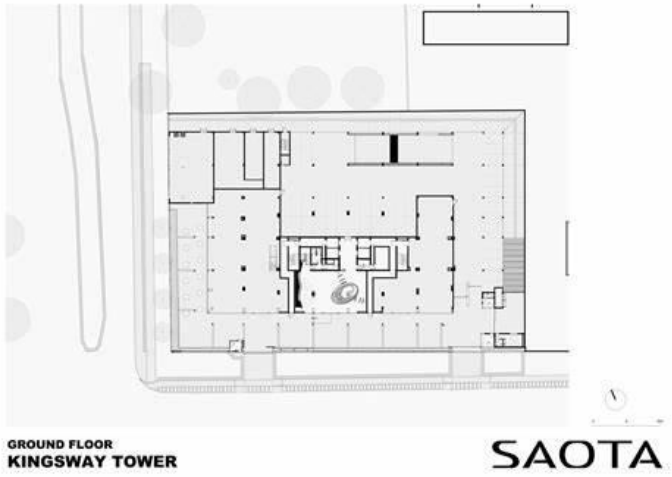

PLATE 5: Ground floor plan of Kingsway Tower
Source - (Google search)

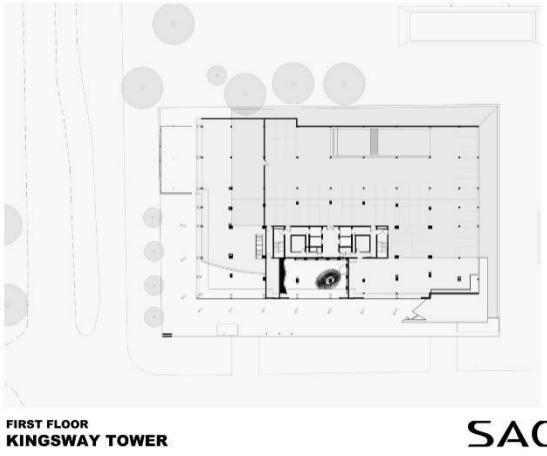

PLATE 6: First floor plan of Kingsway Tower
Source - (Google search)

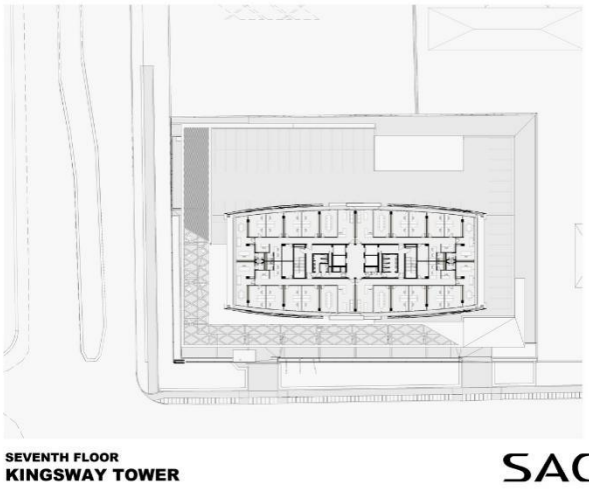

PLATE 7: Seventh floor plan of Kingsway Tower
Source - (Google search)

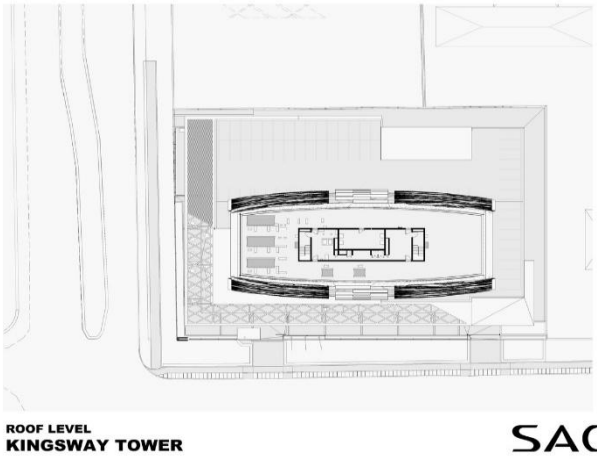

PLATE 8: Roof floor plan of Kingsway Tower
Source - (Google search)

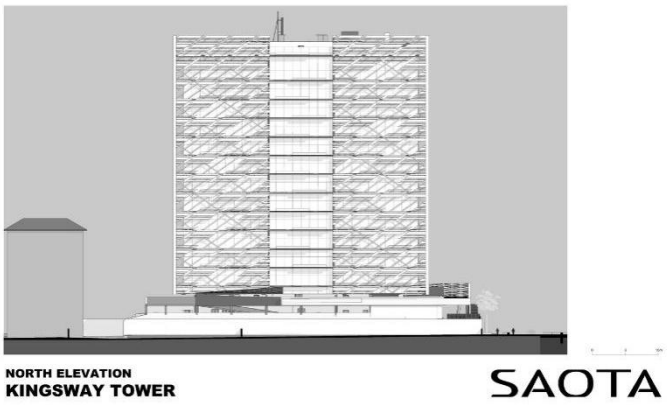

PLATE 9: North elevation of Kingsway Tower
Source - (Google search)

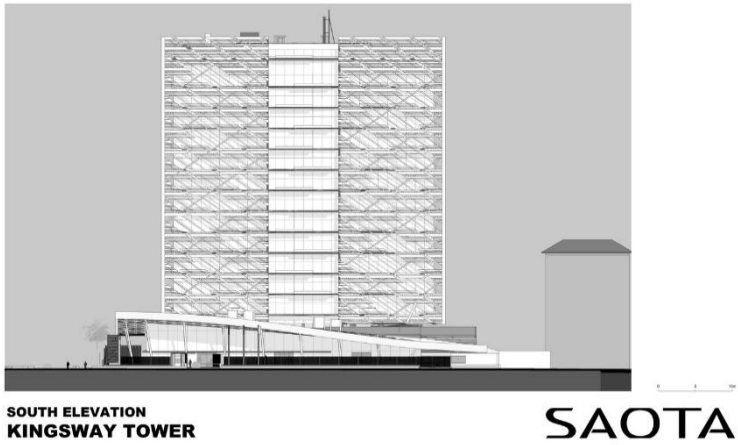

PLATE 10: South elevation of Kingsway Tower
Source - (Google search)

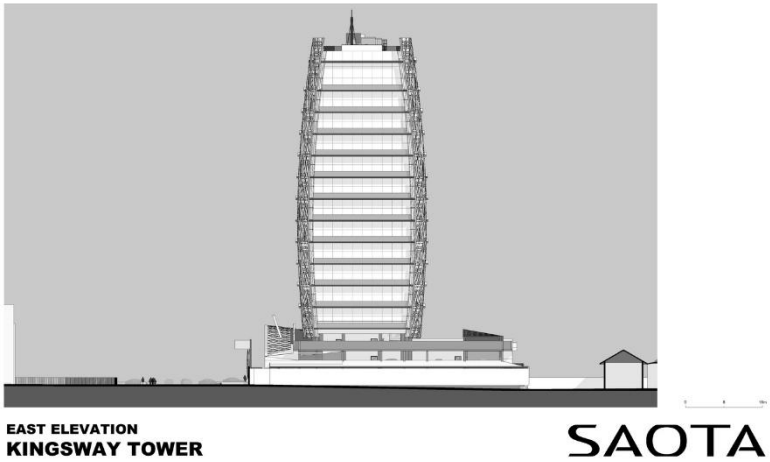

PLATE 11: South elevation of Kingsway Tower
Source - (Google search)

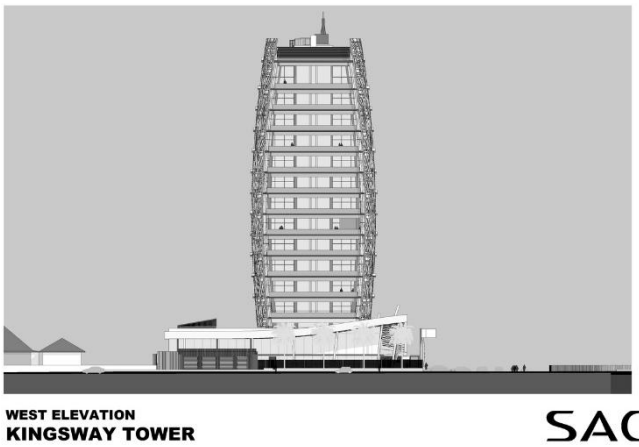

PLATE 12: South elevation of Kingsway Tower
Source - (Google search)

PLATE 14: Section through of Kingsway Tower
Source - (Google search)

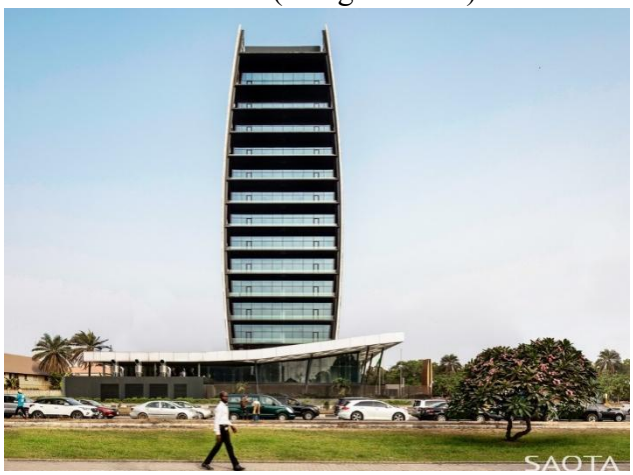

PLATE 15: Section through of Kingsway Tower
Source - (Google search)

3.3.3 Case Study 3 (International)

The Mayfair on Jasper, Edmonton Canada

Location – Canada

Year Built – 2016

Architect - Humphreys & Partners Architects

3.3.3.1 Description

The Mayfair on Jasper, the newest residential building on Jasper Avenue, has now opened its doors after about two years of construction. The 237-unit rental building owned by ProCura calls itself "Edmonton's most innovative rental project," and it has the amenities to prove it.

This opulent 10-story building, which is situated on Jasper Avenue in downtown Edmonton, features a mix of one- and two-bedroom rooms. This brand-new apartment is energy-efficient, has luxurious finishes, and is conveniently close to regular dining and shopping experiences.

Each suite is furnished with high-end appliances including ensuite washer & dryer, granite counter tops, window coverings, and laminate flooring. The floors and walls are all 9-inch concrete, providing soundproofing between units, and the triple-paned windows also shelter each unit from the hustle and bustle of busy Jasper Avenue below.

3.3.3.2 Building Appraisal

Merits

- Saves spaces
- Well laid out circulation
- Increases social connectivity
- Adequate natural lightening and ventilation

Demerits

- Shared parking
- Less storage space/area

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

PLATE 16: Floor plan of Apartments Mayfair of Jasper
Source - (Google search)

PLATE 17: Floor plan of Apartments Mayfair of Jasper
Source - (Google search)

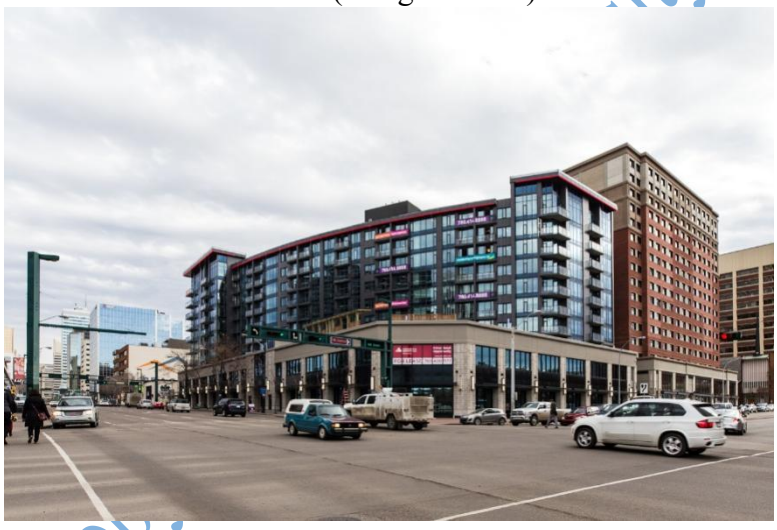

PLATE 18: 3D View of Mayfair of Jasper
Source - (Google search)

3.3.4 Case Study 4 (International)

Funan Mixed Use Complex, Singapore

Location – Singapore

Year Built – 2019

Architect - Humphreys & Partners Architects

3.3.4.1 Description

In Singapore's Civic District, Funan is a mixed-use complex that includes an outlet mall, two office buildings, and a tower housing serviced apartment. On the site of the previous Funan Digita Life Mall building, a new development was created.

As Funan Centre, the original mall debuted in January 1985, giving customers more places to buy besides Orchard Road.[2] The mall started to draw a significant number of electronic and IT retailers in the early 1990s, and this trend continued over time. The entire top level is occupied by Challenger Superstore, a significant domestic IT retailer that has been an anchor tenant for a number of years and occupies the full building. The mall was renovated in 1992. Later, it took on the name Funan. The mall was renamed the IT Mall in 1997 to reflect its present emphasis on gadgets and things connected to IT. The mall had minor renovations in 2005, including the installation of an exterior escalator and business reconfiguration. After the renovations were finished, it was given the new name Funan Digita Life Mall.

On 10 December 2015, the mall's owner, Capital Mall Trust, announced plans to redevelop the mall into an experimental creative hub on its site, comprising a retail mall, a serviced apartment tower and two office towers. To make way for the new development, Funan Digital life Mall ceased operations on 30 June 2016 and was subsequently demolished by the end of that year.

The Tree of Life, the focal point at the middle of Funan, is where the project's design concept is realized. Woods Bagot has centered an effective retail experience around it. This 25-meter, six-story wood and steel building offers rooms for businesses to display their wares, as well as for creative studios and entrepreneurs to hold lectures and workshops.

The Tree of Life serves as a haven for imagination. The Tree's branches, also known as "passion clusters," provide settings for technology, fitness, dining, craft, shopping, and play spaces that serve as places for expression. The Tree of Life, located on Level Four of the

Connector Floor, promotes movement so guests may enjoy restaurants, theater, wellness, offices, co-working, co-living, and outdoor space.

From the Connector Floor, green steps that encourage mobility and exercise lead to Level 7, where the largest rooftop urban garden in Singapore's CBD, measuring 5,000 square feet, is located. A futsal court, an outdoor recreation area, and an 18,000 square foot food garden are also included. Additionally, the office buildings' top levels have exterior staircases that make it simple to access green areas and encourage wellness.

3.3.4.2 Building Appraisal

Merits

- Saves spaces
- Well laid out circulation
- Increases social connectivity
- Adequate natural lightening and ventilation

Demerits

- Shared parking
- Less storage space/area

Variables	Adequate (*)	Inadequate (X)	Not Available (0)
Architectural form	*		

Scope of Facility	*
Construction Technology	*
Building Material	*
Sustainability of building	*

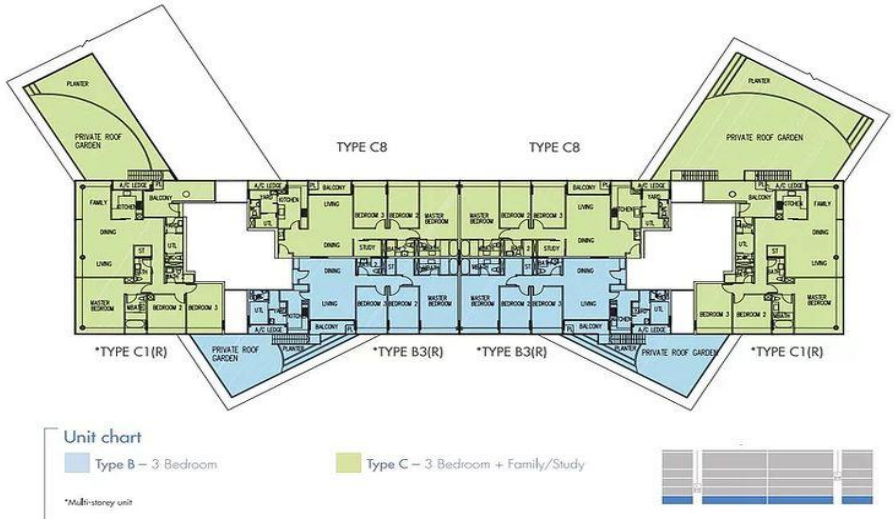

PLATE 19: Floor plan layout of Funan Mixed use complex
Source - (Google search)

PLATE 20: Aerial view of Funan Mixed use complex
Source - (Google search)

PLATE 21: 3V view of Funan Mixed use complex
Source - (Google search)

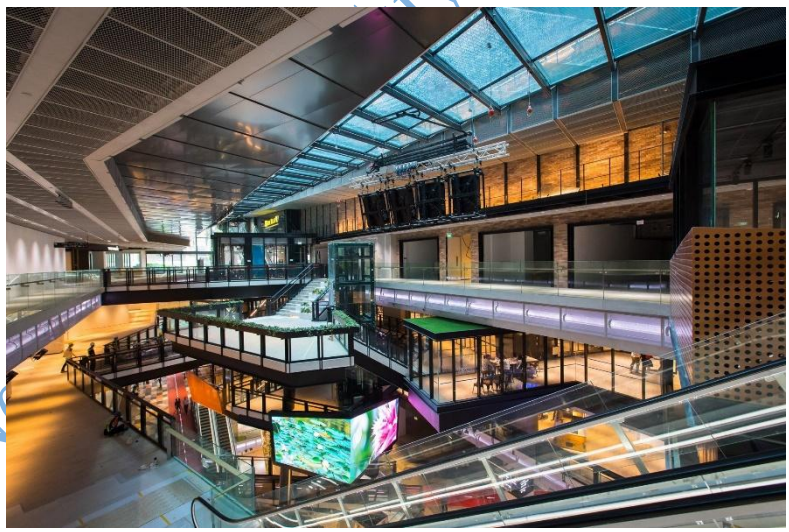

PLATE 22: Interior View Funan Mixed use complex
Source - (Google search)

Chapter Four

Site Analysis and Design Synthesis

4.1 Study Area

4.1.1 Site Location

Oyo State's capital, Ibadan, is the second-largest non-oil state economy in Nigeria after Lagos state and is the fourth-largest state economy overall in the country. As of 2021, the city's population was 3,649,000, while its metropolitan region was home to more over 6 million people. By area, it is the biggest city in the nation.

Ibadan has a fascinating history and a highly rich cultural heritage. The University of Ibadan, Nigeria's first university, as well as Cocoa House, the country's first skyscraper, were all established there. It also served as the location of the continent's first television station. In Oyo State, one of the six richest states in the nation with the highest GDP, the city of Ibadan is a significant economic hub.

The capital city of Oyo State, Ibadan, is where the majority of the state's businesses and financial institutions are located.

4.1.2 Site Selection Criteria

The site is located along liberty road, ring road, Ibadan before Obafemi Awolowo staduim which is the best location for mixed use building because it's at the core of the city and located along the road side.

Preliminary site selection criteria used for the location of the proposed mixed-use building include the following:

i. Ease of accessibility,
ii. Availability of site area and future expansion,
iii. Visibility,
iv. Proximity to urban centers,
v. Availability of social amenities such as electricity, water, telecommunication network, and good road

i. Ease of accessibility

Easy accessibility is a very important factor for the building. The mixed-use building should be easily accessible both vehicularly and for pedestrians without difficulties. The site should be close to a major access road, to achieve this.

ii. Availability of site area and future expansion

Future expansion can either be achieved vertically or horizontally. But to achieve future expansion horizontally, the structure should be situated on a site with a large land mass that will give room for future expansion of the scope or facilities of building.

iii. Visibility

As a commercial building for a vast population of individuals, it is important to situate it in a position where it can be easily seen by everyone to inspire good in-flow of people, and motivate curiosity.

iv. Proximity to urban centers

A mixed-use building should be located in good proximity to urban centers to encourage patronage and sales of manufactured products and hiring of services. The proposal intends to locate the building in the heart of the city where it can conveniently serve the people efficiently.

v. Availability of social amenities

The selected site will be worthier consideration if it improves the viability of the proposed project through its nearness to some basic social amenities such as accommodation, health services, telecommunication, electricity, water supply and good motorable roads connected to interurban highways.

4.2 Project Analysis and Design Synthesis

4.2.1 Brief Analysis

The project's goal is to create a purpose-built mixed-use structure that makes the best use of available resources and space. In order to accommodate both residential and cultural needs, mixed-use developments are necessary to the development of a diversified neighbourhood

The objectives are listed below:

- Spurs revitalization
- Creating a mixed-use structure that would satisfy all of the users' needs while also offering comfort and optimum enjoyment.
- More options and housing opportunities.
- To offer additional alternatives for affordable housing.
- Promotes pedestrian and bicycle mobility by enhancing an area's distinct identity and development possibilities (for example, village centers, positions along bike lanes, or "gateway" places that highlight a community's assets).
- Reduces auto dependency, roadway congestion, and air pollution
- Employment opportunity.

4.2.2 Brief Development

Here is a breakdown of spaces required in the proposed mixed use building design

- Anchor malls
- Lettable spaces and offices (commercial use)
- Front desk/reception hall
- Trash room
- Front office/Administrative offices
- Lounges
- Swimming pool with deck
- Fitness center
- Parking lots
- Security post/Gate house
- Residential apartments

4.2.3 Design Criteria

1. Uniformity over the entire property

There should be an overarching design concept that you stick to, even though you should include various design components to divide the various regions of your structure. This guarantees a smooth transition between the distinctive spaces on your property. Design consistency also creates a sense of unity throughout your property and strengthens your branding.

2. Benefits for Residents in Addition

The majority of mixed-use buildings have hotel, retail, and residential areas. If this is the case with your development, it is crucial that you put the needs of your inhabitants first. You must provide residents with incentives to stay because they pay more over a longer period of time. This can be achieved by upgrading the amenities in resident rooms and designating specific areas of your property exclusively for residents.

3. Community Gathering Places

Finally, allowing residents and visitors to share spaces and interact is one of the main selling aspects of mixed-use homes. Because of this, it's critical to establish a genuine sense of community by designing communal spaces in a way that encourages conversation. Long communal tables or furnishings with a living-room feel can be added to your property's common areas to achieve this. Your home will have the appearance of a lively and welcoming community thanks to these subtle architectural elements. These are a few of the crucial elements to take into account while planning a mixed-use building.

4. Setting

Communities or Districts in the Street or Other Public Areas Street or Building Blocks Individual Structures

5. Locations

Town or City Centers Brownland or the Inner City Locations on the outskirts or in the suburbs.

6. Techniques

Preservation of existing mixed-use environments Towns' existing neighborhoods can be gradually revived and restructured, including through infill development, reuse, conversion, and renovation. Larger areas and sites, or comprehensive development or redevelopment

7. Time

Various timetables and motivations for sharing space for activities

4.2.4 Conceptual Development

The main design challenge in mixed-use projects is balancing the needs of commercial uses for access, visibility, parking, loading, and possibly extended hours of operation with the needs of residential uses for privacy and security. The project is a research and experiment to find possible energy efficiency and sustainable solutions that would enhance easy use of spaces and maintain thermal comfort inside the building without the use of electricity as heating and cooling require the most. The one major concept (basic general idea) utilized in the design of this mixed-use building is energy efficiency, which is very vital in all building designs. This concept can be achieved through the integration of natural lighting and ventilation.

The proposal would therefore be designed conceptually and architecturally to improve energy efficiency and sustainability of the building by incorporating passive design strategies into the design.

4.2.5 Functional Relationship

The functional/spatial criteria are the ideal references, based on which required spaces and other component parts of the building can be used, in terms of size, quality, standard and characteristics. The main aim of having space functional relationship is to understand the interrelationship between different spaces within the development as well as to obtain as form of continuity in the flow of functions within each area thus achieving a sense of unity among the different functions and also increase efficiently within the building.

4.2.6 Space Allocation/Schedule of Accomodation

Due consideration was given to each space when it came to the various functions present in the mixed-use building based on the specific activity anticipated for that space. Maximum space standards were taken from reference data books to determine the space needed. Consequently, the table below illustrates the amount of space needed for this project.

4.2.6.1 Space Program for General area

NAME	UNIT	AREA
RESIDENCE RECEPTION	1	227
RECEPTION DECK	1	40
FIR COMMAND OFFICE	1	41
MANAGER OFFICE	1	16
LOUNGE	1	94
BAR STAND	1	23
STORE	1	13
MAIL ROOM	1	54
PACKAGING ROOM	1	91
LOGISTIC OFFICE	1	10
LIFTS	3	18
ELEVATOR LOBBY	1	25
STAIR HALL	1	28
SECURITY OFFICE	1	10
JANITOR	1	9
ELECTRICAL ROOM	1	9
MECHANICAL ROOM	1	8
CHUTE	1	9

4.2.6.2 Space Program for Administrative section

NAME	UNIT	AREA
OFFICE RECEPTION	1	172
RECEPTION DECK	1	53
OFFICE	1	26
STORAGE	1	46
LIFTS	2	14
PANEL ROOM	1	6
STAIR HALL	1	29
COMMERCIAL AND RESIDENTIAL TRASH ROOM	1	567
PUMP ROOM	1	50
SWITCH GEAR ROOM	1	91
ENGINE ROOM	1	98
MAINTENACE ROOM	1	82
EMPLOYEE FACILITTIES	1	117
ATM STAND	1	19
OFFICE FOR MALL	1	22
MANAGEMENT OFFICE	1	26
LETTABLE SPACES	2	221
PASSAGE WAY	1	219
ANCHOR MALL	2	1014

4.2.6.3 Space Program for Support spaces

NAME	UNIT	AREA
70 CAR PACKS	70	1330
CAR PASSAGE WAY		1821
RESIDENT STORAGE	1	199
STORAGES	5	411
CORE AREA		173

4.2.6.4 Space Program for Ancillary spaces

NAME	UNIT	AREA
CORE AREA		173
AC UNITS	1	709
STORAGE	1	201
GARDEN YARD	1	114
ELECTRICAL PANEL ROOM	1	304
WAREHOUSE	1	163

4.2.6.5 Space Program for Recreation and Sport spaces

NAME	UNIT	AREA
CORE AREA		173
FITNESS CENTER	1	403
TRAINER'S ROOM	1	61
FIRE PUMP ROOM	1	36
REST ROOM		14
LOBBY	1	38
GARDEN PARK	1	104
MOVIE ROOM	1	130
GOLF SIMULATOR ROOM	1	76
STORE	1	31
PRIVATE DINING	1	61
PREP KITCHEN	1	47
INDOOR LOUNGE	1	504
RESTROOM		35
OUTDOOR LOUNGE	1	225
POOL DECK		1053
SWIMMING POOL	1	386

4.2.6.6 Space Program for Apartments

NAME	UNIT	AREA
CORE AREA		173
3BEDROOM APARTMENT		
LIVING ROOM	1	53
KITCHEN	1	11
VISITOR'S TOILET	1	2
BEDROOMS	3	149
T/BATH	3	31
CLOSET		9
2BEDROOM APARTMENT		
LIVING ROOM	1	52
KITTCHEN	1	12
VISITOR'S TOILET	1	3
BEDROOMS	2	90
T/BATHS	2	19

4.2.7 Construction Methods and Materials

Building materials for mixed-use are encompassing and as such care should be taken in their selection because they might affect the health, safety and security of the building users. Basically, in selection of building materials, consideration should be given to the nature of the materials, structural properties, functional characteristics, their characteristics in fire, their limitations with other materials, and cost of installation, maintenance, climatic conditions and aesthetics. The design and choice of materials will also be influenced by the client style and sophistication of the hotel, its local environment, climatic condition and the style of its recreation facilities. However, the materials, ceiling, floor, wall and the roof to be selected should be satisfactory in the following:

i. The materials should have high tensile strength.
ii. They should be durable.
iii. The materials should have good installation properties most especially in the workshops.
iv. The floor material should be able to resist vibration as a result of use of heavy machines in the workshops e.g. generator room.
v. The material should have low combustible property.
vi. The materials should have low expansion property especially in the use of metal.
vii. The material should be high quality. Also, sustainable and non-toxic building materials are encouraged.

4.2.7.1 Criteria for selection of Materials and Finishes

a) Functional Criteria

i. Primary purpose: Suitability to basic purpose.

ii. Secondary purpose: What are some probable but perhaps unanticipated users? For the particular element? Health and safety issues may play a major part.

b) Aesthetic Spatial Criteria

i. Truth in Materials: a basic philosophy in design since the crafts movement not imitate one another but be used in accordance with their own natural properties. At one level this philosophy insists on clarity when using structural or surface materials i.e. one should not imitate the other for instance surface tiles should not pretend to be brick and imitation structure should not be created with non-structural elements.

ii. Appropriateness to design concept: Would you put VCT in a luxury hotel?

iii. Spatial implication (how will material influence the perceive size/shape of space).

c) Economic Criteria

i. Initial cost: this might tend to be high for natural materials such as stone, lower for synthetic such as vinyl.

ii. Life-cycle cost: how long does the installation need to last-short or long term planning.

iii. Cost to maintain: is maintenance an issue in commercial carpet.

d) Environmental criteria

i. Healthy Environments

ii. Sustainability

iii. Upstream impact

4.2.8 Building Services

To ensure environmental quality, adaptability to meet changing requirements, and energy management, high standard engineering services with sophisticated controls are necessary. The engineering system and equipment must be designed for each area as well as the whole to allow for space division. Water supply, sewage and drainage, waste removal, ventilation and air conditioning, electrical distribution and lighting, fire safety, acoustic treatment, lift services, ducting, communication system, and other services should be taken into consideration.

Chapter Five

Conclusion

5.1 Conclusion

From a broad standpoint, Passive Design systems are effective ways to increase a building's energy efficiency. However, each technology has its greatest applicability when combined with Nigeria's circumstances. Additionally, the selection criteria should take into account both technical and economic factors, including the capacities of both consumers and developers. Classified discussion aimed at various topics is a good way to validate emerging strategies.

Building housing is a game that involves various players. The support paradigm and the provider paradigm both failed to achieve the highest levels of energy efficiency. If everyone

adopts strategies based solely on their own absolute rational self-interest, it will be challenging to achieve the goal of energy efficiency. In order to disrupt the Nash equilibrium, various stakeholders must work together more effectively. All program stakeholders should be involved in the decision-making process as it develops. A crucial participant in this process should be the architect.

5.2 Recommendation

Making the game players cooperate is crucial to creating more energy-efficient buildings. All strategies are important to some players, but getting other players to know them and recognize them is more crucial. They won't be implemented until every player is convinced of the benefits of those strategies. If not, a player won't insist on making a contribution by themselves. Nigeria is a developing nation with insufficient resources to support the widespread use of high-tech methods. Nigeria large-scale construction impedes the use of cutting-edge building techniques. Nigerian culture also discourages striving for the highest level of performance. More perseverance and work must be put forth in order to change these states.

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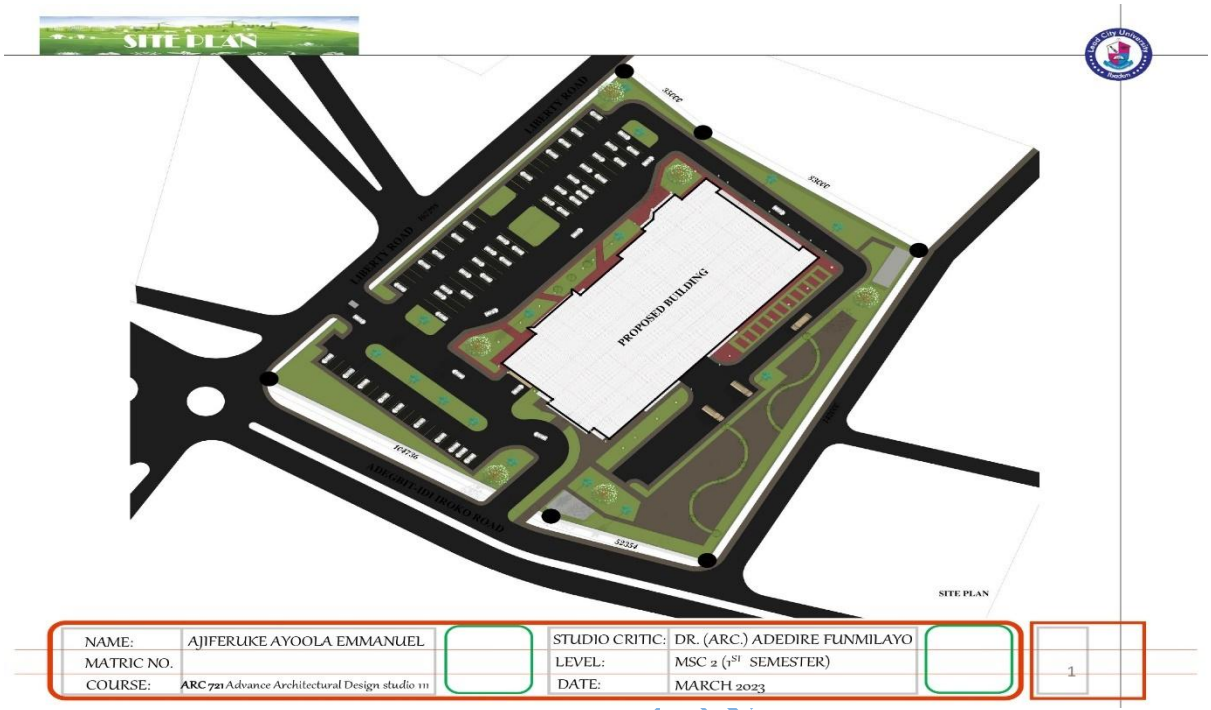
Appendix


SITE PLAN
LIBERTY ROAD
PROPOSED BUILDING
ABIGBE-IDI EKOKO ROAD
SITE PLAN
NAME: AJIFERUKE AYOOLA EMMANUEL
MATRIC NO.
COURSE: ARC 721 Advance Architectural Design studio III
STUDIO CRITIC: DR. (ARC.) ADEDIRE FUNMILAYO
LEVEL: MSC 2 (1ST SEMESTER)
DATE: MARCH 2023
1


GROUND FLOOR PLAN
ANCHOR MALL2
PUMP ROOM
STAIR HALL
SWITCHGEAR
ENGINE ROOM
ANCHOR MALL
COMMERCIAL AND RESIDENTIAL TRASH ROOM
STORE
BAR
LOUNGE
PACKAGING ROOM
SECURITY
MAIL ROOM
JAN
CORRIDOR
LIFT
RESIDENCE RECEPTION
CHUTE
ELEV LOBBY
PANEL
OFFICE
REP. DECK
FIRE COMMAND
MANAGER OFF
LETTABLE SPACE
PASSSAGE WAY
MAINTENACE ROOM
VEHICULAR RAMP
RECEPTION OFFICE
ATM STAND
MANAGEMENT OFFICE
EMPLOYEE FACILITIES
ENTRANCE
STORAGE
GROUND FLOOR
NAME: AJIFERUKE AYOOLA EMMANUEL
MATRIC NO.
COURSE: ARC 721 Advance Architectural Design studio III
STUDIO CRITIC: DR. (ARC.) ADEDIRE FUNMILAYO
LEVEL: MSC 2 (1ST SEMESTER)
DATE: MARCH 2023
2

1ST FLOOR PLAN

MULTI LEVEL FLOOR

NAME:	AJIFERUKE AYOOLA EMMANUEL	STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO	
MATRIC NO.		LEVEL:	MSC 2 (1ST SEMESTER)	
COURSE:	ARC 721 Advance Architectural Design studio III	DATE:	MARCH 2023	5

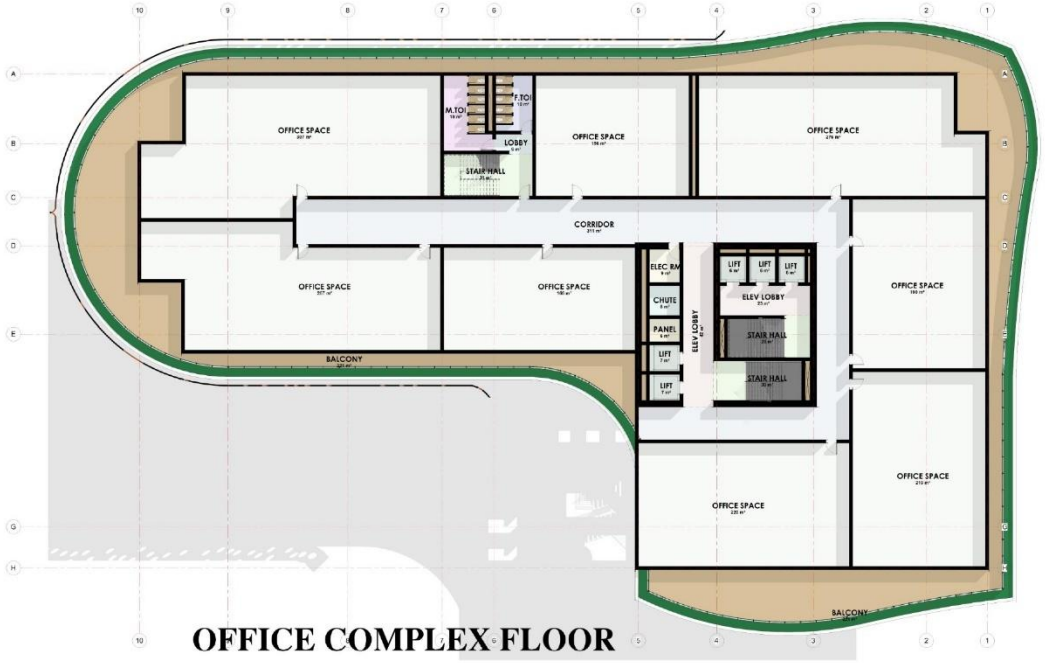
2ND FLOOR PLAN

SERVICE FLOOR

NAME:	AJIFERUKE AYOOLA EMMANUEL		STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO	
MATRIC NO.			LEVEL:	MSC 2 (1ST SEMESTER)	7
COURSE:	ARC 721 Advance Architectural Design studio III		DATE:	MARCH 2023	

RECREATION AREA

NAME:	AJIFERUKE AYOOLA EMMANUEL	STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO	
MATRIC NO.		LEVEL:	MSC 2 (1ST SEMESTER)	9
COURSE:	ARC 721 Advance Architectural Design studio III	DATE:	MARCH 2023	



OFFICE COMPLEX FLOOR

NAME:	AJIFERUKE AYOOLA EMMANUEL	STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO	11
MATRIC NO.		LEVEL:	MSC 2 (1ST SEMESTER)	
COURSE:	ARC 721 Advance Architectural Design studio III	DATE:	MARCH 2023	

NAME:	AJIFERUKE AYOOLA EMMANUEL		STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO	
MATRIC NO.			LEVEL:	MSC 2 (1ST SEMESTER)	13
COURSE:	ARC 721 Advance Architectural Design studio III		DATE:	MARCH 2023	

2 BEDROOM LUXURY APARTMENT

3 BEDROOM LUXURY APARTMENT

NAME:	AJIFERUKE AYOOLA EMMANUEL	STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO	15
MATRIC NO.		LEVEL:	MSC 2 (1ST SEMESTER)	
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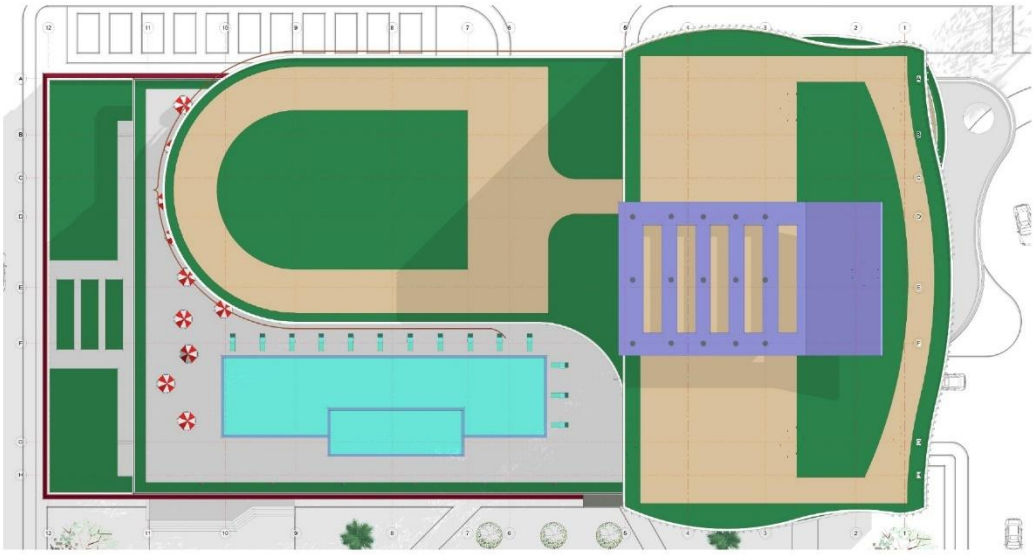

NAME:	AJIFERUKE AYOOLA EMMANUEL		STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO	
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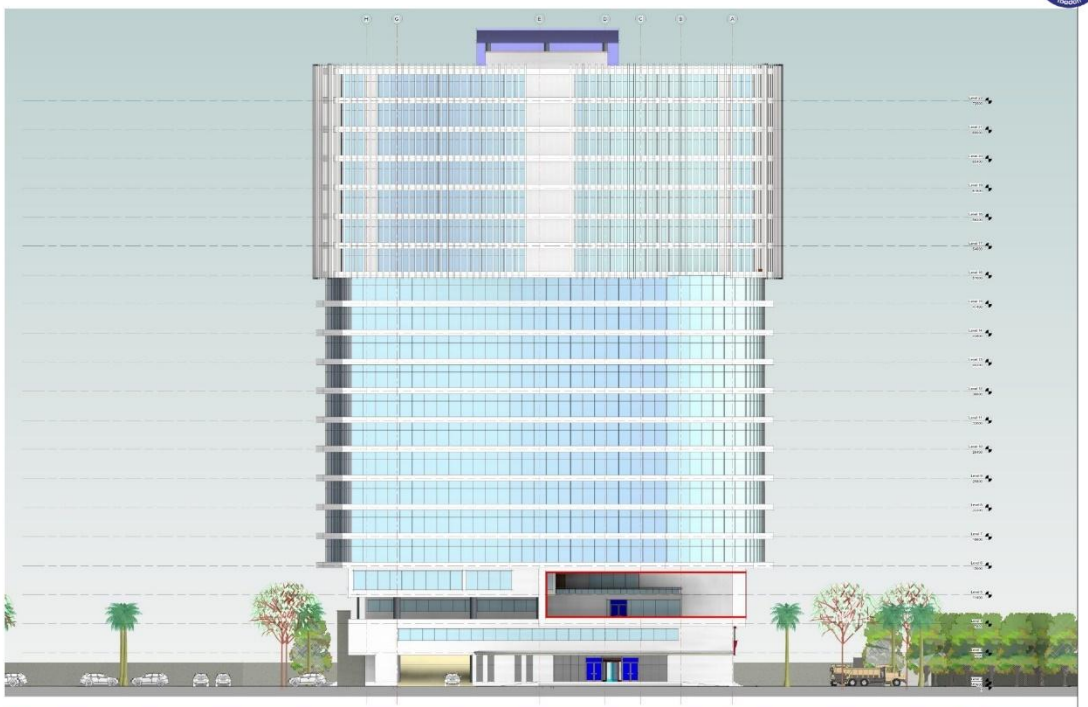

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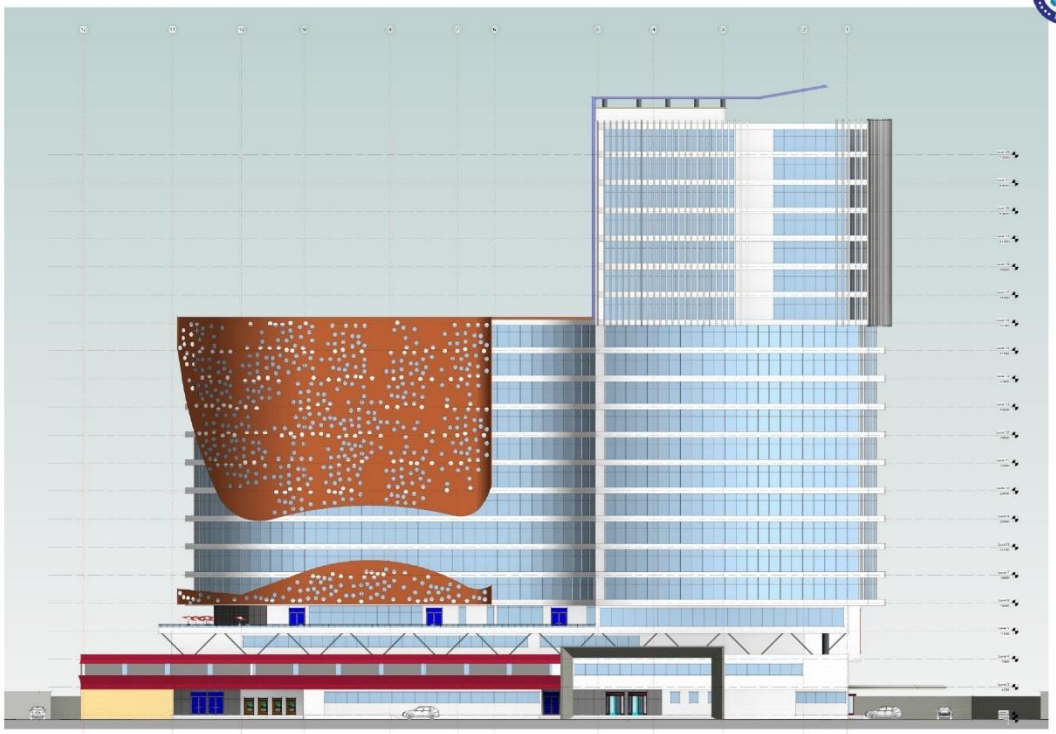
MATRIC NO.			LEVEL:	MSC 2 (1ST SEMESTER)	17
COURSE:	ARC 721 Advance Architectural Design studio III		DATE:	MARCH 2023	

NAME:	AJIFERUKE AYOOLA EMMANUEL		STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO
MATRIC NO.			LEVEL:	MSC 2 (1ST SEMESTER)
COURSE:	ARC 721 Advance Architectural Design studio III		DATE:	MARCH 2023

18



NAME:	AJIFERUKE AYOOLA EMMANUEL		STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO	
MATRIC NO.			LEVEL:	MSC 2 (1ST SEMESTER)	19
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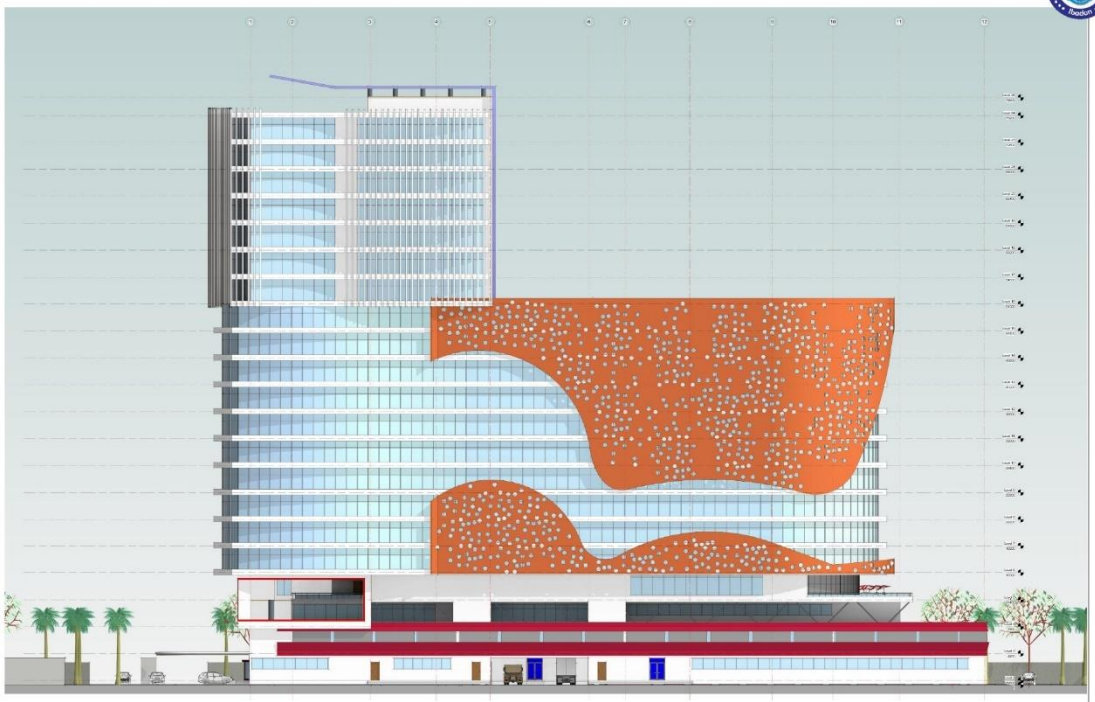

NAME:	AJIFERUKE AYOOLA EMMANUEL	STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO	20
MATRIC NO.		LEVEL:	MSC 2 (1ST SEMESTER)	
COURSE:	ARC 721 Advance Architectural Design studio III	DATE:	MARCH 2023	

NAME:	AJIFERUKE AYOOLA EMMANUEL	STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO	21
MATRIC NO.		LEVEL:	MSC 2 (1ST SEMESTER)	
COURSE:	ARC 721 Advance Architectural Design studio III	DATE:	MARCH 2023	

NAME:	AJIFERUKE AYOOLA EMMANUEL		STUDIO CRITIC:	DR. (ARC.) ADEDIRE FUNMILAYO	
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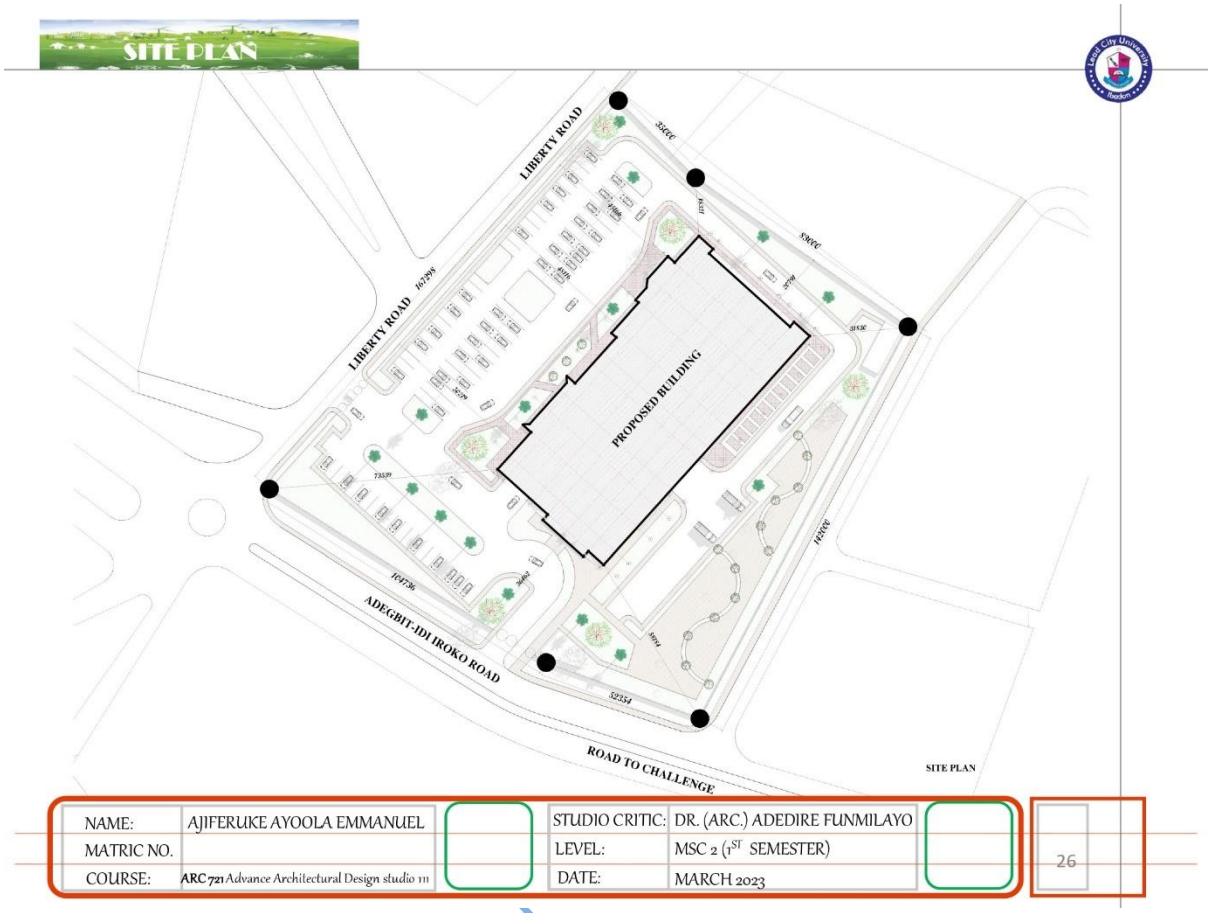

Bio-data

A. Personal Data

1. Full Name:	**AJIFERUKE Ayoola Emmanuel**
2. Address:	Ilesha, Osun State
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4. Phone Number:	08168340052
5. Date of Birth:	23/08/94
6. Place of Birth:	Ilesa, Osun State

7. Nationality: Nigerian

8. Marital Status: Single

9. Name and Address of Next of Kin: Mercy AJIFERUKE

Ilesa, Osun State

B. Educational Background

1. Educational Institutions Attended with Dates and Qualification:

Qualifications	Institution	Date
MSc Architecture	Lead City University, Ibadan, Oyo State.	2021 - Date (Ongoing)
BSc. Architecture	Lead City University, Ibadan, Oyo State.	2019-2021
HND Architecture	Osun State College of Technology Esa Oke, Osun State	2015-2017
ND Architecture	Osun State College of Technology Esa Oke, Osun State	2012-2014
Secondary School Certificate	Ilesa Grammar School _ Okesa, Ilesa Osun State–	2004-2010
Primary School leaving Certificate	Progressive Sister Nur. & Pry. School- Beside Onimo Palace, Imo - Ilesa, Osun State	1996- 2004

C. Awards and Fellowships:

1. Graduate Member, Nigerian Institute of Architects

D. Work Experience: With Dates

Proserve Design Ltd

- 02, Olufemi Street, Opposite International Breweries, Imo Ilesa, Osun State. 2013-2014. An Internship Program For 4 Month Siwes. Assisting Architect, Documentation of Architectural Drawings, Site
- Femi Ayeni Street, Adura Bus Stop, Adura, Along Lagos-Abeokuta Expressway. Lagos. 2015 – 2016. Assisting Architect, Documentation of Architectural Drawings, Site
- Mosfek & Associate, Imo - Ilesa, Osun State. 2016 – 2019. Assisting Architect, Documentation of Architectural Drawings, Site
- Abdt Partnership, Third Floor, Old Skecth Building, Opposite Central Bank of Nigeria, Dugbe, Ibadan, Oyo State. 2019 – 2020. Post: Assisting Architect

E. Publications –

- Safety Considerations in Airport Terminal Design.
- Elevating Energy Efficiency and Sustainability in Mixed-Use Buildings: Strategies for a Greener Future

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Signature **Date**

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