A Proposed Mixed-Use Development, Lagos, Nigeria
(Circulation in Mixed-Use Buildings)

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Certification

This is to certify that Oluwafemi Abolaji ADEWUMI with matriculation number LCU/PG/005089 carried out this research work titled "Circulation in Mixed-use Buildings" in the Department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, Oyo state, for the award of Master Degree (MSc) in Architecture and that this has not been previously submitted.

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Dedication

This Research is dedicated to God for his grace and guidance.

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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

This thesis explores the critical role of circulation design in optimizing functionality and user experience within mixed-use buildings. Through a comprehensive analysis of existing literatures and case studies, the research examines spatial organization, traffic flow management, and user interaction patterns in diverse mixed-use environments. Key findings emphasize the integration of multi-modal transportation networks, inclusive accessibility provisions, and sustainable design strategies to enhance movement efficiency and connectivity. Strategic layout planning, spatial zoning, and technological innovations emerge as pivotal in mitigating congestion, improving navigation, and ensuring user safety. The study underscores the transformative potential of digital technologies in monitoring and optimizing circulation patterns to enhance operational performance and environmental sustainability. By synthesizing empirical review, this thesis contributes to a nuanced understanding of circulation dynamics in mixed-use buildings. It provides actionable recommendations for architects, developers, and urban planners to create resilient, user-centric environments that support vibrant communities and sustainable urban development.

Keywords: Accessibility, Circulation, Efficiency, Mixed-Use Buildings, Spatial Layout, Sustainability, Technology, Traffic Flow, Urban Mobility & User Experience.

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Chapter One

Introduction

1.1 Background to the study

In contemporary urban landscapes, mixed-use buildings have evolved beyond mere functional amalgamations to become catalysts for urban revitalization and community cohesion due to their ability to integrate diverse functions within a single structure. The evolution of mixed-use buildings can be traced to the principles of New Urbanism and smart growth initiatives, which emphasize compact, pedestrian-friendly urban forms that enhance social interaction and environmental sustainability (Litman, 2020).

Mixed-use buildings represent a paradigm shift in urban planning and architecture, responding to the complexities of modern urban environments. These buildings combine residential, commercial, and sometimes industrial spaces in a setting that optimizes land use and promotes vibrant urban environments that reduce reliance on automobile transport (Carmona, 2021). The concept stems from the principles of mixed-use development, which advocate for the co-location of compatible land uses to enhance efficiency, social interaction, and environmental sustainability (Gehl, 2010).

One critical aspect influencing their functionality and user experience is circulation design. Circulation refers to the strategic planning and layout of vertical and horizontal pathways such as corridors, stairs, elevators, and other movement spaces within a building to facilitate safe, efficient movement of people and goods (Dunham-Jones & Williamson, 2011). In mixed-use buildings, effective circulation design is crucial for optimizing spatial efficiency, enhancing user experience, and ensuring operational functionality (Baxendale & Heavey, 2019).

Mixed-use buildings are characterized by their integration of different functions within a single structure or complex. These functions may include residential spaces (apartments or condominiums), commercial areas (retail shops, restaurants, cafes), office spaces, recreational facilities, and sometimes educational or healthcare facilities. The co-location of these uses promotes convenience, reduces the need for automobile travel, encourages walkability, and supports a sustainable urban lifestyle where residents can live, work, and socialize within the same area (Dixon & brown, 2014).

As the prevalence of mixed-use buildings continues to grow, the importance of efficient and effective circulation design within these structures becomes increasingly apparent. Proper circulation design not only enhances the functionality and safety of the building but also improves the overall user experience, making these buildings more appealing for contemporary urban living. The study of circulation in mixed-use buildings is therefore critical for architects, urban planners, and developers aiming to enhance the usability and attractiveness of these developments.

1.2 Problem Statement

Despite their numerous benefits, the effective design and management of circulation within mixed-use buildings poses significant challenges due to the complex interaction of various user groups, functional requirements, and spatial configurations (Peiser & Chang, 2015). Poorly designed circulation systems can lead to congestion, inefficient space utilization, decreased user satisfaction, compromised safety and operational inefficiencies (Baxendale & Heavey, 2019). A common issue is the lack of clear separation between different types of users, such as residents and commercial visitors, which can result in conflicts and inefficiencies. For instance, residents require privacy and security, while commercial tenants need easy access for customers and deliveries. Balancing these requirements is essential to creating functional and efficient mixed-use spaces (Chiaradia et al., 2012). Given the complexity of mixed-use environments, which accommodate diverse user groups with varying needs and behaviors,

designing with effective circulation requires intricate understanding of spatial dynamics and user interactions.

1.3 Aim and Objectives of the Study

Aim

This research aims to evaluate the principles, strategies, and best practices for optimizing circulation in mixed-use buildings to enhance accessibility, safety, and user satisfaction. To achieve this aim, the study will focus on the following specific objectives:

Objectives

1. To examine existing literature on circulation design principles in mixed-use buildings.
2. To identify challenges and constraints in the design and implementation of circulation systems.
3. To propose guidelines and recommendations for optimizing circulation design in mixed-use buildings.

1.4 Research Questions

1. What are the key principles of circulation design that should be considered in mixed-use buildings?
2. What are the common challenges faced in the implementation of effective circulation systems in mixed-use buildings?
3. What strategies can be employed to optimize circulation and enhance user experience in mixed-use buildings?

1.5 Significance of the Study

This study is significant as it contributes to the understanding and improvement of circulation in mixed-use buildings, thereby enhancing urban livability, efficiency of space utilization, and user

satisfaction. The findings will be valuable to architects, urban planners, developers, and policymakers involved in the design and management of mixed-use developments.

1.6 Scope and Limitations to Study

This study will primarily focus on a comprehensive review of scholarly literature and case studies related to circulation in mixed-use buildings. Limitations include the variability in design preferences across different regions and the availability of comprehensive case studies for analysis. The research will explore various practical applications to provide a broad understanding of circulation within mixed-use contexts.

1.7 Operational Definition of Terms

Mixed-Use Buildings: Structures or complexes that integrate diverse functions such as residential, commercial, office, and sometimes industrial spaces within a single setting.

Circulation Design: The strategic planning and layout of pathways, including corridors, stairs, elevators, and other movement spaces within a building, to facilitate safe and efficient movement of people and goods.

Urban Revitalization: The process of improving and renewing urban areas to enhance their appeal, functionality, and sustainability.

Community Cohesion: The integration and sense of belonging among different groups within a community, fostering social interaction and collaboration.

New Urbanism: An urban design movement promoting walkable neighborhoods, mixed-use development, and environmentally sustainable practices.

Pedestrian-Friendly Urban Forms: Urban layouts designed to prioritize pedestrian access and movement, enhancing walkability and reducing dependence on automobiles.

Environmental Sustainability: Practices and designs aimed at reducing environmental impact, preserving natural resources, and promoting ecological balance.

Operational Functionality: The effectiveness with which a building or system operates to meet its intended purposes, ensuring smooth and efficient processes.

Walkability: The measure of how friendly an area is to walking, often enhanced by mixed-use developments that provide various amenities within close proximity.

Compact Urban Forms: Urban designs that use land efficiently by concentrating development within a smaller area to reduce sprawl and enhance accessibility.

User Experience: The overall experience and satisfaction of individuals using a building, influenced by design, functionality, and ease of navigation.

Mixed-Use Development: The planning and creation of urban areas where different land uses are co-located, promoting efficiency, social interaction, and sustainability.

Functional Amalgamations: The combination of various functions within a single structure or space to enhance utility and integration.

Vertical and Horizontal Pathways: The designed routes within a building, including stairs, elevators (vertical), corridors, and walkways (horizontal), facilitating movement.

Chapter Two

Literature Review

The concept of circulation within mixed-use buildings plays a pivotal role in shaping their functionality, efficiency, and user experience. Effective circulation design ensures seamless movement of people, goods, and services throughout the building, thereby enhancing accessibility, safety, and overall satisfaction. This chapter reviews existing literature on circulation in mixed-use buildings, focusing on its various aspects, design principles, challenges, and innovations.

2.1 Conceptual Review

2.1.1 Mixed-Use Buildings

Fig 2.1: Mixed-use Building

Source: (Google Search, 2024)

Mixed-use buildings are structures that incorporate multiple functions, such as residential, commercial, cultural, institutional, or entertainment uses, within a single building or development. This concept aims to create vibrant, walkable communities by integrating various activities and reducing the need for extensive travel between different zones (Rowley, 1996; Schwanke, 2003). The Urban Land

Institute defines mixed-use developments as projects that include three or more significant revenue-producing uses that are functionally and physically integrated, and that provide pedestrian connections (Urban Land Institute, 2011) .

2.1.1.1 Brief History of Mixed-Use Buildings

The concept of mixed-use buildings is not new as it can be traced back to ancient civilizations, with one of the earliest examples being Trajan's Market in Rome, constructed around 110 AD; it has roots in the early urban settlements where commercial and residential spaces coexisted (Dovey & Pafka, 2017; Woo & Cho, 2018).

This multi-level structure combined shops, administrative offices, and residential spaces, reflecting the integration of different functions in a single building. During the 20th century, urban sprawl and the rise of automobile dependency led to the separation of different land uses. However, the last few decades have seen a resurgence of mixed-use developments in modern urban planning as a response to increasing urban density and the need for sustainable development (Gast, 2023).

2.1.1.2 Characteristics of Mixed-Use Buildings

Mixed-use buildings are characterized by their diversity of uses and the integration of these uses within a single structure or development. They promote a live/work/play environment, often supported by public transportation networks. Key primary characteristics include:

1. **Functional Integration**

   Functional integration refers to the combination of different uses within a single building or complex. This typically includes residential, commercial, office, and recreational spaces. The goal is to create a self-sustaining environment where people can live, work, and play without

needing extensive travel. This integration promotes convenience, reduces commuting time, and can enhance the overall quality of life for residents and users of the space (Lee, 2022).

2. **Pedestrian Connectivity**

Pedestrian connectivity is a crucial feature of mixed-use buildings. It involves designing spaces that are easily accessible and walkable, with pathways that connect various uses within the building or complex. This feature encourages walking over driving, which can reduce traffic congestion and pollution. Effective pedestrian connectivity also enhances the user experience, making it easier for people to navigate between different areas, such as from their homes to nearby shops or offices (Bahadure & Kotharkar, 2015).

3. **Shared Spaces**

Shared spaces are common areas within mixed-use developments that are accessible to all users. These can include parks, plazas, courtyards, and communal amenities like gyms or lounges. Shared spaces are designed to foster social interaction and community engagement, providing places where people can meet, relax, and participate in activities. They are essential for creating a sense of community and belonging among residents and users of the mixed-use building (Urban Land Magazine, 2023).

4. **Flexibility**

Flexibility in design and function is another hallmark of mixed-use buildings. These developments are often designed to be adaptable to changing needs and uses over time. This can involve flexible floor plans that can be easily reconfigured, spaces that can serve multiple purposes, and infrastructure that supports various types of businesses and residential units. Flexibility ensures that the building can remain relevant and useful as the needs of the community evolve. The ability to adapt to changing market demands, and community needs over time (Rowley, 1996; Woo & Cho, 2018).

2.1.1.3 Types of Mixed-Use Buildings

There are several types of mixed-use buildings, including:

a. **Vertical Mixed-Use:** Different uses are stacked vertically within a single building, such as residential units above retail spaces. This arrangement maximizes land use efficiency and enhances the accessibility of amenities for residents.
b. **Horizontal Mixed-Use:** Different uses are spread horizontally across a single development, like a complex with separate buildings for residential, commercial, and recreational purposes (Dovey & Pafka, 2017). These developments often form part of a master-planned community, offering diverse functions like retail, office, and residential spaces within walking distance of each other.
c. **Integrated (Hybrid) Mixed-Use:** A combination of vertical and horizontal integration, where multiple uses coexist within the same or adjacent structures (Komossa, 2011). This type of development can provide the benefits of both vertical and horizontal mixed-use formats.

2.1.1.4 Components and Features of Mixed-Use Buildings

Key components of mixed-use buildings include residential units, commercial spaces, office areas, and public amenities. Features often integrated into these buildings are green spaces, recreational facilities, and efficient circulation systems that facilitate seamless movement between different functional areas (Woo & Cho, 2018; Schwanke, 2003). They include:

Residential Units

Residential units are a core component of mixed-use buildings, providing living spaces for individuals and families. These units can vary from luxury Apartments or condominiums to affordable housing

options, catering to diverse socioeconomic groups. Key design considerations for residential units include:

- **Privacy and Security:** Ensuring residents' privacy and security is crucial. This involves soundproofing, secure entry systems, and private outdoor spaces (e.g., balconies or terraces) (Bremner & O'Sullivan, 2020).
- **Natural Light and Ventilation:** Maximizing natural light and ventilation improves residents' quality of life and reduces energy consumption. Strategic placement of windows and the use of light wells are common strategies (Smith & Jones, 2021).
- **Access to Amenities:** Proximity to amenities such as gyms, pools, laundry facilities, and common areas enhances the living experience (Johnson & Weber, 2023).

Commercial Spaces

Commercial spaces within mixed-use buildings include retail stores, restaurants, cafes, and service-oriented businesses. These spaces serve both residents and the wider community, contributing to the building's vibrancy. Design considerations include:

- **Foot Traffic and Visibility:** Commercial spaces should be easily accessible and visible to attract customers. Ground-floor locations and clear signage are essential (Lopez et al., 2022).
- **Flexible Layouts:** Designing adaptable spaces that can accommodate different types of businesses over time helps maintain commercial viability (Turner & Hall, 2020).
- **Integration with Public Spaces:** Commercial areas should seamlessly connect with public and community spaces, encouraging social interaction (Clark & Roberts, 2018).

Office Spaces

Office spaces are another integral component of mixed-use buildings, providing workspaces for businesses and professionals. These spaces need to be designed with several key features in mind:

- **Ergonomic Design:** Office spaces should promote comfort and productivity through ergonomic furniture and flexible layouts (Miller & Thompson, 2019).
- **Technology Integration:** High-speed internet, smart office systems, and advanced IT infrastructure are critical for modern office environments (Phillips & Martin, 2023).
- **Natural Light:** Like residential spaces, office areas benefit from natural light, which can enhance productivity and well-being (Gibson & Park, 2021).

Public Amenities

Public amenities are essential for fostering community engagement and enhancing the livability of mixed-use buildings. These amenities can include:

- **Community Centers:** Spaces for community events, meetings, and social gatherings (Hernandez & Williams, 2020).
- **Green Spaces:** Parks, gardens, and rooftop terraces that provide areas for relaxation and recreation (Anderson & Kim, 2022).
- **Recreational Facilities:** Gyms, swimming pools, and sports courts that promote physical activity and wellness (Lee & Evans, 2021).

Transportation Access

Efficient transportation access is crucial for the success of mixed-use buildings. This involves:

- **Proximity to Public Transit:** Easy access to public transportation options such as buses, trains, and subways reduces the need for car travel and supports sustainable urban living (Miller & Thompson, 2019).

- **Parking Facilities:** Adequate parking for residents, workers, and visitors, including provisions for bicycles and electric vehicles (Clark & Roberts, 2018).
- **Pedestrian and Bicycle Infrastructure:** Safe and convenient pathways for pedestrians and cyclists encourage active transportation (Lopez et al., 2022).

Cultural and Recreational Facilities

Cultural and recreational facilities enrich the mixed-use environment by providing spaces for leisure, education, and cultural engagement. Museums, theaters, gyms, and other amenities that enhance the livability of the development (Rowley, 1996; Rabianski et al., 2009). These facilities can include:

- **Museums and Galleries:** Spaces that showcase art, history, and culture, fostering a sense of community identity (Johnson & Weber, 2023).
- **Theaters and Performance Spaces:** Venues for live performances, movies, and community events (Hernandez & Williams, 2020).
- **Educational Institutions:** Schools, libraries, and learning centers that serve residents and the surrounding community (Gibson & Park, 2021).

2.1.1.5 Advantages of Mixed-Use Development

Mixed-use buildings offer several advantages in terms of urban sustainability, economic vitality, and social cohesion.

- **Urban Sustainability**

  By promoting compact, mixed-use development patterns, mixed-use buildings reduce the need for vehicular travel, thus minimizing carbon emissions and traffic congestion. They support sustainable transportation modes such as walking, cycling, and public transit, contributing to urban livability and environmental quality (Kamruzzaman et al., 2017).

- **Economic Vitality**

Mixed-use developments stimulate local economies by creating diverse employment opportunities, attracting businesses, and generating tax revenues. The co-location of residential and commercial activities enhances business viability and consumer convenience, fostering economic resilience and growth (Cheshire et al., 2020).

- **Social Cohesion**

Mixed-use buildings foster social interaction and community cohesion by bringing together people from diverse backgrounds and lifestyles. Shared spaces such as sidewalks, plazas, and parks encourage spontaneous encounters and collective activities, fostering a sense of belonging and social capital (Carmona et al., 2019).

2.1.1.6 Theoretical Frameworks

Several theoretical frameworks guide the conceptualization and analysis of mixed-use development projects, shaping their spatial organization, functional integration, and social dynamics.

a. **Urban Morphology**

Urban morphology examines the physical form and spatial structure of cities, including the arrangement of buildings, streets, and open spaces. Mixed-use buildings contribute to the morphological diversity and complexity of urban environments by accommodating multiple functions within a single development, fostering compact and walkable neighborhoods (Marshall & Çelik, 2020).

b. **New Urbanism**

New Urbanism advocates for sustainable, human-scale development patterns that prioritize pedestrian-friendly streets, mixed land uses, and diverse housing options. Mixed-use buildings embody the principles of New Urbanism by creating vibrant, transit-oriented communities that promote social interaction, economic vitality, and environmental sustainability (Duany et al., 2000).

c. Activity Theory

Activity theory examines the relationship between individuals, their environment, and the activities they engage in within that environment. Mixed-use buildings provide opportunities for diverse activities such as living, working, shopping, and leisure, facilitating social interaction, cultural exchange, and economic exchange among residents, workers, and visitors (Hägerstrand, 1970).

2.1.1.7 Conceptual Principles

The design and planning of mixed-use buildings are guided by several conceptual principles that optimize functionality, accessibility, and livability for users.

a. Activity Zoning

Activity zoning involves organizing different land uses and functions within mixed-use developments to create synergies and minimize conflicts. Placing residential units above commercial spaces or clustering similar activities together promotes convenience, efficiency, and social interaction, enhancing the overall quality of urban life (Carr et al., 2019).

b. Complete Streets

Complete streets design principles prioritize the needs of all users, including pedestrians, cyclists, motorists, and public transit riders. Mixed-use buildings located along complete streets

incorporate pedestrian-friendly sidewalks, bike lanes, transit stops, and green spaces, fostering active transportation, safety, and accessibility for people of all ages and abilities (Gehl, 2010).

c. Placemaking

Placemaking strategies aim to create memorable, inclusive, and vibrant public spaces that reflect the identity and aspirations of local communities. Mixed-use buildings contribute to placemaking efforts by activating street frontages, providing gathering spaces, and incorporating public art, landscaping, and amenities that enhance the sense of place and foster social cohesion (Gehl, 2010).

2.1.1.8 Implementation Strategies

Implementing mixed-use developments requires collaborative planning, regulatory flexibility, and community engagement to overcome barriers and realize project goals.

a. Form-Based Codes

Form-based codes offer a regulatory framework for shaping the physical form and character of mixed-use developments based on urban design principles and community preferences. By prioritizing building form, scale, and massing over land use, form-based codes promote walkable, mixed-use neighborhoods that reflect local context and aspirations (Congress for the New Urbanism, 2020).

b. Transit-Oriented Development (TOD)

Transit-oriented development integrates mixed-use buildings with public transit infrastructure, encouraging higher-density development and reducing automobile dependence. By locating residential, commercial, and recreational amenities within walking distance of transit stations,

TOD promotes sustainable mobility, land use efficiency, and access to economic opportunities (Cervero & Kockelman, 1997).

c. Community Benefits Agreements (CBAs)

Community benefits agreements facilitate collaboration between developers, local governments, and community organizations to negotiate equitable outcomes for mixed-use development projects. CBAs address issues such as affordable housing, job creation, environmental sustainability, and cultural preservation, ensuring that the benefits of development are shared equitably among stakeholders (Cohen et al., 2007).

2.1.2 Circulation in mixed use buildings

Circulation in architecture refers to the systematic movement of people through, around, and between different parts of a building. It encompasses vertical and horizontal movement facilitated by corridors, stairways, elevators, and pathway. Circulation is essential for ensuring that a space is functional, accessible, and safe for its intended users. It influences the overall layout and design of a building, impacting both its aesthetic appeal and its practical usability (Hillier & Hanson, 1984).

2.1.2.1 Historical Development

The evolution of circulation in architecture encompasses the development of pathways and spaces designed to facilitate movement within buildings and across urban areas. The evolution of circulation has been influenced by various factors, including technological advancements, changing architectural styles, and evolving human needs.

A. Early Civilizations

In ancient times, circulation was largely determined by the basic functional needs of structures. Early buildings and settlements were designed with straightforward, often linear pathways that

connected essential spaces such as living areas, workspaces, and communal areas (Kostof, 1995). For example, in ancient Egyptian and Mesopotamian architecture, circulation patterns were simple and direct, reflecting the hierarchical organization of space.

- **Classical Antiquity**

  The Greeks and Romans made significant contributions to the understanding of circulation. Roman architecture introduced the concept of the forum, a central public space with organized pathways and connections to various parts of the city. The layout of Roman cities with their grid patterns and colonnaded streets exemplified advanced planning for movement and accessibility (Vitruvius, 1960).

- **Middle Ages**

  During the Middle Ages, circulation within buildings became more complex, especially in religious and fortified structures. Gothic cathedrals, for example, featured intricate labyrinths of corridors, stairways, and passageways designed to control the flow of people and enhance the spiritual experience (Trachtenberg & Hyman, 2002).

- **Renaissance and Baroque Periods**

  The Renaissance and Baroque periods brought a renewed focus on symmetry, proportion, and grandiose spaces. Circulation patterns were designed to create dramatic visual experiences. In palaces and mansions, processional routes were carefully planned to emphasize hierarchy and status. The Baroque period saw the development of dynamic and curvilinear circulation paths that guided visitors through elaborate interiors (Blunt, 1980).

B. Modern and Contemporary Developments

- **Industrial Revolution**

The Industrial Revolution introduced new materials and construction techniques, which significantly influenced circulation design. The advent of iron and steel allowed for larger spans and open spaces, leading to the development of wide corridors, atria, and interconnected spaces in public buildings like train stations and factories (Giedion, 1941).

- **20th Century**

  The 20th century saw the emergence of Modernism, which emphasized functionality and efficiency. Architects like Le Corbusier and Mies van der Rohe promoted open floor plans and flexible spaces that facilitated free movement. The introduction of elevators and escalators revolutionized vertical circulation, making multi-story buildings more accessible and practical (Curtis, 1996).

- **Postmodern and Deconstructivist Movements**

  Postmodern architecture brought a reaction against the rigid functionalism of Modernism. Circulation became more varied and playful, with a focus on creating engaging and unpredictable pathways. Deconstructivist architects like Frank Gehry and Zaha Hadid further pushed the boundaries, designing buildings with complex, fragmented circulation patterns that challenge traditional notions of movement and space (Jencks, 2002).

- **Technological Advancements**

  The evolution of circulation has been significantly influenced by technological advancements. The development of advanced structural systems, building materials, and digital design tools has allowed architects to explore new forms and configurations of circulation.

- **Digital Design and Parametricism**

In recent years, digital design and parametricism have enabled architects to create highly complex and adaptive circulation systems. Advanced software allows for the simulation of movement patterns and the optimization of pathways to enhance efficiency and user experience. These tools have been used in large-scale projects like airports, museums, and urban master plans to design intuitive and responsive circulation networks (Schumacher, 2009).

C. Human-Centered Design

Contemporary architectural practice places a strong emphasis on human-centered design, which considers the needs and behaviors of users. Inclusive design principles ensure that circulation systems are accessible to people of all abilities. This approach involves the integration of universal design features such as ramps, tactile indicators, and wayfinding systems to create environments that are navigable and welcoming for everyone (Steinfeld & Maisel, 2012). Early circulation systems were simple and direct, but modern designs emphasize efficiency, accessibility, and user experience (Dovey & Pafka, 2017).

2.1.2.2 Factors Influencing Circulation in Mixed-Use Buildings

Circulation in mixed-use buildings, where residential, commercial, and recreational spaces coexist, is influenced by several critical factors. These factors determine how effectively and comfortably people can move through these spaces. The primary factors influencing circulation in mixed-use buildings include building layout, functionality, accessibility, visibility, safety and security, and aesthetic appeal.

Building Layout

The layout of a mixed-use building significantly impacts circulation by determining how spaces are organized and connected.

- **Functional Zoning**

Functional zoning involves organizing different uses within the building in a way that enhances accessibility and minimizes conflicts. For instance, commercial areas are often located on lower floors for easy public access, while residential areas are placed on upper floors to ensure privacy and tranquility (Lehnerer, 2020). Proper zoning ensures that high-traffic areas are separated from quieter zones, facilitating smoother circulation.

- **Hierarchical Pathways**

  Creating a hierarchy of pathways—primary, secondary, and tertiary—is essential for effective circulation. Primary pathways, such as main corridors and lobbies, should be wide and direct to accommodate high foot traffic. Secondary and tertiary pathways lead to specific areas like offices or apartments and can be narrower and more intimate (Alexander, 2019).

Functionality

Functionality refers to how well the circulation design meets the needs of the building's users and supports its various uses.

- **Space Utilization**

  Effective circulation design maximizes space utilization by ensuring that pathways and communal areas are appropriately sized and placed. This involves balancing open spaces with designated pathways to prevent congestion and ensure ease of movement (Duffy, 2018).

- **Adaptability**

  Adaptable circulation systems can accommodate changing uses and user needs over time. For example, flexible layouts that allow for reconfiguration can extend the lifespan of a mixed-use building by adapting to evolving demands (Eastman et al., 2018).

Accessibility

Accessibility is a critical factor that ensures all users, regardless of their physical abilities, can navigate the building easily and safely.

- **Universal Design**

  Universal design principles aim to create environments usable by all people. Features such as ramps, wide doorways, and elevators are essential for ensuring that the building is accessible to everyone, including individuals with disabilities (Mace, 2020).

- **Compliance with Standards**

  Adhering to accessibility standards, such as the Americans with Disabilities Act (ADA), is essential for creating inclusive environments. These standards specify the minimum requirements for accessible design, including the width of pathways, slope of ramps, and height of handrails (ICC, 2021).

Visibility

Visibility refers to how easily people can see and navigate through a building, which impacts their ability to move efficiently and safely.

- **Wayfinding and Signage**

  Effective wayfinding and signage are crucial for helping people navigate complex mixed-use buildings. Clear, consistent signage that uses universally understood symbols and languages can reduce confusion and improve circulation. Digital wayfinding solutions, such as smartphone apps and interactive kiosks, provide real-time directions and information (Arthur & Passini, 2019).

- **Open Sightlines**

  Designing open sightlines, especially in larger buildings, helps users orient themselves and find their way more easily. Open sightlines in corridors, lobbies, and communal areas enhance visibility and create a sense of openness (Gehl, 2018).

Safety and Security

Safety and security are paramount in circulation design, ensuring that users can move through the building without risk.

- **Lighting**

  Adequate lighting is essential for safe circulation, particularly in corridors, stairwells, and parking areas. Proper lighting reduces the risk of accidents and enhances the sense of security for building users (Lechner, 2021).

- **Emergency Exits and Pathways**

  Clearly marked and easily accessible emergency exits and pathways are critical for safety. Regular drills and maintenance ensure that these pathways remain functional and can be used effectively in an emergency (Strakosch & Caporale, 2021).

Aesthetic Appeal

Aesthetic appeal enhances the overall user experience, making circulation spaces pleasant and inviting.

- **Design Elements**

Incorporating design elements such as natural lighting, greenery, and art can transform circulation spaces from mere pathways into engaging environments. These elements contribute to the aesthetic appeal and psychological well-being of users (Kellert, 2018).

- **Material Choice**

  The choice of materials for floors, walls, and ceilings in circulation spaces can impact both aesthetics and functionality. Durable, easy-to-clean materials that also offer visual appeal enhance the overall experience of moving through the building (Oldenburg, 2019).

Human Behavior and Experience

Understanding human behavior and designing with user experience in mind is critical for successful circulation in mixed-use buildings.

User Comfort and Safety

Designing circulation spaces that prioritize user comfort and safety is paramount. This includes ensuring adequate lighting, ventilation, and visibility, as well as incorporating safety features such as handrails, non-slip surfaces, and emergency exits. Comfortable and safe circulation spaces encourage use and enhance the overall user experience (Steinfeld & Maisel, 2012).

Environmental and Sustainability Considerations

Sustainability considerations are increasingly influencing the design of circulation spaces in mixed-use buildings.

- **Energy Efficiency**

  Designing circulation spaces with energy efficiency in mind can reduce the environmental impact of mixed-use buildings. This includes optimizing natural lighting and ventilation, using

energy-efficient lighting and HVAC systems, and incorporating renewable energy sources where possible. Energy-efficient circulation spaces not only reduce operational costs but also contribute to overall sustainability goals (Lechner, 2021).

- **Biophilic Design**

  Biophilic design principles, which integrate natural elements into the built environment, can enhance circulation spaces by making them more pleasant and health-promoting. Incorporating features such as indoor gardens, green walls, and natural materials can create a more inviting atmosphere and improve the well-being of users (Kellert, 2018).

Fig 2.2: Biophilic Design

Source: (Google Search, 2024)

2.1.2.3 Elements of Circulation in Mixed-Use Buildings

Circulation within mixed-use buildings encompasses various elements that ensure smooth, efficient, and safe movement of people. These elements include pathways, vertical transportation, nodes, wayfinding systems, and transitions. Each element plays a crucial role in the overall circulation system, contributing to the functionality, accessibility, and user experience of the building.

Pathways

Pathways are fundamental components of circulation, providing the routes through which people navigate a building. Effective pathway design is essential for facilitating smooth and efficient movement.

- **Corridors**

  Corridors are primary pathways that connect different areas within a building. They must be wide enough to accommodate the expected foot traffic and should be designed to minimize bottlenecks and congestion. In mixed-use buildings, corridors serve multiple functions, from connecting commercial spaces to residential areas, and their design must consider the diverse needs of users. Wide corridors can also serve as informal meeting areas or display spaces, adding to the functionality and aesthetic value of the building.

  The materials and finishes used in corridors play a crucial role in their durability and maintenance. High-traffic areas require robust materials that can withstand wear and tear. Additionally, proper lighting and ventilation are essential to maintain a pleasant and safe environment. Corridors should be designed to accommodate emergency situations, with clear and accessible routes for evacuation (Alexander, 2019).

- **Hallways**

  Hallways are secondary pathways that lead to individual rooms or smaller areas within a building. They are typically narrower than corridors but still need to ensure sufficient space for movement. The design of hallways should consider privacy and noise reduction, especially in residential areas. Effective hallway design can enhance the sense of security and comfort for residents and users.

  In residential sections of mixed-use buildings, hallways can contribute to a sense of community by incorporating design elements that promote social interaction, such as small seating areas or

community notice boards. In commercial sections, hallways should be designed to direct foot traffic efficiently, reducing congestion and improving the shopping experience. The choice of finishes and lighting in hallways can also affect the overall ambiance, making spaces feel more welcoming and comfortable (Ching, 2018).

Vertical Transportation

Vertical transportation systems, such as elevators, escalators, and stairs, are crucial for moving people between different floors of a mixed-use building.

- **Elevators**

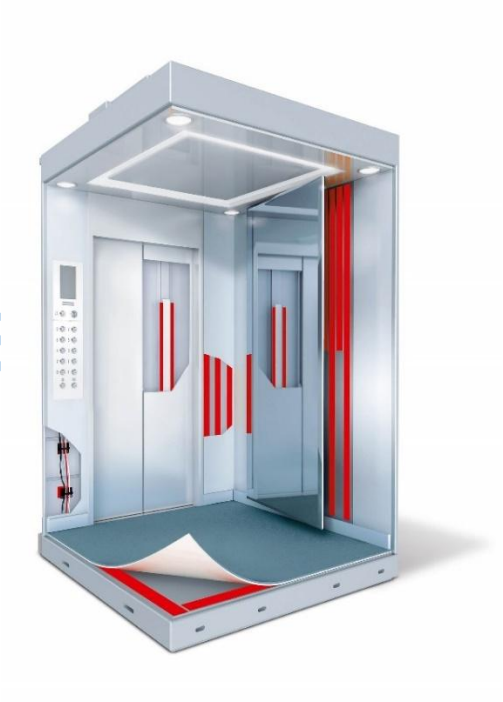

Fig 2.3: Elevator

Source: (Google Search, 2024)

Elevators are essential for vertical circulation, particularly in high-rise buildings. They need to be strategically located to serve different areas efficiently and minimize waiting times. Modern

elevator systems incorporate advanced technologies to enhance efficiency and user experience, such as destination control systems that reduce travel time and energy-efficient designs that lower operational costs (Strakosch & Caporale, 2021).

Elevator design must consider the needs of all users, including those with disabilities. Features such as audible announcements, braille buttons, and spacious cabins enhance accessibility. Elevators should also be designed for safety, with robust control systems to handle emergencies and power failures. In high-traffic areas, multiple elevators with intelligent dispatch systems can improve efficiency and reduce wait times (Strakosch & Caporale, 2021).

- **Escalators**

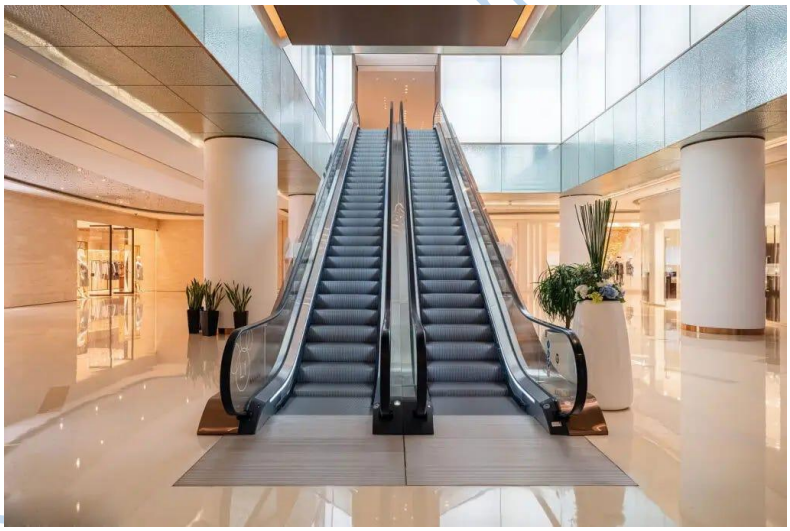

Fig 2.4: Escalator

Source: (Google Search, 2024)

Escalators are ideal for continuous vertical movement in areas with high foot traffic, such as shopping centers within mixed-use buildings. They provide a constant flow of movement and are often used in conjunction with elevators to enhance overall circulation. Escalators should be

designed to handle peak loads and ensure safety, with features like emergency stop buttons and safety barriers (Mehta & Mehta, 2020).

The placement of escalators within a building is crucial for efficient circulation. They should be in central areas to facilitate easy access and improve flow. Escalators can also serve as visual anchors, guiding people through large open spaces and connecting different levels seamlessly. Maintenance and regular inspection are vital to ensure the safety and reliability of escalators (Mehta & Mehta, 2020).

- **Stairs**

Fig 2.5: Stairs

Source: (Google Search, 2024)

Stairs are a crucial component of vertical circulation, providing an alternative to elevators and escalators. They are essential for safety, offering an emergency exit route, and promoting health

by encouraging physical activity. The design of stairs should prioritize user safety, incorporating handrails, adequate lighting, and slip-resistant surfaces (Bachman, 2018).

In addition to functional considerations, stairs can have significant architectural features that enhance the aesthetic appeal of a building. Grand staircases in lobbies or atriums can serve as focal points, while more utilitarian stairs should be designed for comfort and ease of use. The integration of natural lighting and visually appealing materials can make stairs more inviting and less daunting for users (Mehta & Mehta, 2020).

Nodes

Nodes are critical points within a circulation system where pathways intersect, and people make decisions on where to go next.

- **Lobbies**

  Lobbies serve as primary nodes in mixed-use buildings, acting as central hubs for orientation and access to different areas. They should be spacious, well-lit, and include amenities such as seating, information desks, and clear signage to assist users. Lobbies can also serve as social spaces, encouraging interaction and community building (Gehl, 2018).

  The design of lobbies should reflect the overall character of the building, creating a welcoming and professional atmosphere. Features such as high ceilings, natural light, and quality finishes can enhance the sense of space and importance. Lobbies must also consider security, with controlled access points and surveillance systems to protect occupants. Additionally, lobbies

should accommodate the needs of all users, including those with disabilities, ensuring easy access and navigation (Gehl, 2018).

- **Intersections**

  Intersections occur where corridors and hallways meet. The design of these nodes should ensure clear visibility and minimize congestion. Open sightlines and intuitive layouts help users navigate intersections effectively. These areas can be enhanced with design elements such as distinctive flooring patterns or lighting to guide users (Arthur & Passini, 2019).

  Intersections are opportunities to create visual interest and enhance wayfinding. Incorporating design elements such as color coding or thematic décor can help users orient themselves and find their way more easily. Seating areas or small lounges at intersections can provide resting points and encourage social interaction. Effective signage and digital wayfinding tools can further assist in navigation, making intersections more user-friendly (Arthur & Passini, 2019).

Wayfinding Systems

Wayfinding systems are essential for helping users navigate complex mixed-use buildings. They include signage, maps, and digital navigation aids.

- **Signage**

  Effective signage provides clear, concise, and consistent information to guide users. It should be strategically placed at decision points, such as intersections and entry points, and use universal symbols and multilingual text to cater to diverse users. Signage should be designed to be easily visible and readable, with appropriate fonts, colors, and lighting (Arthur & Passini, 2019).

  Signage can be categorized into different types, including directional signs, informational signs, and identification signs. Directional signs guide users to their destinations, while informational

signs provide essential details such as building directories and emergency procedures. Identification signs label rooms and areas, helping users confirm their location. Integrating these different types of signage into a cohesive system ensures that users receive consistent and helpful information throughout their journey (Arthur & Passini, 2019).

- **Digital Wayfinding**

  Digital wayfinding solutions, such as interactive kiosks and smartphone apps, offer dynamic and real-time navigation assistance. These technologies can enhance user experience by providing personalized directions and information. Digital wayfinding can also integrate with other building systems, such as security and management, to provide comprehensive support (Duffy, 2018).

  Interactive kiosks placed at strategic locations can provide detailed maps and route planning assistance. Smartphone apps can offer turn-by-turn navigation, notifications, and updates, enhancing convenience for users. Digital wayfinding systems can also adapt to changing conditions, such as temporary closures or high-traffic events, providing real-time adjustments to navigation instructions. The integration of augmented reality (AR) can further enhance wayfinding by overlaying digital information on the physical environment, making navigation more intuitive and engaging.

Transitions

Transitions refer to the spaces and elements that facilitate movement from one area or function to another within a building.

- **Entrances and Exits**

  Entrances and exits are critical transition points that manage the flow of people into and out of the building. Their design should consider accessibility, security, and ease of movement.

Automatic doors, ramps, and security checkpoints are common features that enhance the functionality of these areas. Entrances and exits should also create a positive first impression, reflecting the character and quality of the building (Mace, 2020).

The design of entrances should prioritize accessibility, ensuring that people with disabilities can enter and exit the building easily. Features such as ramps, wide doorways, and automatic doors facilitate access for all users. Security measures, including access control systems and surveillance, are essential to protect occupants and assets. Aesthetically, entrances should be welcoming and align with the overall design of the building, using materials and finishes that convey a sense of quality and professionalism (Mace, 2020).

- **Thresholds**

Thresholds are transitional spaces between different functional areas, such as the entrance to a residential unit from a public corridor. They help delineate different zones and can include elements like doorways, vestibules, and foyers. The design of thresholds should balance openness and privacy, ensuring smooth transitions without abrupt changes in environment. Thresholds can also incorporate design elements that enhance the aesthetic appeal and comfort of the building (Lechner, 2021).

Thresholds serve as points of transition, marking the shift from one environment to another. In residential areas, thresholds can create a sense of privacy and security, with features such as soundproof doors and entry foyers. In commercial areas, thresholds can signal the entrance to different stores or offices, using distinct design elements to create a welcoming and professional atmosphere. The choice of materials, lighting, and décor in thresholds can significantly impact the user experience, making transitions smooth and visually appealing (Lechner, 2021).

2.1.2.4 Types of Circulation in Mixed-Use Buildings

Circulation in mixed-use buildings can be categorized into several key types, each serving different purposes and enhancing the building's functionality and user experience. These include:

1. Primary Circulation
2. Secondary Circulation
3. Tertiary Circulation
4. Emergency Circulation

Each type of circulation is designed to manage the flow of people and goods within the building efficiently.

Primary Circulation

Primary circulation refers to the main routes that facilitate the movement of large numbers of people through the building. These include:

- **Main Corridors:** These are the wide corridors that connect major areas of the building, such as entrances, exits, and central hubs like atriums or lobbies. They are designed to handle high volumes of foot traffic and often feature clear wayfinding signage.
- **Elevator Banks:** Located at strategic points, often near entrances and major intersections, elevator banks serve as primary vertical circulation routes, moving large numbers of people efficiently between floors.
- **Escalators:** Commonly found in retail areas and transit hubs within mixed-use buildings, escalators provide continuous vertical movement and are essential for high-traffic areas.

Primary circulation routes are essential for maintaining an efficient flow of people, minimizing congestion, and ensuring that the main areas of the building are easily accessible (Adams, Rosenbloom, & Duerksen, 2023).

Secondary Circulation

Secondary circulation refers to the pathways that connect primary circulation routes to individual rooms or smaller areas within the building. These include:

- **Secondary Hallways:** Narrower than main corridors, these hallways connect to offices, residential units, and smaller commercial spaces. They are crucial for distributing foot traffic from main corridors to specific destinations.
- **Staircases:** Secondary staircases provide alternative vertical routes, often used for emergency access and as a secondary option to elevators and escalators. They are crucial for the safety and accessibility of the building.

Secondary circulation routes support the primary pathways by providing detailed connections to specific destinations, ensuring that all areas of the building are reachable without overloading the main circulation routes (Gehl, 2018).

Tertiary Circulation

Tertiary circulation involves pathways that are used less frequently and typically serve specific purposes. These include:

- **Service Corridors:** Used primarily by building staff for maintenance and deliveries, service corridors ensure that these activities do not interfere with the main circulation routes used by the public.

- **Private Hallways:** Found in residential or restricted areas, these hallways provide access to private spaces and are designed to ensure privacy and security.

Tertiary circulation routes are essential for the operational efficiency of the building, allowing maintenance and services to be conducted without disrupting the primary and secondary circulation (ULI, 2023).

Emergency Circulation

Emergency circulation refers to the pathways and routes designed specifically for use during emergencies. These include:

- **Fire Exits:** Clearly marked and easily accessible, fire exits are crucial for the safe evacuation of the building in case of fire or other emergencies.
- **Emergency Staircases:** Designed to be used exclusively during emergencies, these staircases are often located at the ends of corridors and connect directly to exits.
- **Emergency Signage:** Clear and illuminated signage that guides occupants to the nearest exit or safe area during an emergency.

Emergency circulation routes are designed to comply with safety regulations and ensure the swift and safe evacuation of all building occupants in the event of an emergency (Bachman, 2018).

2.1.2.5 Principles of Circulation in Mixed-Use Buildings

The principles of circulation in mixed-use buildings are fundamental to creating functional, efficient, and user-friendly spaces. These principles guide the design and layout of circulation routes to ensure that people can move through the building safely and comfortably.

Clarity

Clarity in circulation design ensures that users can easily understand and navigate the layout of a building. This principle is critical for reducing confusion and enhancing the overall user experience.

- **Wayfinding:** Effective wayfinding involves clear signage, intuitive layout, and visual cues that guide users through the building. According to Passini (2019), wayfinding design should consider user needs, incorporating clear symbols, maps, and directional signs.
- **Visibility:** Ensuring that major circulation routes are visible from key entry points helps users orient themselves. Clear sightlines and logical progression of spaces contribute to intuitive navigation (Arthur & Passini, 2019).
- **Design Consistency:** Consistent design elements, such as flooring patterns, lighting, and color schemes, can guide users through different areas, creating a coherent and understandable environment (Weisman, 2019).

Clarity in circulation design reduces the cognitive load on users, making it easier for them to move through complex mixed-use buildings efficiently.

Efficiency

Efficiency in circulation design minimizes travel distances and time, ensuring that users can reach their destinations quickly and with minimal effort.

- **Direct Routes:** Designing direct routes between key destinations minimizes travel time and enhances user convenience. Efficient circulation reduces unnecessary detours and ensures smooth flow (Peponis, Zimring, & Choi, 2020).

- **Adequate Capacity:** Circulation routes must be designed to handle the expected volume of traffic without causing congestion. This involves calculating the width of corridors, the number of elevators, and the capacity of stairs and escalators (Hajdu & Polacek, 2021).
- **Vertical Integration:** Efficient integration of vertical circulation elements like elevators, escalators, and stairs ensures seamless movement between floors. Proper placement and sufficient capacity are crucial for vertical circulation efficiency (Pike, 2020).

Efficiency in circulation design enhances the functionality of mixed-use buildings, ensuring that spaces are used effectively and that users can move quickly and easily.

Safety

Safety in circulation design ensures that users can move through the building without risk of injury or harm.

- **Emergency Egress:** Designing safe and accessible emergency exits and routes is paramount. These routes must comply with building codes and be clearly marked and unobstructed (Bachman, 2018).
- **Fire Safety:** Incorporating fire-resistant materials, smoke control systems, and safe stairwell designs can prevent the spread of fire and ensure safe evacuation (Paulsen, 2019).
- **Universal Design:** Ensuring that circulation routes are accessible to all users, including those with disabilities, enhances safety. Features such as ramps, elevators, handrails, and tactile paving contribute to universal accessibility (Mace, 2020).

Safety in circulation design is critical for protecting building occupants and ensuring compliance with regulatory standards.

Accessibility

Accessibility ensures that all users, regardless of physical ability, can navigate the building with ease.

- **Barrier-Free Design:** Creating barrier-free routes involves eliminating physical obstacles and providing features like ramps, wide doorways, and accessible elevators (Steinfeld & Maisel, 2020).
- **Inclusive Signage:** Signage should include tactile and braille options, as well as visual and auditory cues, to assist users with different needs (Arthur & Passini, 2019).
- **Proximity:** Locating accessible routes close to primary circulation paths ensures that users with disabilities do not have to travel significantly longer distances (Mace, 2020).

Accessibility in circulation design promotes inclusivity and ensures that all users can navigate the building independently.

Flexibility

Flexibility in circulation design allows the building to adapt to changing needs and future growth.

- **Modular Design:** Using modular components in circulation design allows for easy reconfiguration of spaces. This is particularly important in mixed-use buildings, where the function of spaces may change over time (Duffy, 2021).
- **Scalability:** Designing circulation routes that can accommodate increased traffic in the future ensures the building remains functional as occupancy grows (Peponis, Zimring, & Choi, 2020).
- **Adaptable Spaces:** Creating adaptable spaces that can serve multiple purposes reduces the need for extensive redesigns and helps maintain efficient circulation (Duffy, 2021).

Flexibility in circulation design ensures that mixed-use buildings can adapt to future needs, maintaining efficiency and usability over time.

2.1.2.6 The Importance of Circulation

1. **Enhancing User Experience**

   One of the primary reasons circulations is crucial in architectural design is its direct impact on user experience. Good circulation patterns help users to easily find their way, reducing confusion and stress. This is particularly important in large or complex buildings such as hospitals, schools, shopping centers and mixed-use buildings. According to a study by Zeisel and Tyson (2020), well-designed circulation systems contribute significantly to user satisfaction and overall building usability. The study emphasizes that clear wayfinding strategies, such as signage and spatial cues, play a vital role in guiding users efficiently through a building.

2. **Improving Safety**

   Safety is another critical aspect influenced by circulation design. Proper circulation paths are essential for ensuring that people can evacuate a building quickly and safely in case of an emergency. Buildings with poorly designed circulation can become hazardous during emergencies, leading to congestion and delays in evacuation. A study by Proulx (2018) highlights the importance of incorporating clear and unobstructed egress routes in building design to enhance safety. The study also points out that regular drills and clear emergency signage are crucial components of an effective circulation plan that ensures the safety of occupants.

3. **Facilitating Accessibility**

   Accessibility is a key consideration in modern architectural design, and circulation plays a significant role in ensuring that buildings are inclusive and usable by all individuals, including those with disabilities. The Americans with Disabilities Act (ADA) provides guidelines for accessible design, which include requirements for ramps, elevators, and clear pathways (United

States Access Board, 2021). Effective circulation design considers the needs of people with varying mobility levels, ensuring that everyone can navigate the building comfortably and independently. Research by Steinfeld and Maisel (2019) underscores the importance of designing circulation systems that are not only compliant with regulations but also empathetic to the diverse needs of users.

4. **Supporting Functional Efficiency**

Circulation also affects the functional efficiency of a building. Well-designed circulation systems facilitate smooth and efficient movement of people and goods, which is particularly important in commercial and industrial buildings. In healthcare facilities, for example, efficient circulation patterns can significantly improve operational efficiency by reducing the time it takes for staff to move between different areas. A study by Ulrich et al. (2020) found that optimized circulation routes in hospitals lead to improved workflow, reduced stress for staff, and better patient outcomes. The study suggests that strategic placement of key functional areas and minimizing travel distances are crucial for achieving an efficient circulation system.

5. **Enhancing Aesthetic and Spatial Quality**

The design of circulation spaces also contributes to the aesthetic and spatial quality of a building. Corridors, staircases, and lobbies are not merely functional spaces; they also play a role in defining the character and ambiance of a building. Well-designed circulation spaces can create a sense of openness, flow, and connectivity. According to a study by Salama and Wiedmann (2019), integrating natural lighting, interesting views, and architectural details into circulation spaces can enhance the overall aesthetic appeal and create a more pleasant environment for users. The study highlights the importance of considering circulation spaces as integral components of the overall architectural design rather than mere afterthoughts.

2.2 Design Considerations

Key Design Considerations

A. Zoning and Spatial Layout

The spatial layout of mixed-use buildings should be organized into clear zones based on the primary functions, such as residential, commercial, and recreational areas. This zoning facilitates intuitive navigation and reduces the potential for congestion. Effective spatial layout considers the relationships between different zones, ensuring that high-traffic areas are easily accessible and connected by primary circulation routes (Cerver, 1995). Each zone requires tailored circulation solutions to accommodate the specific needs of its occupants.

- **Residential Areas**: These zones should have secure and private circulation paths, ensuring residents can move safely and conveniently from public to private spaces (Baldwin et al., 2021).
- **Commercial and Retail Spaces**: Circulation should promote ease of access to various shops and services, often involving clear and direct pathways to enhance the shopping experience.
- **Office Areas**: Efficient circulation in office spaces boosts productivity, necessitating well-designed corridors, elevators, and staircases to minimize travel time and enhance connectivity (Thompson, 2023).

B. Vertical Circulation

Vertical circulation elements, including stairs, elevators, and escalators, play a vital role in connecting different levels within a mixed-use building. The placement and number of these elements should accommodate peak usage times and comply with accessibility standards. Elevators should be strategically located to serve all user groups, while staircases should provide an appealing alternative for those who prefer to walk (HOK, 2016).

C. Horizontal Circulation

Horizontal circulation includes corridors, hallways, and pathways that connect different spaces on the same level. These routes should be wide enough to handle anticipated foot traffic and allow for smooth movement. The use of wayfinding elements such as signage, lighting, and floor markings can enhance the efficiency of horizontal circulation by guiding users through the building (Alexander, Ishikawa, & Silverstein, 1977).

D. Accessibility

Accessibility is a fundamental consideration in circulation design. Buildings must comply with regulations such as the Americans with Disabilities Act (ADA) to ensure that all users, including those with disabilities, can navigate the space independently. This includes providing ramps, wide doorways, tactile signage, and accessible elevators (U.S. Access Board, 2010).

E. Safety and Security

Safety is paramount in circulation design. Emergency egress routes must be clearly marked and free from obstructions. Fire exits should be easily accessible from all parts of the building, and the design should incorporate features such as smoke barriers and fire-resistant materials to enhance safety. Security considerations include surveillance systems, controlled access points, and adequate lighting to deter crime (Jacobs, 1961).

F. Flow and Movement Patterns

Understanding the flow and movement patterns of building users is essential for effective circulation design. Analyzing pedestrian traffic can identify potential bottlenecks and areas that may require additional circulation capacity. Design solutions such as open atriums, wide corridors, and strategically placed entrances and exits can facilitate smooth movement and reduce congestion (Litman, 2020). A study by Fruin (2021) on pedestrian movement patterns

suggests that the width of circulation paths should be proportional to the expected foot traffic. Additionally, the study recommends the use of turnstiles, barriers, and directional signage to manage and control traffic flow.

- **Natural Lighting and Ventilation**: Integrating natural lighting and ventilation in circulation areas not only enhances aesthetic appeal but also improves the overall environment, contributing to the well-being of occupants (Martin & Perez, 2023).

G. Integration with Building Systems

Circulation spaces must be integrated with other building systems, including HVAC, lighting, and electrical systems. Proper ventilation in stairwells and corridors ensures a comfortable environment, while adequate lighting enhances visibility and safety. Theitionally, the placement of electrical outlets and data ports in common areas can support the needs of modern building users (HOK, 2016). According to Kensek and Noble (2020), the use of sensors and data analytics can provide valuable insights into movement patterns, allowing for real-time adjustments to improve efficiency and user experience. Technology can also facilitate wayfinding through digital signage and mobile applications.

H. Aesthetic and Psychological Factors

The aesthetic design of circulation spaces can significantly impact the user experience. Natural lighting, attractive finishes, and thoughtfully designed public areas create a pleasant environment that encourages use. Psychological factors, such as a sense of security and wayfinding ease, are also crucial. Clear sightlines and intuitive navigation aids contribute to a positive user experience (Alexander et al., 1977). Studies by Salamshowsd Wiedmann (2019) show that incorporating natural light, artwork, and greenery in circulation areas can create a more pleasant and stimulating environment. The use of materials, colors, and textures can also

influence the psychological well-being of occupants, making them feel more comfortable and engaged.

2.3 Empirical Review

2.3.1 Impact of Circulation in Mixed-Use Buildings

Mixed-use buildings, which combine residential, commercial, and sometimes industrial spaces within a single development, have become increasingly popular due to their numerous benefits in urban planning and real estate. The concept of circulation within these buildings is critical to their success, influencing the functionality, accessibility, and overall user experience.

1. **Enhancing Accessibility and Connectivity**

   One of the primary impacts of effective circulation in mixed-use buildings is enhanced accessibility and connectivity. Proper circulation design ensures that all parts of the building are easily accessible to users, promoting seamless movement between different areas. This includes the integration of clear signage, well-designed pathways, and strategically placed entrances and exits. Effective circulation not only improves the user experience but also ensures compliance with accessibility standards, making the building usable by people with diverse needs (SolutionsGC, 2023).

2. **Supporting Mixed-Use Functionality**

   The functionality of mixed-use buildings heavily relies on efficient circulation systems that support the diverse uses within the structure. For instance, separate circulation paths for residential and commercial areas can maintain privacy and security for residents while allowing easy access to commercial spaces for the public. The inclusion of communal areas such as lounges, courtyards, and plazas within the circulation design encourages social interaction and community building among residents and visitors (SolutionsGC, 2023).

3. **Promoting Economic Viability**

   Efficient circulation can significantly enhance the economic viability of mixed-use developments. By ensuring easy access to commercial areas, developers can attract more foot traffic, which in turn boosts retail and office businesses. Proximity to amenities such as gyms, restaurants, and retail stores within the same building can enhance the attractiveness of residential units, thereby increasing property values and rental rates (JPMorgan, 2023).

4. **Encouraging Sustainable Practices**

   Circulation design in mixed-use buildings also plays a crucial role in promoting sustainability. Features such as pedestrian-friendly pathways, bicycle storage areas, and easy access to public transportation can reduce reliance on automobiles, thereby lowering the carbon footprint of the building. Incorporating green spaces and natural lighting within circulation areas can enhance the environmental performance of the building, contributing to certifications such as LEED (Urban Land Magazine, 2023).

5. **Mitigating Construction Challenges**

   During the construction phase, efficient circulation planning can mitigate various challenges associated with mixed-use developments. For example, managing noise and disruption is critical in mixed-use buildings where construction activities can affect existing residents and businesses. Proper planning of circulation routes for construction activities can minimize these disruptions, ensuring a smoother construction process (SolutionsGC, 2023).

2.3.2 Benefits of Circulation in Mixed-Use Buildings

These buildings, which combine residential, commercial, and sometimes industrial spaces, rely heavily on efficient circulation systems to ensure functionality, safety, and user satisfaction.

1. **Improved Accessibility**

   Efficient circulation design enhances accessibility, ensuring that all areas within a mixed-use building are easily reachable for all occupants, including those with disabilities. Features such as ramps, wide corridors, and strategically placed elevators facilitate smooth movement, making the building more inclusive. Improved accessibility benefits not only people with disabilities but also the elderly, children, and those carrying heavy loads, contributing to a more user-friendly environment (U.S. Department of Justice, 2010).

2. **Enhanced Safety**

   Safety is a paramount concern in building design, and effective circulation systems play a critical role in maintaining it. Properly designed circulation pathways facilitate safe evacuation during emergencies, such as fires or natural disasters. Clear, unobstructed exit routes, well-marked emergency exits, and strategically placed staircases can significantly reduce evacuation time and minimize the risk of accidents during emergencies (Zhang et al., 2019). Additionally, separating pedestrian and vehicular traffic enhances safety by reducing the likelihood of collisions.

3. **Better User Experience**

   A well-planned circulation system significantly enhances the user experience in mixed-use buildings. It ensures that occupants can navigate the building easily and intuitively, reducing frustration and improving overall satisfaction. Wayfinding elements such as signage, color-coded pathways, and interactive directories contribute to a seamless navigation experience (Passini, 1996). Efficient circulation design also considers the flow of foot traffic to minimize congestion, particularly in high-traffic areas such as lobbies, entrances, and corridors, resulting in a more pleasant and efficient movement throughout the building.

4. **Increased Efficiency**

Efficient circulation contributes to the overall operational efficiency of mixed-use buildings. By optimizing the flow of people, goods, and services, well-designed circulation systems can enhance productivity and reduce operational costs. Strategically placed service areas and freight elevators streamline the movement of goods and services, improving the efficiency of commercial operations within the building (Kim & Hong, 2016). Additionally, efficient circulation can enhance the energy performance of a building by reducing the need for extensive lighting and climate control in areas with low foot traffic.

5. **Enhanced Social Interaction**

Mixed-use buildings are designed to foster a sense of community by integrating various functions and services within a single structure. Effective circulation design plays a vital role in promoting social interaction among occupants. Communal spaces such as atriums, courtyards, and lounges encourage spontaneous interactions and social gatherings, contributing to the vibrancy and social sustainability of urban environments (Gehl, 2011). These spaces foster a sense of belonging and community among occupants, enhancing the overall appeal of the building.

6. **Increased Economic Valued**

Well-designed circulation systems can enhance the economic value of mixed-use buildings. Improved accessibility, safety, and user experience can attract and retain tenants, increasing occupancy rates and rental income. Buildings with efficient circulation systems often require less maintenance and incur lower operational costs, contributing to long-term economic sustainability (Ding, 2010). In real estate development, properties with superior circulation designs are likely to command higher market values and attract more investors.

7. **Sustainability and Environmental Benefits**

Sustainable design principles often incorporate efficient circulation systems to reduce the environmental impact of buildings. Proper circulation design can reduce energy consumption by optimizing natural light and ventilation, minimizing the need for artificial lighting and air conditioning. This not only lowers the building's carbon footprint but also contributes to the well-being of its occupants by providing a healthier indoor environment (Kim & Hong, 2016).

2.3.3 Application of Circulation

A. Circulation Design in Residential Areas

Residential spaces in mixed-use buildings require circulation design that prioritizes privacy, accessibility, and convenience for residents while ensuring efficient movement throughout the building.

Private Access Routes

- **Direct Entrances:** Designating dedicated entrances and access points for residential units ensures privacy and security for residents. These entrances are often separated from commercial and public areas to maintain exclusivity. Separate lobbies for residential floors can prevent non-residents from accessing private areas, enhancing security and privacy.
- **Controlled Elevator Access:** Implementing keycard or fob-accessed elevator banks restricts entry to designated floors, enhancing security and maintaining a sense of exclusivity. This ensures that only residents and authorized personnel can access residential floors. Luxury mixed-use buildings often employ elevator systems that require residents to scan a key card to access their specific floor, providing an additional layer of security (Doe, 2020).

Internal Circulation Efficiency

- **Floor Planning:** Optimize floor layouts to minimize corridor lengths and maximize space utilization within residential floors. Efficient floor planning reduces the distance residents must

travel to reach their units and amenities, improving convenience. Compact floor layouts with centralized corridors reduce walking distances and enhance overall spatial efficiency.

- **Amenity Access:** Strategically locate circulation paths to provide convenient access to shared amenities such as fitness centers, communal lounges, or rooftop gardens. Easy access to amenities encourages their use and enhances the living experience. Placing shared amenities like gyms and lounges near elevator lobbies can increase their visibility and usage (Brown, 2023).

Vertical Connectivity

- **Centralized Cores:** Utilize central atriums, core staircases, or interconnected elevator lobbies to facilitate vertical movement between residential levels and other building functions. Centralized cores improve spatial orientation and make it easier for residents to navigate the building. A central atrium with glass elevators provides a focal point and enhances connectivity between floors (Williams & Taylor, 2021).
- **Emergency Egress:** Integrate clear evacuation routes and emergency stairwells that are easily accessible and well-lit to ensure resident safety during emergencies. Properly designed emergency exits are crucial for safety and compliance with building codes. Emergency stairwells that are centrally located and well-marked ensure quick and safe evacuation in case of emergencies (Miller, 2022).

B. Circulation Design in Commercial Spaces

Commercial areas within mixed-use buildings, such as retail shops, restaurants, and office spaces, require circulation design that enhances customer accessibility, operational efficiency, and storefront visibility.

Customer Traffic Flow

- **Entrance Placement:** Position main entrances and storefronts along high-traffic areas to maximize visibility and attract foot traffic. Well-placed entrances ensure easy access and draw customers into commercial spaces. Entrances facing busy streets or main thoroughfares enhance accessibility and increase customer traffic (Anderson, 2023).
- **Clear Pathways:** Design spacious corridors and aisles that allow for smooth customer navigation and accommodate peak traffic volumes during busy periods. Wide pathways prevent bottlenecks and improve the shopping experience. Malls with wide walkways and clear sightlines enhance customer movement and visibility of stores (Lee, 2021).

Service Integration

- **Delivery Access:** Incorporate service corridors or loading docks separate from customer pathways to facilitate efficient deliveries without disrupting commercial operations. Separate service areas ensure smooth logistics and maintain a pleasant customer environment. Loading docks located at the rear of the building prevent disruption to customer areas and streamline deliveries (Davis, 2020).
- **Back-of-House Efficiency:** Design efficient circulation routes for staff and service personnel, ensuring seamless access to storage areas, kitchens, and administrative offices. Efficient back-of-house circulation supports smooth operations and quick restocking. Separate service elevators and corridors for staff enhance operational efficiency and reduce customer interference (Johnson, 2021).

Wayfinding and Signage

- **Clear Signage:** Install prominent signage, digital directories, and wayfinding systems that guide customers to different retail outlets, amenities, and facilities within the building.

Effective signage improves navigation and customer satisfaction. Digital directories at key junctions provide real-time information and assist customers in finding their destinations (Martin & White, 2022).

C. Circulation Design in Recreational Facilities

Recreational amenities in mixed-use buildings, such as fitness centers, swimming pools, and community spaces, require circulation design that supports functionality, user comfort, and operational flexibility. Here's how circulation can be optimized for recreational facilities:

Functional Integration

- **Direct Access:** Provide direct circulation paths to recreational facilities from residential areas, ensuring convenience for residents and promoting active lifestyles. Direct access routes encourage regular use of recreational amenities. Pathways that lead directly from residential units to gyms or pools encourage frequent use and enhance resident satisfaction (Clark & Adams, 2023).
- **Multi-Functional Spaces:** Design flexible circulation spaces that can accommodate various activities and events, such as fitness classes or social gatherings. Versatile spaces enhance the building's functionality and appeal. Multi-purpose halls with adaptable layouts can host fitness classes, meetings, or social events, making efficient use of space (Robinson, 2021).

User Experience

- **Spatial Planning:** Optimize the layout of recreational facilities to minimize congestion and provide ample space for users to move comfortably between different activity zones. Well-planned spaces improve user comfort and enjoyment. Large, open-plan fitness centers with clear pathways enhance user experience and reduce overcrowding (King & Thompson, 2022).

- **Natural Light and Views:** Incorporate design elements that maximize natural light and offer scenic views to enhance user experience and promote well-being. Natural lighting improves ambiance and reduces energy costs. Floor-to-ceiling windows in recreational areas provide natural light and views of outdoor spaces, creating a pleasant environment (Evans & Harris, 2023).

Safety and Accessibility

- **Universal Design:** Implement accessibility features such as ramps, elevators, and ADA-compliant pathways to ensure inclusivity and accommodate users with diverse mobility needs. Accessible design ensures that all users can enjoy the facilities. Ramps and wide pathways in recreational areas ensure access for people with disabilities, enhancing inclusivity (Nelson, 2021).
- **Emergency Preparedness:** Integrate emergency evacuation routes and safety protocols within recreational spaces to facilitate safe egress during emergencies. Clearly marked exits and safety signage are crucial for emergency response. Well-marked emergency exits and safety drills in recreational areas ensure preparedness and user safety (Young, 2020).

2.3.4 Challenges of Circulation

Effective circulation design in buildings is crucial for facilitating movement and ensuring functionality, safety, and user satisfaction. However, achieving optimal circulation poses several challenges that designers must address to create successful spaces.

1. **Spatial Efficiency and Layout Complexity**

   One of the primary challenges in circulation design is optimizing spatial efficiency while accommodating complex building layouts. Buildings with irregular shapes, multiple levels, or

diverse functions require careful planning to ensure that circulation routes are intuitive, direct, and efficient (Lam et al., 2020). Poorly designed layouts can lead to confusion, congestion, and inefficient use of space, impacting the overall usability of the building.

2. **Accessibility and Universal Design**

   Ensuring accessibility for all users, including those with disabilities or mobility impairments, is a critical challenge in circulation design. Compliance with accessibility standards such as the Americans with Disabilities Act (ADA) in the United States or similar regulations globally adds complexity to circulation planning (McGuirk & Cai, 2019). Designers must incorporate features such as ramps, elevators, and tactile signage to ensure equitable access throughout the building.

3. **Integration of Technological Advances**

   The rapid evolution of technology presents both opportunities and challenges for circulation design. Integrating smart building systems, including automated doors, wayfinding apps, and occupancy sensors, can enhance user experience and operational efficiency (Zhang et al., 2021). However, technological integration requires careful planning to ensure compatibility, reliability, and user acceptance while maintaining security and privacy.

4. **Safety and Security Concerns**

   Safety and security considerations significantly influence circulation design, particularly in public and high-traffic buildings. Designers must balance openness for efficient flow with measures to prevent unauthorized access, ensure emergency egress routes, and mitigate risks such as overcrowding and potential threats (Chang et al., 2022). Implementing effective security protocols without compromising user convenience remains a persistent challenge in circulation design.

5. **Environmental and Sustainability Factors**

Incorporating environmental sustainability principles into circulation design is increasingly important but challenging. Strategies such as natural ventilation, daylight harvesting, and energy-efficient lighting impact circulation pathways and spatial planning (Garg & Chandak, 2020). Designers must navigate trade-offs between sustainability goals and circulation efficiency while considering lifecycle impacts and operational costs.

6. **User Experience and Behavior**

   Understanding user behavior and preferences is essential for designing intuitive circulation systems. Cultural factors, user demographics, and behavioral patterns influence circulation flow and usability (Chung et al., 2021). Designers face the challenge of balancing functional requirements with user-centric design principles to enhance comfort, satisfaction, and productivity.

Chapter Three

Methodology

The methodology in research refers to the structured approach used to address a research question by collecting data through diverse methods, analyzing the gathered data, and drawing conclusions. It essentially serves as the blueprint for a research project, making the methodology outlined in a research proposal crucial (Murthy & Bhojanna, 2009).

This chapter shows the methodological procedures that were used in gathering and analyzing data to study the proposed building.

3.1 Methodological Approach

This study employs a qualitative research design to explore the circulation patterns in mixed-use buildings. The main tool of data collection is a case study approach. For this thesis, three case studies were analyzed, two of which are foreign and one local. Each symbolizing and identifying instances possessing certain intrinsic qualities that pertain to the proposed design. They are as outlined:

3.2 Analytical Framework

To analyze the circulation in mixed-use buildings effectively, a comprehensive framework is required. This framework encompasses various aspects that directly influence and are influenced by circulation patterns within these complex structures. The following framework elements are derived from architectural principles would guide the case studies analysis:

1. **Spatial Organization:**

   Zoning: Understanding how different functions are zoned within the building (e.g., commercial, residential, office, and recreational spaces) and their interconnectivity.

   Flow Paths: Identifying primary, secondary, and tertiary circulation paths to ensure efficient movement and minimize congestion.

   Accessibility: Ensuring all areas are accessible to all users, including those with disabilities.

2. **Vertical Circulation:**

   Elevators and Escalators: Placement, capacity, and efficiency in serving various floors.

   Staircases: Both functional and emergency use, their design, and distribution.

3. **Horizontal Circulation:**

   Corridors and Hallways: Width, design, and potential bottlenecks.

   Public vs. Private Corridors: Differentiation and security considerations.

4. **Integration of Services:**

   Service Circulation: Routes for maintenance, waste management, and emergency services.

Separation from Public Circulation: Ensuring minimal disruption to regular users.

5. **User Experience:**

   Wayfinding: Signage, visual cues, and ease of navigation.

   Safety and Security: Surveillance, lighting, and emergency evacuation routes.

   Aesthetics and Comfort: Visual appeal, ventilation, and comfort level in circulation spaces.

6. **Technological Integration:**

   Smart Building Technologies: Use of IoT for monitoring and managing circulation flows.

   Energy Efficiency: Sustainable practices in circulation areas (e.g., lighting, HVAC systems).

3.3 Case Study Analysis

3.3.1 Case Study One - One Angel Square, Manchester, United Kingdom.

Location: Manchester, United Kingdom.

Construction Year: Completed in 2013.

Architect: Designed by 3D Reid Architects.

Area: 3,900 m².

3.3.1.1 Building Description

- Angel Square is a landmark office building, it serves as the headquarters of the Co-operative Group.
- The building features a modern design with sustainable elements such as rainwater harvesting and solar panels.
- It is part of the NOMA (North Manchester) mixed-use development area.
- Building orientation maximizes passive solar gain, Underground concrete earth tubes, Greywater, and rainwater recycling systems.

- Glass panels possess a bronze anodized surface which ensures the electromagnetic radiation of the sun, converts to infrared to heat up the building during winter and vice versa in summer.

Figure 3.1: Exterior of One Angel Square Building

Source: (ArchDaily, 2024)

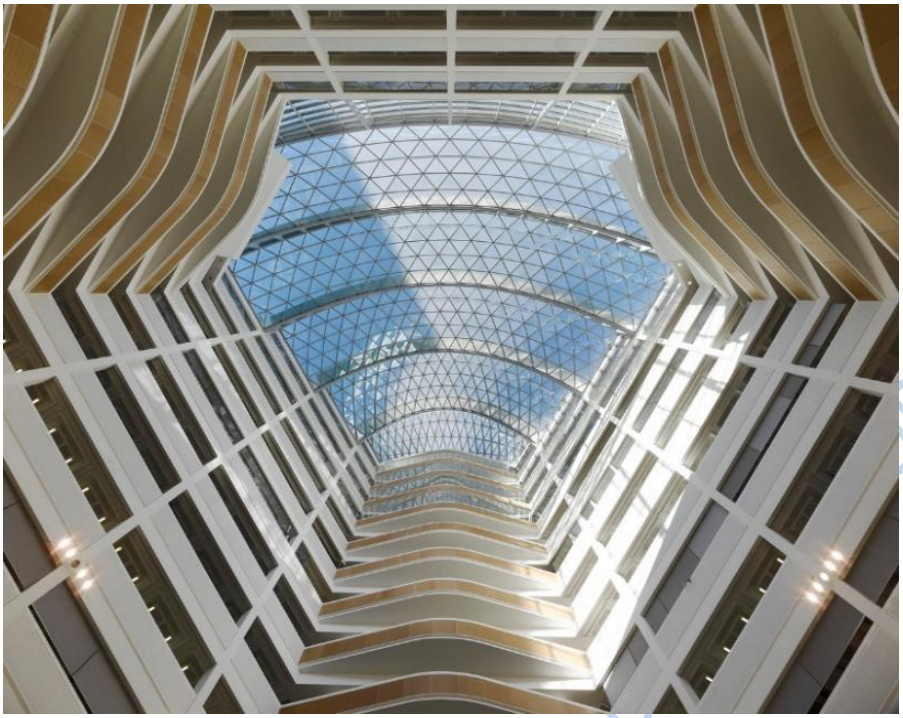

Figure 3.2: Interior of Building showing the Atrium of One Angel Square

Source: (ArchDaily, 2024)

3.3.1.2 Spatial Accommodation

Basement parking level, 12 office floor levels, Auditorium.

Figure 3.3: Exterior of Building Showing Façade of One Angel Square

Source: (ArchDaily, 2024)

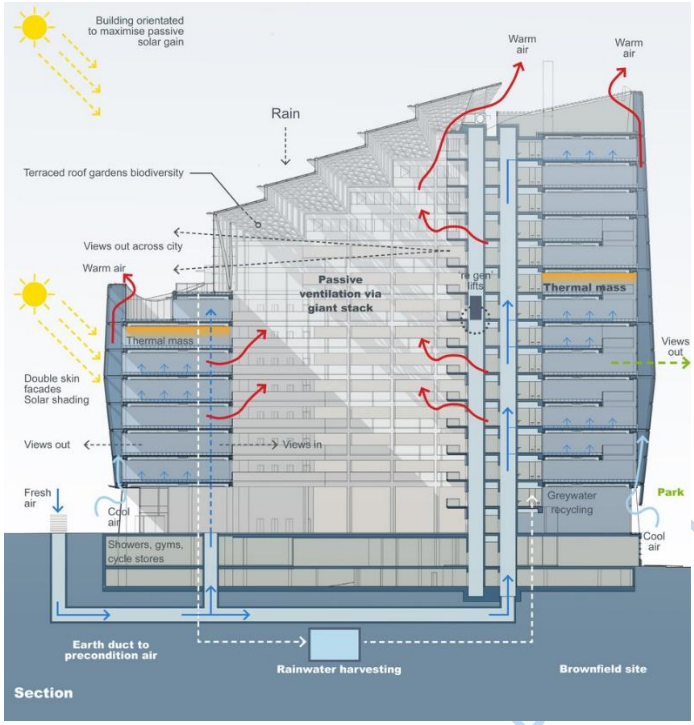

Figure 3.4: Detailed Building Section of One Angel Square

Source: (ArchDaily, 2024)

3.3.1.3 Analytical Framework

Spatial Organization

- **Zoning:** One Angel Square's design zones the building into distinct areas, such as open-plan office spaces, meeting rooms, and communal areas. The zoning ensures efficient use of space and facilitates easy access to various functions.
- **Flow Paths:** The central atrium acts as the main circulation spine, connecting different levels and zones efficiently. This clear flow path minimizes congestion and enhances movement.
- **Accessibility:** The building complies with accessibility standards, featuring wide corridors, ramps, and accessible elevators to cater to all users, including those with disabilities.

Vertical Circulation

- **Elevators and Escalators:** Strategically placed elevators in the atrium ensure quick vertical movement, reducing wait times and congestion. The number and capacity of elevators are designed to handle peak traffic effectively.
- **Staircases:** The building features multiple staircases, both for regular use and emergency egress, ensuring safety and accessibility across all floors.

Horizontal Circulation

- **Corridors and Hallways:** Wide corridors connect various functional zones, facilitating smooth horizontal movement. The design minimizes long, straight corridors to avoid monotony and enhance user experience.
- **Public vs. Private Corridors:** There is a clear distinction between public and private areas, with secure access controls to ensure privacy and security for office spaces while allowing public access to communal areas.

Integration of Services

- **Service Circulation:** Dedicated service routes ensure that maintenance and deliveries do not interfere with public circulation. These routes are designed to be efficient and discrete.
- **Separation from Public Circulation:** Service corridors are separated from main public paths to avoid disruptions, ensuring smooth and uninterrupted public circulation.

User Experience

- **Wayfinding:** Clear signage and intuitive design of the atrium enhance wayfinding, making navigation easy for first-time visitors and regular users alike.

- **Safety and Security:** Comprehensive surveillance and well-lit corridors ensure user safety. The building design includes multiple emergencies exits to facilitate quick evacuation if needed.
- **Aesthetics and Comfort:** The atrium design allows natural light to penetrate deep into the building, enhancing visual appeal and user comfort. Ventilation systems ensure a comfortable indoor climate.

Technological Integration

- **Smart Building Technologies:** One Angel Square utilizes smart building technologies to monitor and manage circulation flows, optimizing efficiency and user experience. Sensors and automated systems adjust lighting and HVAC based on occupancy.
- **Energy Efficiency:** Sustainable practices in circulation areas, such as energy-efficient lighting and climate control systems, contribute to the building's BREEAM 'Outstanding' rating.

3.3.1.4 Appraisals

Merits

1. Utilizes materials, including reclaimed brick and recycled steel, reflecting Manchester's industrial heritage for the building façade making it aesthetics pleasing.
2. Embraces mixed-use delivery, integrating office spaces, retail outlets, and communal areas within the NOMA development.
3. Exemplifies sustainability with features like rainwater harvesting and energy-efficient systems, setting a standard for green urban development in Manchester.

Demerits

1. **Limited Mixed-Use Integration:** While Angel Square is part of the NOMA mixed-use development area, its primary function as an office building might limit its integration with other uses such as residential or cultural spaces, potentially reducing the diversity and vibrancy of the surrounding neighborhood.
2. **Environmental Impact during Construction:** Despite its sustainable features, the construction process for Angel Square might have resulted in temporary environmental impacts such as noise pollution, disruption to local ecosystems, and increased traffic congestion.

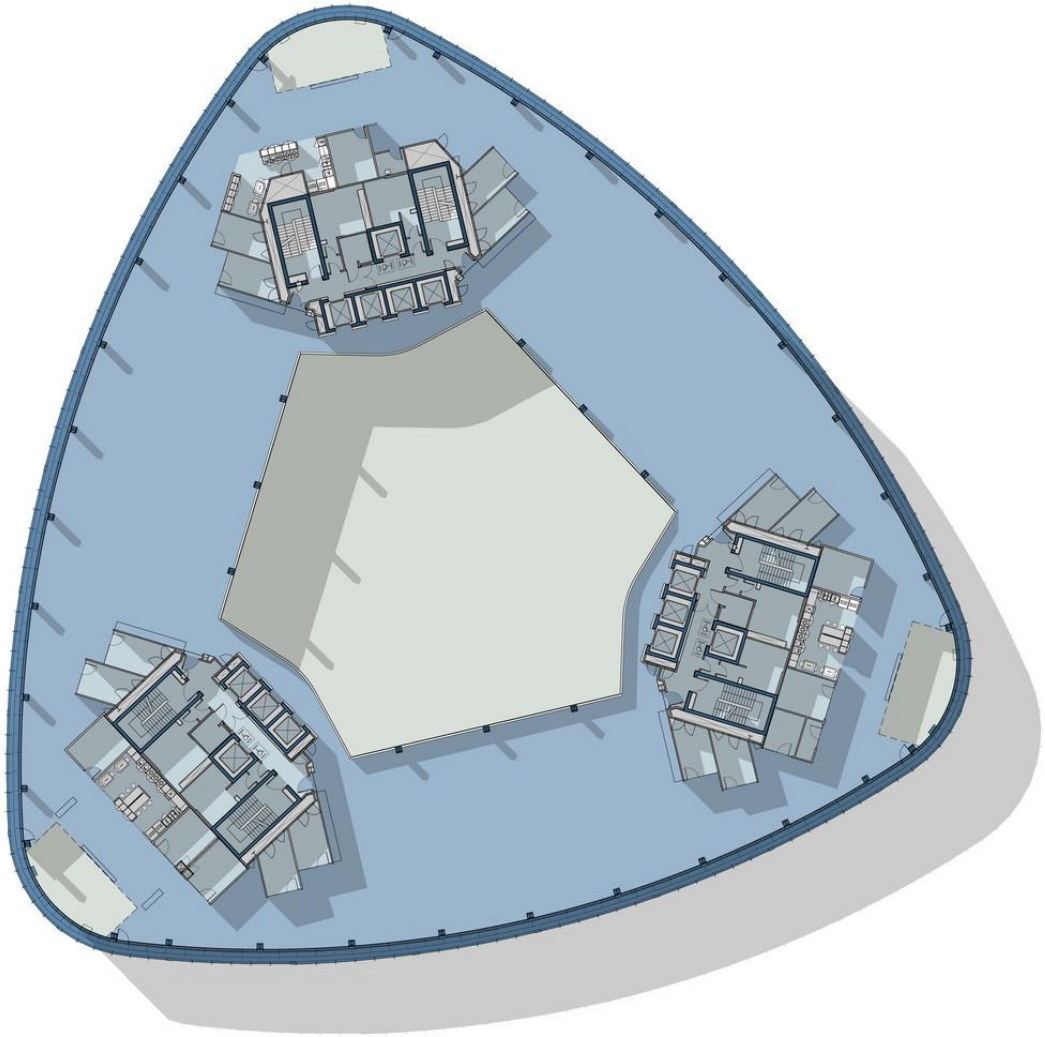

Figure 3.5: Ground Floor Plan of One Angel Square

Source: (ArchDaily, 2024)

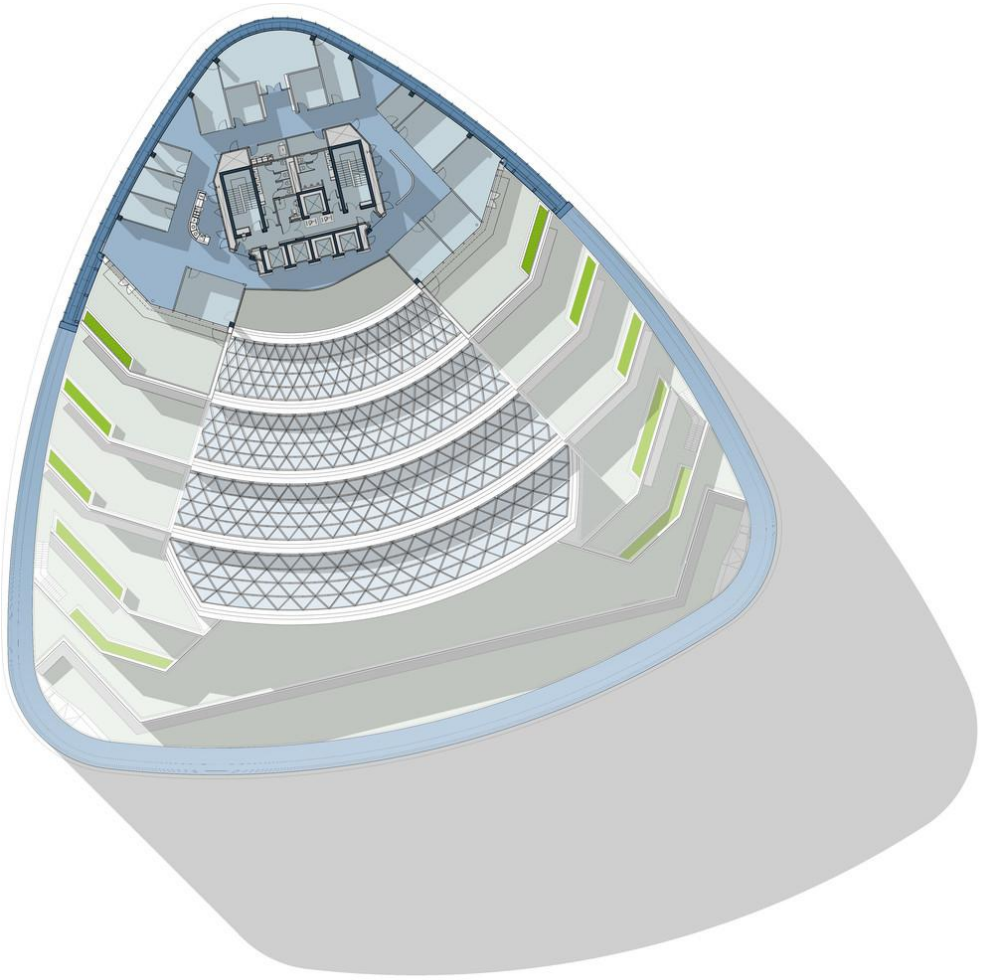

Figure 3.6: Top Floor Plan of One Angel Square

Source: (ArchDaily, 2024)

3.3.2 Case Study Two - The Edge, Amsterdam, The Netherlands.

Location: Amsterdam, Netherlands.

Construction Year: Completed in 2015.

Architect: Designed by PLP Architecture.

Area: 40,000 m².

3.3.2.1 Building Description

- The Edge is a cutting-edge office building Situated in Amsterdam's Zuidas district, it houses Deloitte's Amsterdam office and is renowned for its innovative design.
- Features advanced technologies such as smart lighting systems and an app for building control.
- The building is characterized by sustainable design elements and a focus on occupant comfort.
- Façade equipped with louvers at the top enabling hot air escape and retain during summer and winter, building oriented by the path of the sun, Rainwater harvesting, high insulation from glass façade.
- Photovoltaic Panels on the south façade, Energy reuse with a heat exchanger.

Figure 3.7: Exterior of The Edge Building

Source: (ArchDaily, 2024)

3.3.2.2 Spatial Accommodation

Office floors and spaces, 15 Storey atrium, Restaurant etc.

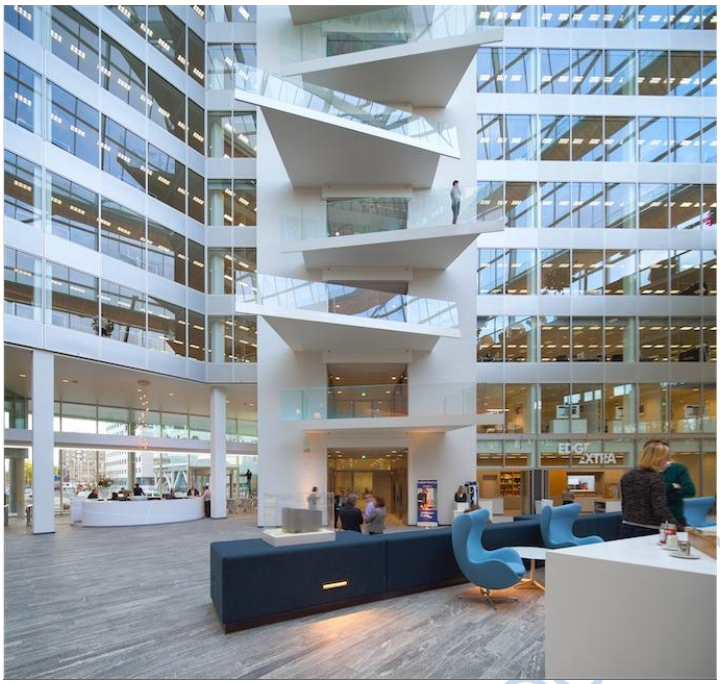

Figure 3.8: Interior of The Edge Building

Source: (ArchDaily, 2024)

3.3.2.3 Analytical Framework

Spatial Organization

- **Zoning:** The Edge's design zones the building into office spaces, meeting rooms, and communal areas. The zoning supports efficient workflow and easy access to different functions.
- **Flow Paths:** The 15-storey atrium serves as the main circulation hub, facilitating vertical and horizontal movement. The atrium's design minimizes congestion and provides clear flow paths.
- **Accessibility:** The building complies with accessibility standards, featuring wide pathways, accessible elevators, and ramps to cater to all users.

Vertical Circulation

- **Elevators and Escalators:** The Edge uses smart elevators to manage vertical circulation efficiently. The elevators are strategically placed to reduce wait times and handle peak traffic effectively.
- **Staircases:** Multiple staircases are provided for regular use and emergency egress, ensuring safety and accessibility across all floors.

Horizontal Circulation

- **Corridors and Hallways:** Wide corridors connect various functional zones, facilitating smooth horizontal movement. The design minimizes long, straight corridors to avoid monotony and enhance user experience.
- **Public vs. Private Corridors:** There is a clear distinction between public and private areas, with secure access controls to ensure privacy and security for office spaces while allowing public access to communal areas.

Integration of Services

- **Service Circulation:** Dedicated service routes ensure that maintenance and deliveries do not interfere with public circulation. These routes are designed to be efficient and discrete.
- **Separation from Public Circulation:** Service corridors are separated from main public paths to avoid disruptions, ensuring smooth and uninterrupted public circulation.

User Experience

- **Wayfinding:** Clear signage and intuitive design of the atrium enhance wayfinding, making navigation easy for first-time visitors and regular users alike.

- **Safety and Security:** Comprehensive surveillance and well-lit corridors ensure user safety. The building design includes multiple emergencies exits to facilitate quick evacuation if needed.
- **Aesthetics and Comfort:** The atrium design allows natural light to penetrate deep into the building, enhancing visual appeal and user comfort. Ventilation systems ensure a comfortable indoor climate.

Technological Integration

- **Smart Building Technologies:** The Edge utilizes advanced IoT systems to monitor and manage circulation flows, optimizing efficiency and user experience. Sensors and automated systems adjust lighting and HVAC based on occupancy.
- **Energy Efficiency:** Sustainable practices in circulation areas, such as energy-efficient lighting and climate control systems, contribute to the building's high sustainability rating.

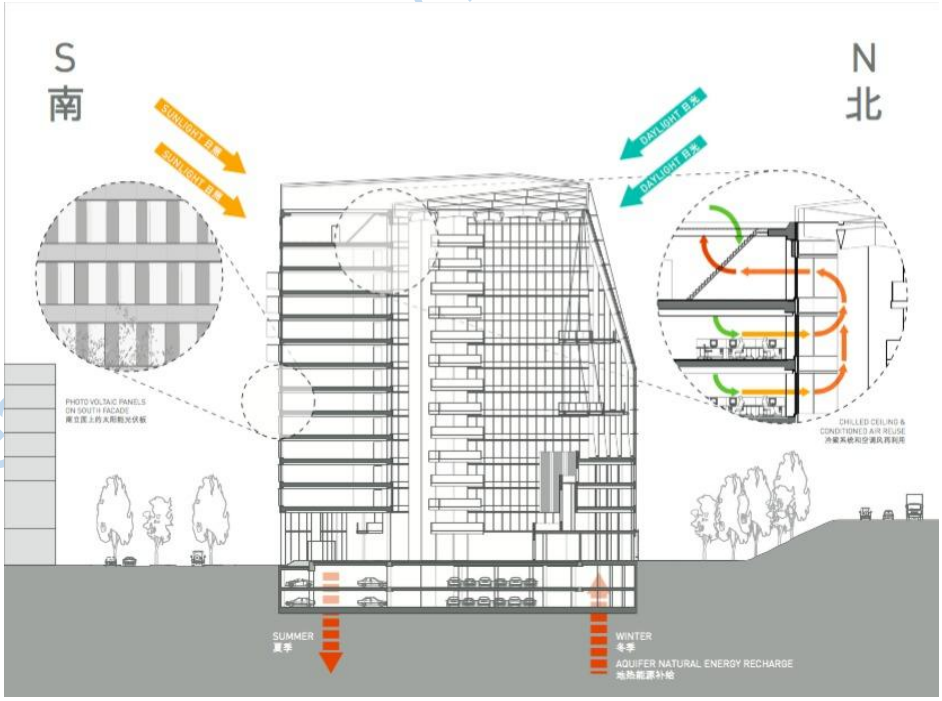

Figure 3.9: Detailed Building Section of The Edge

Source: (ArchDaily, 2024)

3.3.2.4 Appraisals

Merits

1. Incorporates materials such as recycled glass and sustainable timber, reflecting the Netherlands' commitment to innovative architecture.
2. Embraces mixed-use delivery, providing office spaces, retail establishments, and recreational facilities within Amsterdam's dynamic urban fabric.
3. Sets a global standard for sustainability with features like energy-efficient systems and passive design strategies, showcasing Amsterdam's leadership in eco-conscious urban development.

Demerits

1. **High Initial Cost:** The innovative design and advanced technologies incorporated into The Edge may have led to higher initial construction costs compared to conventional office buildings, potentially limiting its accessibility to smaller businesses or organizations with limited budgets.
2. **Dependency on Technology:** The Edge's reliance on technology for building management and operations could pose challenges in the event of technical failures or cybersecurity threats, potentially disrupting its functionality and occupant comfort.

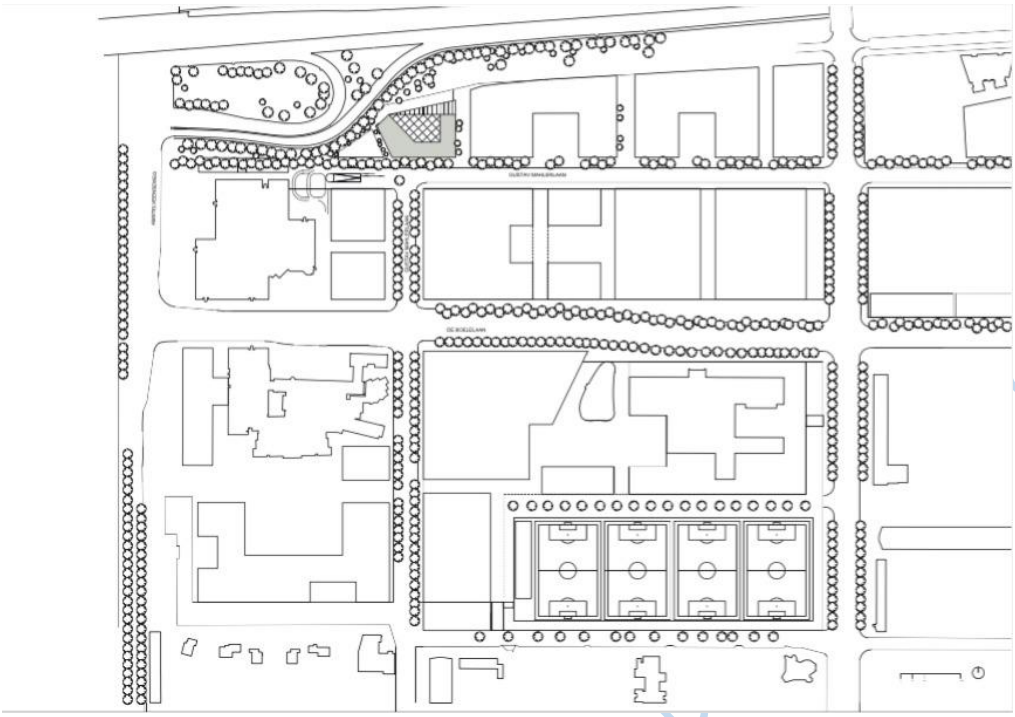

Figure 3.10: Site Plan of The Edge Building

Source: (ArchDaily, 2024)

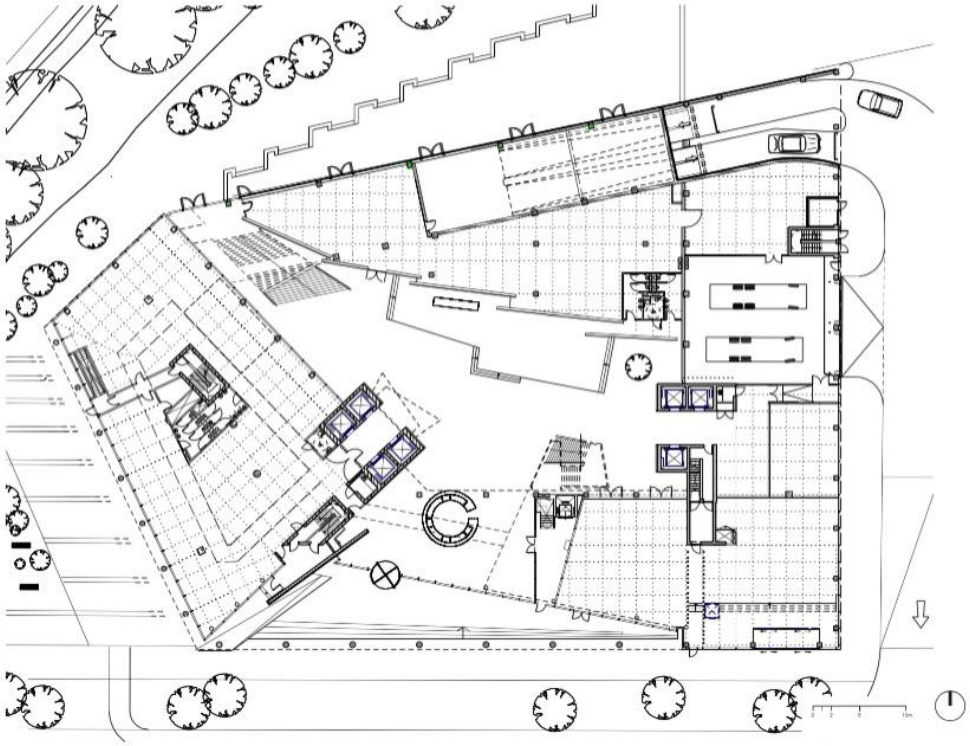

Figure 3.11: Ground Floor Plan of The Edge Building

Source: (ArchDaily, 2024)

3.3.3 Case Study Three - Kings Tower, Lagos, Nigeria.

Location: Alfred Rewane Road, Ikoyi, Lagos, Nigeria.

Construction Year: Completed in 2019.

Architect: Designed by SAOTA Architects.

Area: 27,832 m².

3.3.3.1 Building Description

- Kings Tower is a prominent high-rise building, The tower serves as a multifunctional hub, potentially housing office spaces, retail outlets, and residential units.
- Reflects Lagos' cultural identity through its design and choice of materials.
- The construction likely incorporates locally sourced materials such as laterite, clay bricks, and sustainable concrete products.
- Curtain Wall Panels, Permeable double skin Façade that also serve as sun shading features.
- Natural lighting features with shaders, Projection of the building slab past the glass face in which an aluminum screen is installed to improve the building passive performance, building orientation (short facades facing east-west, and the long facades north and south).

Figure 3.12: Exterior of Kings Tower Building

Source: (Archdaily, 2024)

3.3.3.2 Spatial Accommodation

Basement level, 2 retail floors, 12 office floor levels.

Figure 3.13: Exterior of Kings Tower Building

Source: (Archdaily, 2024)

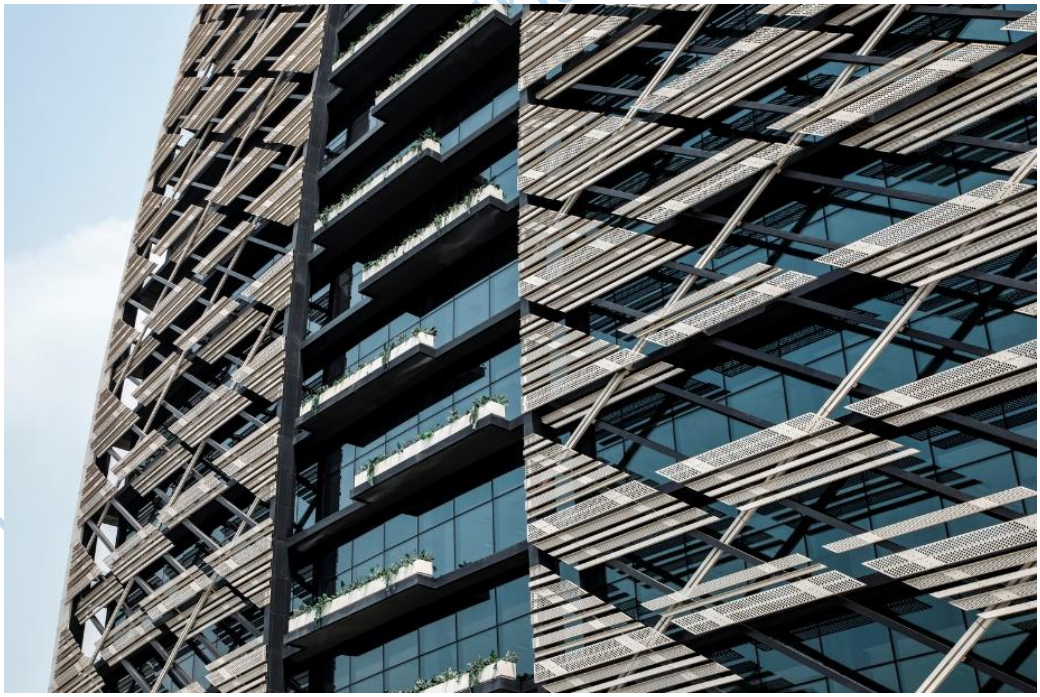

Figure 3.14: Exterior Showing Facade of Kings Tower Building

Source: (Archdaily, 2024)

3.3.3.3 Analytical Framework

Spatial Organization

- **Zoning:** King's Tower zones the building into distinct areas, such as commercial, residential, and recreational spaces. This zoning ensures efficient use of space and facilitates easy access to various functions.
- **Flow Paths:** Multiple entry points and vertical circulation cores manage different user groups efficiently, providing clear flow paths and minimizing congestion.
- **Accessibility:** The building complies with accessibility standards, featuring wide corridors, ramps, and accessible elevators to cater to all users.

Vertical Circulation

- **Elevators and Escalators:** Dedicated elevators for residential and commercial areas reduce wait times and ensure smooth flow for different user groups.
- **Staircases:** The building features multiple staircases, both for regular use and emergency egress, ensuring safety and accessibility across all floors.

Horizontal Circulation

- **Corridors and Hallways:** Wide corridors connect various functional zones, facilitating smooth horizontal movement. The design minimizes long, straight corridors to avoid monotony and enhance user experience.
- **Public vs. Private Corridors:** There is a clear distinction between public and private areas, with secure access controls to ensure privacy and security for residential spaces while allowing public access to commercial areas.

Integration of Services

- **Service Circulation:** Dedicated service routes ensure that maintenance and deliveries do not interfere with public circulation. These routes are designed to be efficient and discrete.
- **Separation from Public Circulation:** Service corridors are separated from main public paths to avoid disruptions, ensuring smooth and uninterrupted public circulation.

User Experience

- **Wayfinding:** Clear signage and intuitive design enhance wayfinding, making navigation easy for first-time visitors and regular users alike.
- **Safety and Security:** Comprehensive surveillance and well-lit corridors ensure user safety. The building design includes multiple emergencies exits to facilitate quick evacuation if needed.
- **Aesthetics and Comfort:** The design incorporates natural lighting and ventilation to enhance user comfort. The building's aesthetics are designed to create a pleasant environment for users.

Technological Integration

- **Smart Building Technologies:** Efficient circulation strategies optimize the flow of users and services, although less technologically advanced than The Edge, the building uses smart systems for managing circulation effectively.
- **Energy Efficiency:** Sustainable practices in circulation areas, such as energy-efficient lighting and climate control systems, contribute to the building's overall sustainability.

3.3.3.4 Appraisals

Merits

1. Stands out as an architectural masterpiece with its outstanding Aesthetics portrayed by the facade.
2. Supports mixed-use delivery by accommodating various functions within the tower, fostering a sense of community and vitality in Lagos' urban landscape.
3. Embodies sustainability using eco-friendly materials and design principles, promoting responsible urban development in Nigeria's burgeoning metropolis.

Demerits

1. **Infrastructure Strain:** The development of high-rise buildings like Kings Tower in Lagos could place strain on existing infrastructure such as transportation networks, water supply, and waste management systems, potentially exacerbating urban challenges like traffic congestion and environmental pollution.
2. **Accessibility Concerns:** The vertical nature of high-rise buildings like Kings Tower may present accessibility challenges for certain populations, including people with disabilities or limited mobility, potentially excluding them from fully accessing the building's amenities and opportunities.

Figure 3.15: Site plan of Kings Tower Building

Source: (Archdaily, 2024)

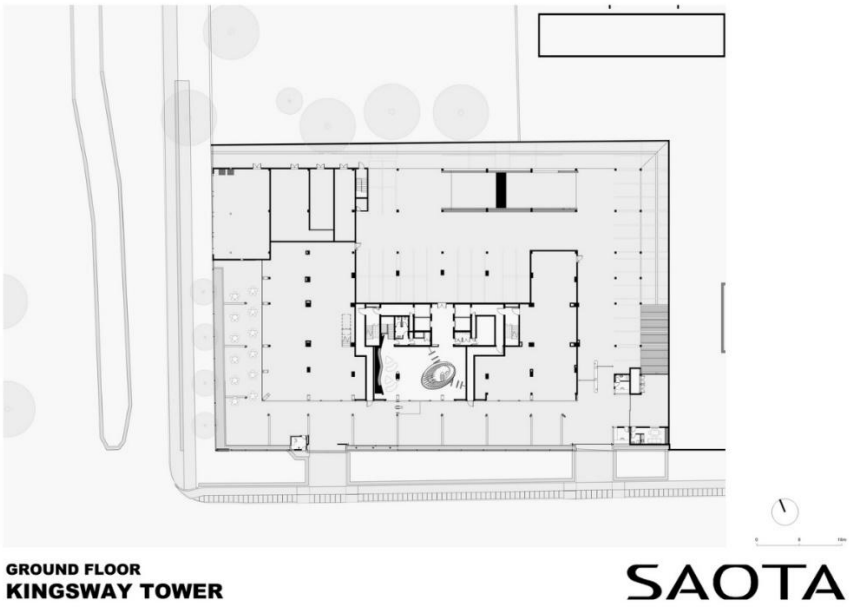

Figure 3.16: Ground Floor Plan of Kings Tower Building

Source: (Archdaily, 2024)

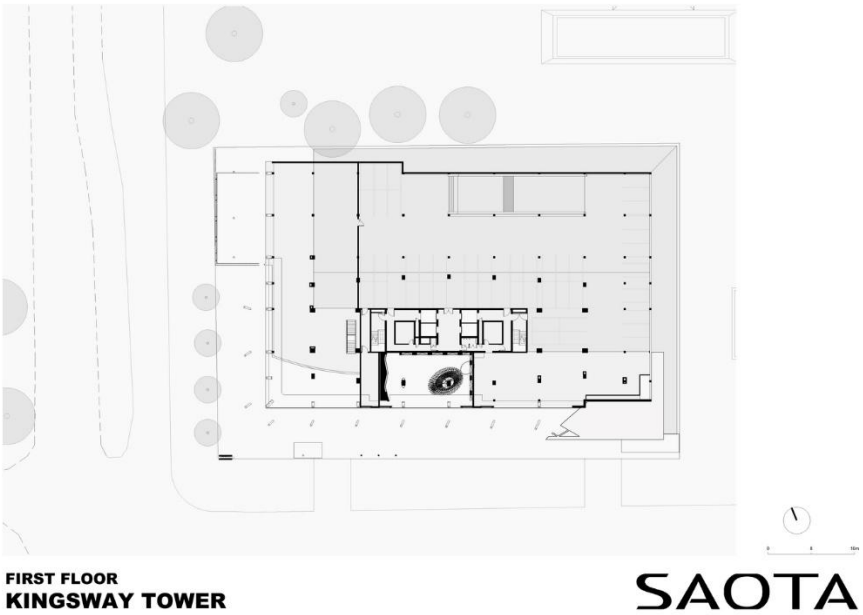

Figure 3.17: First Floor Plan of Kings Tower Building

Source: (Archdaily, 2024)

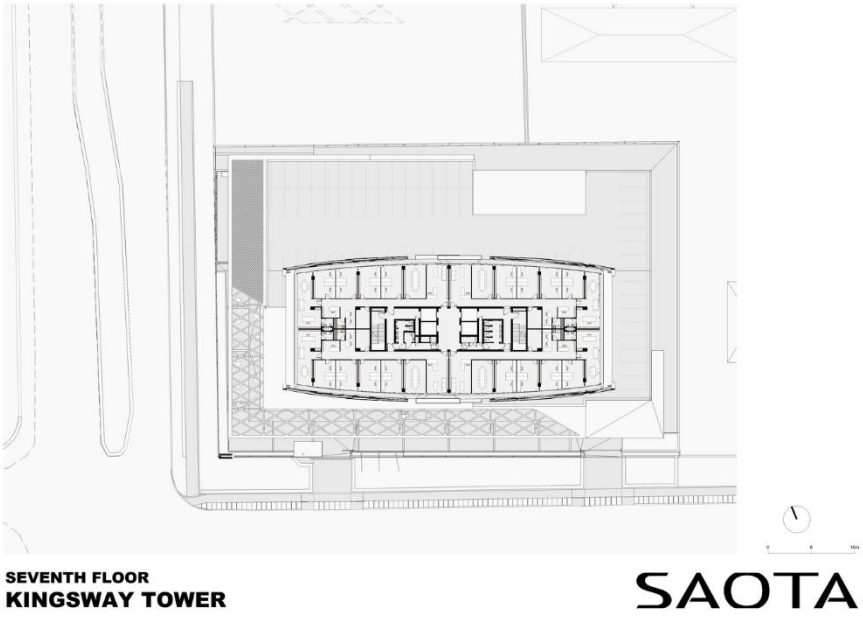

Figure 3.18: Seventh Floor Plan of Kings Tower Building

Source: (Archdaily, 2024)

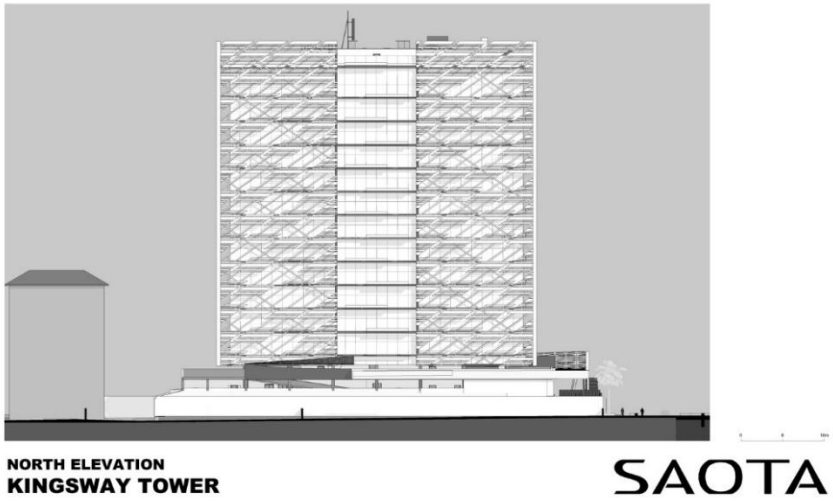

Figure 3.19: North Elevation of Kings Tower Building

Source: (Archdaily, 2024)

3.3.4 Case Studies Adoptions

- Ensure integration of office spaces, retail outlets, and communal areas to enhance neighborhood diversity and vibrancy.
- Design efficient circulation paths that connect different functions seamlessly to encourage interaction and user convenience.
- Incorporate advanced technologies where feasible to enhance building efficiency and occupant comfort.
- Ensure the building is designed for universal accessibility, accommodating diverse user needs including those with disabilities.
- Optimize circulation paths throughout the building to minimize congestion and facilitate smooth movement of users.
- Design clear wayfinding systems and intuitive layout to enhance user experience and navigation within the mixed-use environment.

- Integrate passive design strategies to optimize natural ventilation and lighting, reducing energy consumption.
- Implement rainwater harvesting and energy-efficient systems to meet green urban development standards.

Chapter Four

Site Analysis and Design Synthesis

4.1 Study Area

Lagos, the largest city in Nigeria, is a bustling metropolitan area with high population density and rapid urbanization. It serves as the economic and commercial capital of the country, contributing significantly to Nigeria's GDP. This study aims to evaluate the use of locally sourced building materials in mixed-use developments across Lagos, focusing on the city's diverse urban landscape and dynamic growth. Lagos is situated in the southwestern region of Nigeria, along the Atlantic coast. It encompasses several islands and a mainland area, connected by bridges and a network of roads.

The city's population is a mix of various ethnic groups, including Yoruba, Igbo, and Hausa, as well as a significant number of expatriates and immigrants. The city's infrastructure is extensive but strained, with ongoing improvements and expansions. Key infrastructure components include transportation networks, residential and commercial buildings, and public utilities.

Victoria Island, particularly the area around Muri Okunola, is one of the prime locations in Lagos known for its blend of commercial, residential, and leisure facilities. This area is well-known for its strategic importance, high economic activity, and ongoing urban developments, making it an ideal location. Muri Okunola is situated in the heart of Victoria Island, bordered by key commercial streets such as Adetokunbo Ademola Street and Ozumba Mbadiwe Avenue. It covers an area of approximately 2.5 square kilometers.

Muri Okunola is characterized by high-rise office buildings, luxury apartments, hotels, restaurants, and retail outlets. The infrastructure is well-developed, with ongoing improvements to roads, drainage

systems, and public amenities. The area has a mixed population, including expatriates, professionals, and residents. The population density is high, reflecting the urban and commercial nature of the area.

4.1.1 Site Location

The site of the proposed mixed-use development is located at Muri Okunola, Victoria Island, Lagos.

Figure 4.1: Picture Showing Site Location

Source: (GoogleEarth, 2024)

4.1.2 Site Selection Criteria

Selecting the site for a project is crucial, as it significantly influences the facility's functional use and overall success. To ensure an effective site selection, several key criteria were carefully considered:

1. **Economic and Commercial Hub:** Victoria Island is a major financial center in Lagos, hosting numerous corporate headquarters, international businesses, and upscale commercial establishments.

2. **High Demand for Mixed-Use Spaces:** There is a growing demand for developments that combine residential, commercial, and leisure facilities in one location to cater to the needs of professionals and residents.
3. **Accessibility:** Muri Okunola is well-connected by major roads and public transport networks, facilitating easy access for construction and future users.
4. **Urban Development Potential:** The area is undergoing significant redevelopment, providing opportunities to implement innovative and sustainable building practices.

4.1.3 Site Analysis

The site is crucial in a design proposal, influencing the project's tangible development and final outcome. Environmental and geographical characteristics such as micro-climate, topography, temperature, humidity, and vegetation determine its suitability.

Key factors like water bodies, access, trees, local climate, and utility lines shape the building layout. Proximity to existing features affects the design's form, aesthetics, and economy. A thorough site analysis ensures the design meets its objectives, integrating the site and structure effectively and reflecting the environment.

Figure 4.2: Site Analysis

Source: (Researcher's field work)

Site Accessibility

The site has easy and convenient access for both vehicular and pedestrian. The site is accessible from the major road of Muri Okunola in Lagos.

Proximity to Public Utilities

The site has excellent access to essential infrastructure, including well-maintained roads, reliable electricity, potable water, advanced telecommunications, and robust security systems.

Drainage and Topography

The site features a gentle, evenly distributed slope. It is essential to design the site to direct rainwater flow towards designated collection areas, ensuring efficient drainage and water management.

Vegetation

The site is densely covered with vegetation, including tall grasses, shrubs, and large trees. These will need to be cleared to prepare the area for construction.

Soil Condition

The site has firm laterite soil, which is ideal for construction and landscaping. There are no rocky outcrops, and the presence of clay soil suitable for making hydra form bricks adds to the site's suitability for sustainable building practices.

Wind Direction

The site is influenced by both the north-east trade wind and the south-west trade wind. The north-east wind brings cool, dusty conditions, while the south-west wind offers cold humidity, providing comfort. Proper ventilation is crucial, with the building's long sides positioned to maximize airflow and natural cooling.

Sunlight and Temperature

Solar gain and temperature management are vital, particularly for harnessing solar energy to power the proposed mixed-use development. The building's orientation is designed to minimize excess heating, and solar panels are strategically placed to maximize the capture of solar radiation throughout the day.

4.2 Project Analysis and Design Synthesis

4.2.1 Brief Analysis

There is a growing need in Lagos for developments that address both urban density and environmental sustainability. The current urban infrastructure in Victoria Island struggles to accommodate the increasing population and the corresponding demand for residential, commercial, and recreational

spaces. This underscores the necessity to design a mixed-use development in Muri Okunola that not only optimizes land use but also promotes economic growth and enhances the quality of life for residents.

4.2.2 Brief Development

In the examination of three case studies within this study, several shared spaces emerged across all instances. These spaces underwent thorough scrutiny to ascertain the requisite standards, optimal occupancy ratios, capacity assessments, and precise functions within the context of mixed-use development. These spaces encompass:

1. Residential Units
2. Commercial Zones
3. Recreational Areas
4. Public Amenities
5. Circulation Spaces

4.2.3 Design Considerations

In the design of proposed mixed-use development in Muri Okunola, Victoria Island, Lagos, a range of design considerations were meticulously incorporated to ensure a holistic, sustainable, and user-centric environment. Here's how each consideration was integrated:

1. **Aesthetics**

   Prioritize aesthetic appeal by incorporating modern architectural designs and landscaping elements that complement the surrounding urban landscape. Attention was given to the use of high-quality materials and finishes to enhance the visual appeal of the development

2. **Modularity**

The design should embrace modularity to facilitate flexibility and adaptability in the use of space over time. Modular design principles to be applied to residential units, commercial spaces, and recreational areas, allowing for easy reconfiguration as needs evolve.

3. **Energy Efficiency**

   Energy-efficient technologies and strategies integrated into the development to minimize energy consumption and reduce environmental impact. This includes the use of solar panels for renewable energy generation, energy-efficient lighting systems, and passive design techniques to optimize natural lighting and ventilation.

4. **Smartness**

   Smart technologies incorporated to enhance the efficiency, convenience, and security of the development. This includes smart building management systems for energy monitoring and optimization, as well as smart security systems for access control and surveillance.

5. **Circulation**

   Circulation within the development should be carefully planned to ensure efficient movement of residents, visitors, and vehicles. Pedestrian-friendly walkways, well-designed parking facilities, and clear signage were implemented to enhance circulation and accessibility.

6. **Flexibility**

   Flexibility embedded into the design to accommodate diverse uses and functions within the development. Multi-functional spaces were created to serve varying needs, allowing for seamless transitions between residential, commercial, and recreational activities.

4.2.4 Conceptual Development

The design for the proposed mixed-use development is driven by an idea encapsulated in the concept of **"Live, Work & Play"**. This approach represents more than just a design philosophy; it's a fundamental belief in creating spaces that enrich the lives of those who inhabit them.

- **Live:** At the core of vision is the idea of creating homes that transcend mere shelter. Crafting residential spaces that offer comfort, community, and a sense of belonging. From modern apartments with ample natural light to communal areas that encourage social interaction, our goal is to foster a vibrant residential experience.
- **Work:** But the development isn't just about living; it's about thriving. By integrating flexible office spaces and co-working areas, we're cultivating an environment that nurtures creativity, collaboration, and innovation.
- **Play:** Life isn't all about work, it's about finding balance and enjoying the moments in between. From green spaces and recreational facilities to cultural venues and entertainment options, there will always be opportunities for residents to relax, unwind, and connect with their surroundings.

This concept isn't just a theoretical framework; it's the driving force behind every decision made in the design process. By embracing the **"Live, Work & Play"** ethos, we're creating more than just buildings and building communities where people can truly live their best lives.

Building Concept

The design concept "**Rectilinear Form"** for the building emerged from the need to create an energy-efficient building. The instinctive, billowing form of the tower subtly references the form of a yacht. The structure maintains a slender rectilinear form which faces the northern and southern side to maximize daylighting. Also, the building consists of distinctive adaptive façade that responds to the

local climate condition of the surrounding to create a porous permeable façade with depth and sculptural quality

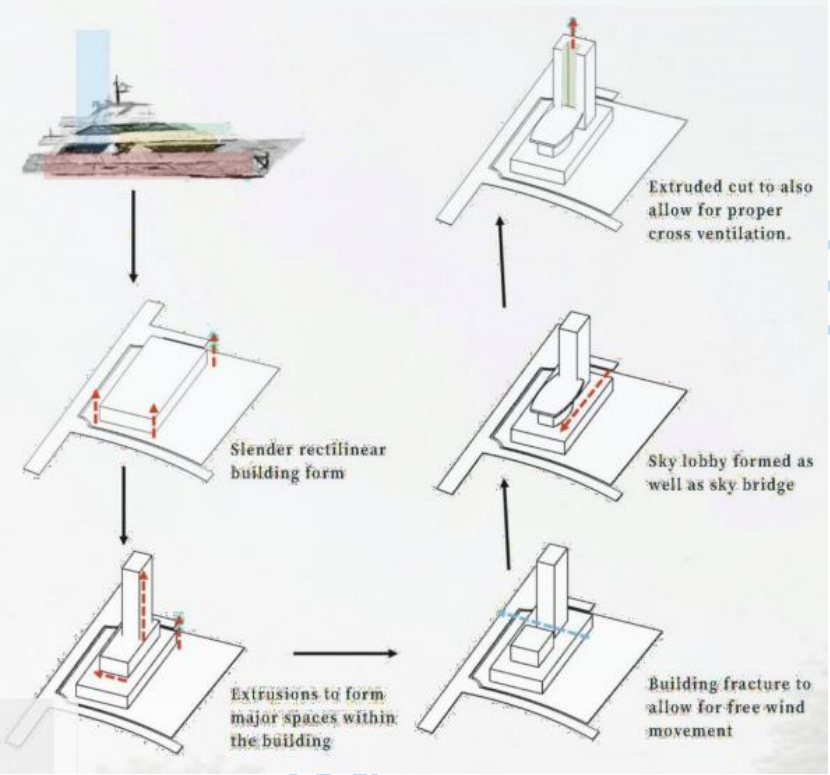

Figure 4.3: Building Concept

Source: (Researcher's field work)

4.2.5 Functional Relationship

The functional relationship chart provides a clear understanding of the connections between different spaces within the facility. By visually mapping these relationships, designers can quickly identify which areas are interconnected and which are not. This allows for the strategic placement of related spaces near each other, while also isolating those that are unrelated. Additionally, the chart facilitates zoning decisions and enhances the overall functionality of the design by ensuring that spaces are organized in a logical and efficient manner.

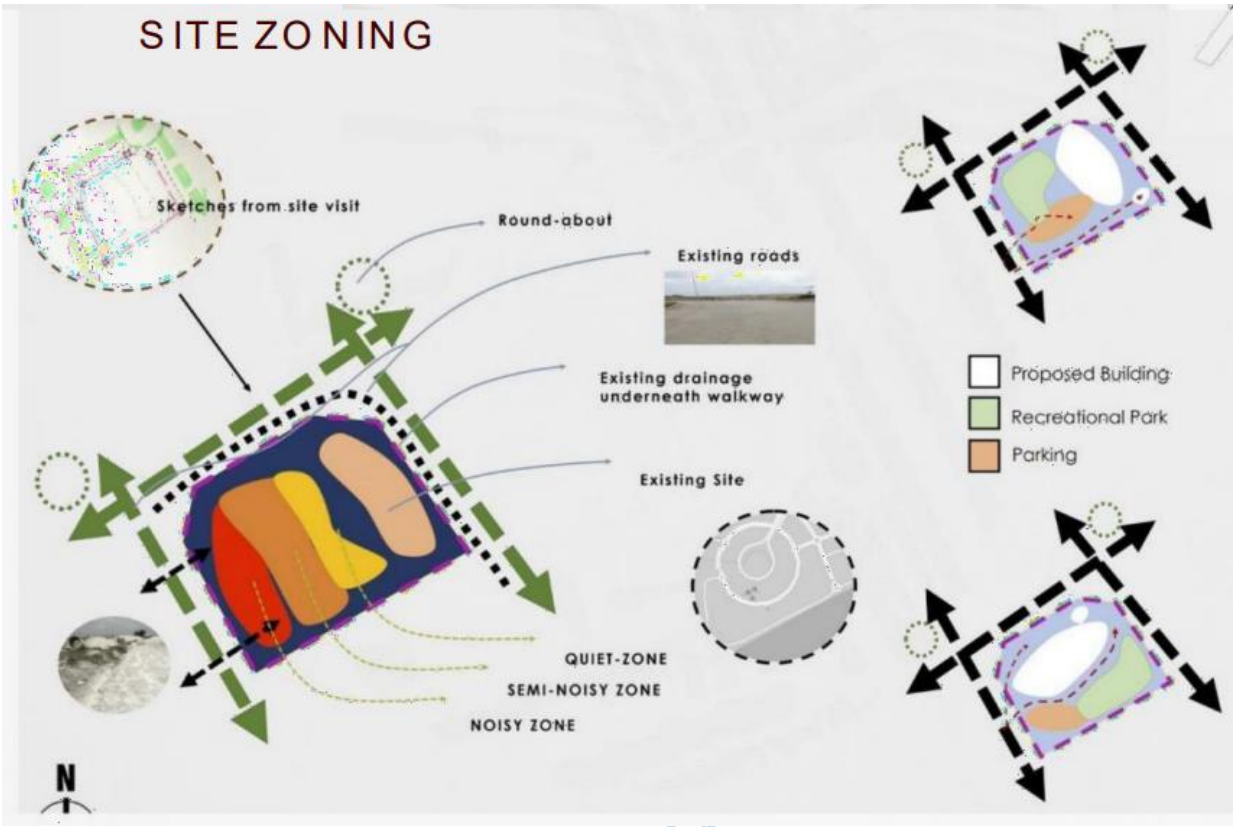

Figure 4.4: Site Zoning

Source: (Researcher's field work)

4.2.6 Space Allocation / Schedule of Accommodation

Figure 4.5: Space Allocation

Source: (Researcher's field work)

ACCOMODATION SCHEDULE

SPACE	QUANTITY	MIN. REQ(M2)
Living room	40	60
dinning	40	24
kitchen	40	24
bedroom	90	18
Single room	28	36
Double room	15	36
Standard suite	8	60
Presidential suite	16	60
Reception hall/lobby	1	60
Service room	8	18
Departmental store	1	250
Retail stores	32	60
Gym	1	60
Food court	1	120
Bar/sit outs	1	56
Open plan office	40	60
Conference room	1	56
Reception/lounge	2	30
Convenience	6	36
Managers office	40	30

Table 4.1: Schedule of Accommodation

Source: (Researcher's field work)

4.2.7 Construction Methods and Materials

Methods

- **Prefabrication:** Off-site fabrication of building components improves efficiency and reduces construction time.
- **Modular Construction:** Assembly of standardized modules off-site and then transported to the construction site, offering speed and cost-effectiveness.
- **Green Building Practices:** Incorporating energy-efficient design, passive solar techniques, and sustainable materials to minimize environmental impact.

Materials

- **Structural Systems**

  Reinforced Concrete: Often used for high-rise buildings and provides strength and durability.

  Steel Frame: Provides flexibility and allows for large spans, commonly used in commercial and office spaces.

  Timber Frame: Utilized for low to mid-rise buildings, offering sustainability and a shorter construction time.

- **Exterior Finishes**

  Brick: Provides a classic aesthetic and durability, commonly used for facades in residential and commercial buildings.

  Glass Curtain Walls: Allows for ample natural light and a modern aesthetic, often used in office and retail spaces.

  Metal Panels: Provides a sleek and contemporary look, used for accent features or entire facades.

- **Interior Finishes**

  Drywall: Offers flexibility and ease of installation, used for interior walls and partitions.

  Ceramic Tile: Provides durability and a wide range of design options, used for flooring in commercial and residential spaces.

  Vinyl Flooring: Offers affordability and low maintenance, commonly used in retail and hospitality spaces.

- **Roofing Systems**

  Flat Roof: Provides flexibility for rooftop amenities and solar installations, commonly used in commercial buildings.

Sloped Roof: Offers drainage efficiency and aesthetic variety, often used in residential buildings.

Green Roof: Enhances sustainability and insulation, used for environmental benefits and aesthetic appeal.

- **Sustainable Materials**

Recycled Content Materials: Such as recycled steel, glass, and concrete, reduce environmental impact and promote sustainability.

Low VOC Paints: Minimize indoor air pollution and improve indoor air quality.

Bamboo Flooring: Renewable and durable material, commonly used for flooring in residential and commercial spaces.

4.2.8 Building Services

- **Mechanical Systems**

Heating, Ventilation, and Air Conditioning (HVAC): Provides climate control for residential, commercial, and office spaces, ensuring comfort and indoor air quality.

Mechanical Ventilation: Removes stale air and introduces fresh air into the building, maintaining optimal air circulation.

Boilers and Chillers: Provide hot water for heating and cooling systems, respectively, utilizing energy-efficient technologies to minimize energy consumption.

- **Electrical Systems**

Power Distribution: Delivers electricity from the main electrical panel to various outlets and appliances throughout the building.

Lighting: Provides interior and exterior illumination, incorporating energy-efficient fixtures and controls to minimize electricity usage.

Emergency Power Systems: Ensures continuity of critical operations during power outages, including backup generators and uninterruptible power supplies (UPS).

- **Plumbing Systems**

  Water Supply: Delivers potable water to sinks, showers, and toilets, incorporating water-saving fixtures to minimize water consumption.

  Sanitary Drainage: Removes wastewater from plumbing fixtures and directs it to the municipal sewer system or on-site treatment facility.

  Stormwater Management: Collects and directs rainwater away from the building, utilizing drainage systems and retention ponds to prevent flooding.

- **Fire Protection Systems**

  Fire Sprinkler Systems: Automatically detect and extinguish fires using water or other extinguishing agents, protecting life and property.

  Fire Alarm Systems: Detect smoke and fire conditions and alert occupants to evacuate the building safely.

  Smoke Control Systems: Manage smoke movement within the building, aiding in safe egress during a fire emergency.

- **Communication and Security Systems**

  Structured Cabling: Provides a network infrastructure for telecommunications, internet, and data transmission throughout the building.

  Access Control Systems: Restricts entry to authorized personnel using keycards, biometric readers, or electronic locks, enhancing security.

  Surveillance Systems: Monitor and record activity within and around the building, deterring crime and providing evidence in the event of security incidents.

- **Environmental and Sustainable Systems**

  Energy Management Systems: Monitor and optimize energy usage, identifying opportunities for efficiency improvements and cost savings.

  Renewable Energy Systems: Incorporates solar panels, wind turbines, or geothermal systems to generate renewable energy on-site, reducing reliance on fossil fuels.

Chapter Five

Conclusion and Recommendations

5.1 Project Appraisal

The study on circulation in mixed-use buildings has explored fundamental aspects of spatial planning and user experience within these complex environments. By analyzing existing literature reviews and various case studies, the research has highlighted critical factors influencing circulation efficiency, such as layout design, traffic flow management, accessibility provisions, and user behavior patterns. The findings underscore the importance of integrating functional efficiency with user comfort and safety in enhancing the overall usability and appeal of mixed-use developments.

5.2 Conclusion

In conclusion, the research has illuminated key insights into the intricate dynamics of circulation within mixed-use buildings. Effective circulation design not only facilitates seamless movement but also contributes significantly to the overall functionality and attractiveness of these multifaceted spaces. By adopting a holistic approach that balances spatial efficiency with user-centric design principles, designers and architects can optimize circulation pathways to enhance user experience and operational effectiveness.

5.3 Recommendation

Based on the findings of this thesis, the following recommendations are proposed:

Integrate Multi-Modal Connectivity: Enhance circulation by integrating pedestrian-friendly pathways, bicycle lanes, and efficient vehicular access points to accommodate diverse modes of transportation.

Enhance Spatial Efficiency: Optimize layout design and zoning strategies to minimize congestion and improve navigation efficiency within mixed-use buildings.

Prioritize Accessibility: Ensure universal access through inclusive design features such as ramps, elevators, and clear signage to enhance user mobility and convenience.

Promote User Safety: Implement robust security measures and emergency evacuation plans to safeguard occupants and visitors during emergencies.

Utilize Technology: Incorporate smart technologies and digital platforms to monitor and manage circulation patterns, enhancing operational efficiency and user experience.

Foster Sustainability: Integrate sustainable design principles, such as energy-efficient lighting and natural ventilation, to promote environmental stewardship and occupant well-being.

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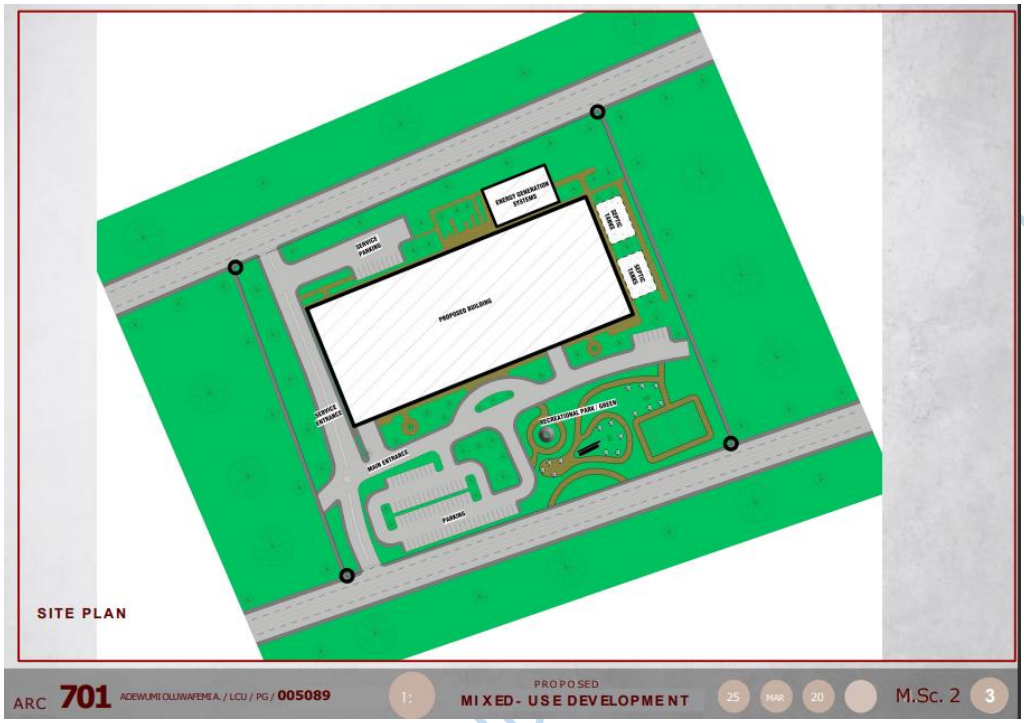
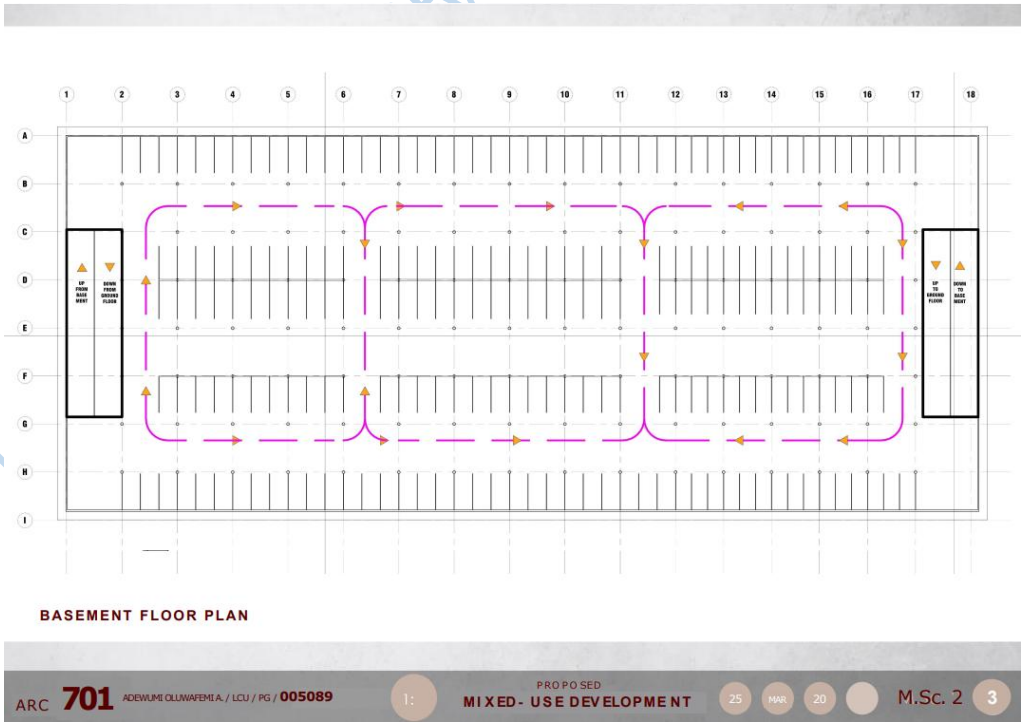
Appendices

Appendix 1 – Presentation Drawings





GROUND FLOOR PLAN

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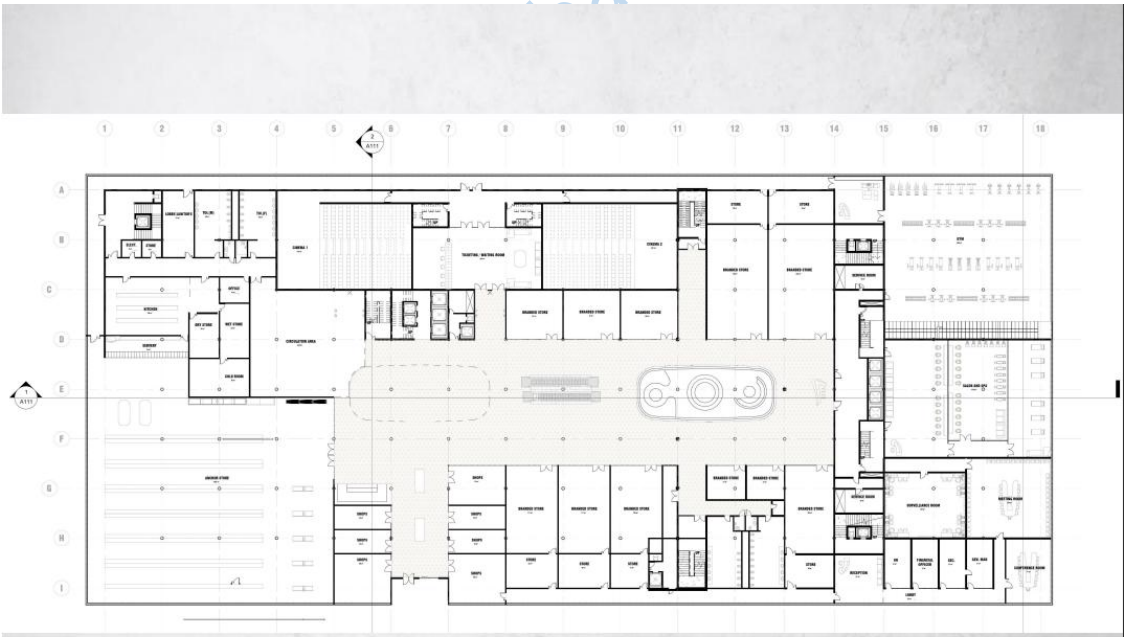

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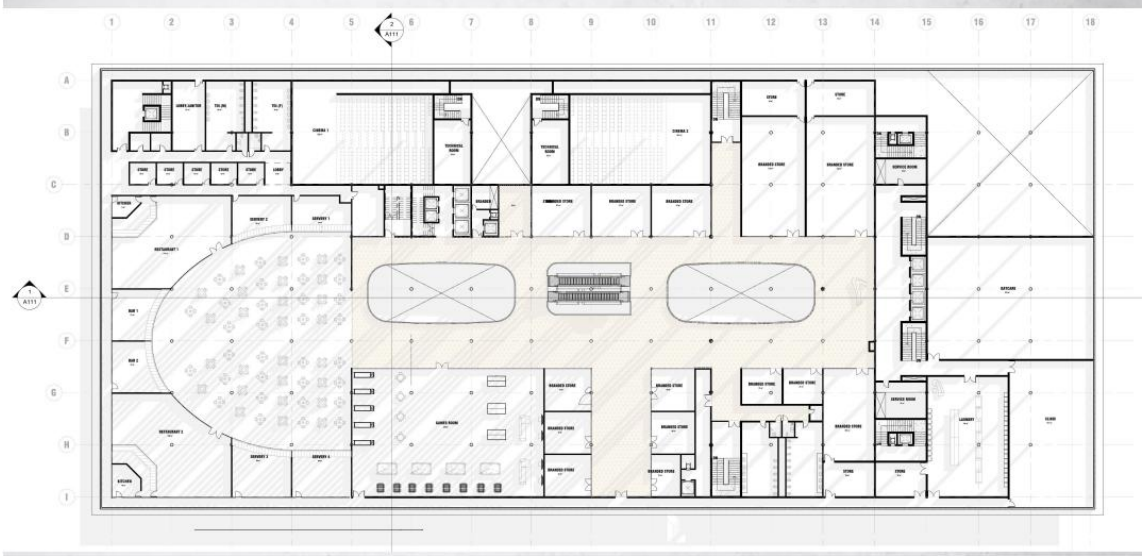

SECOND FLOOR PLAN

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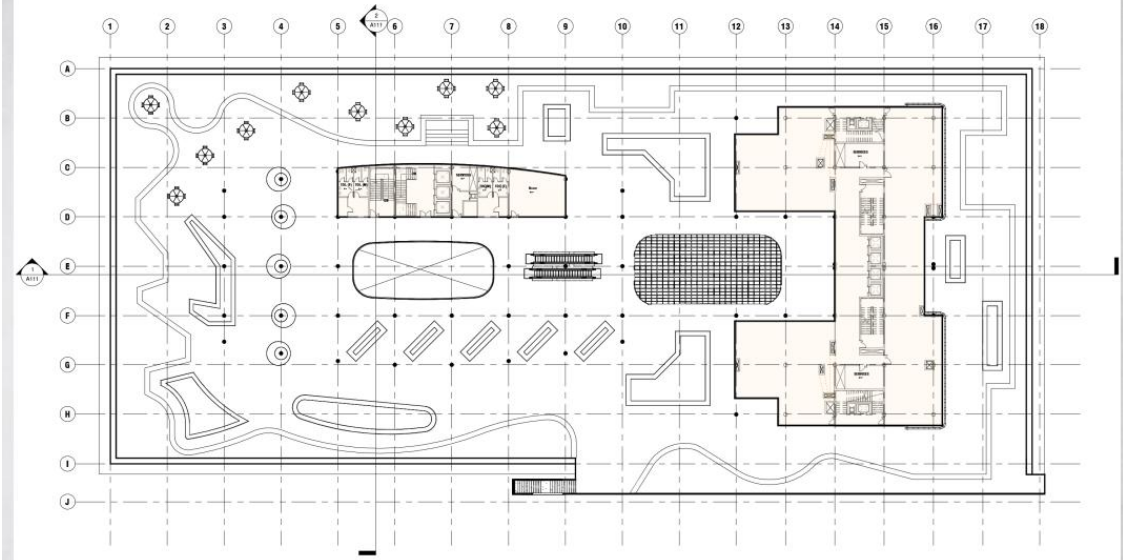

THIRD FLOOR PLAN (SERVICE FLOOR)

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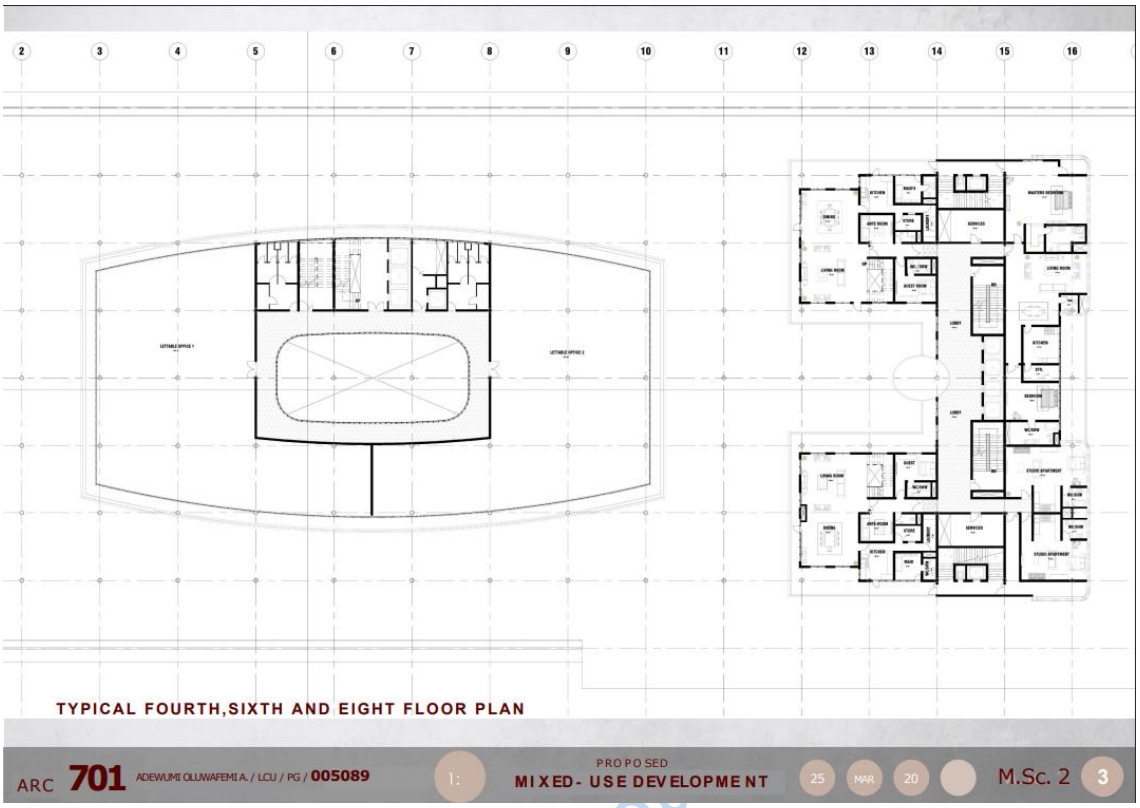
TYPICAL FOURTH,SIXTH AND EIGHT FLOOR PLAN
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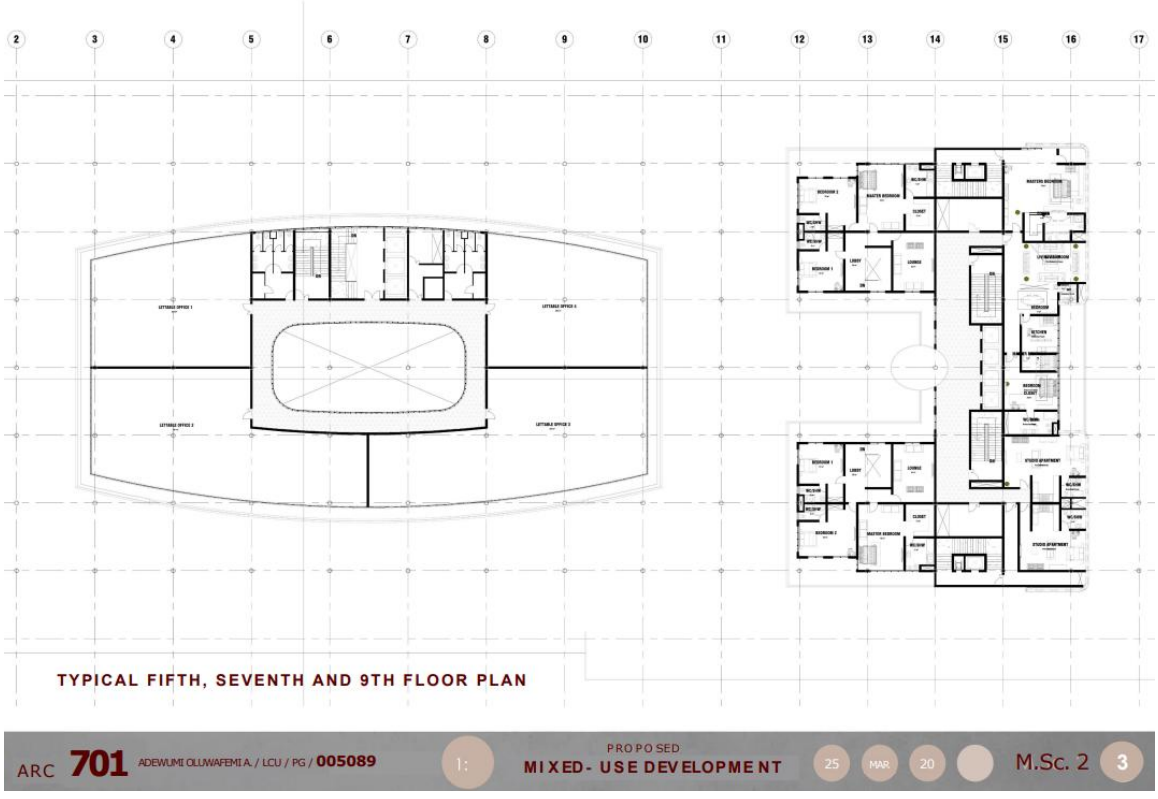
PROPOSED
MIXED- USE DEVELOPMENT
25 MAR 20
M.Sc. 2
3


TYPICAL FIFTH, SEVENTH AND 9TH FLOOR PLAN
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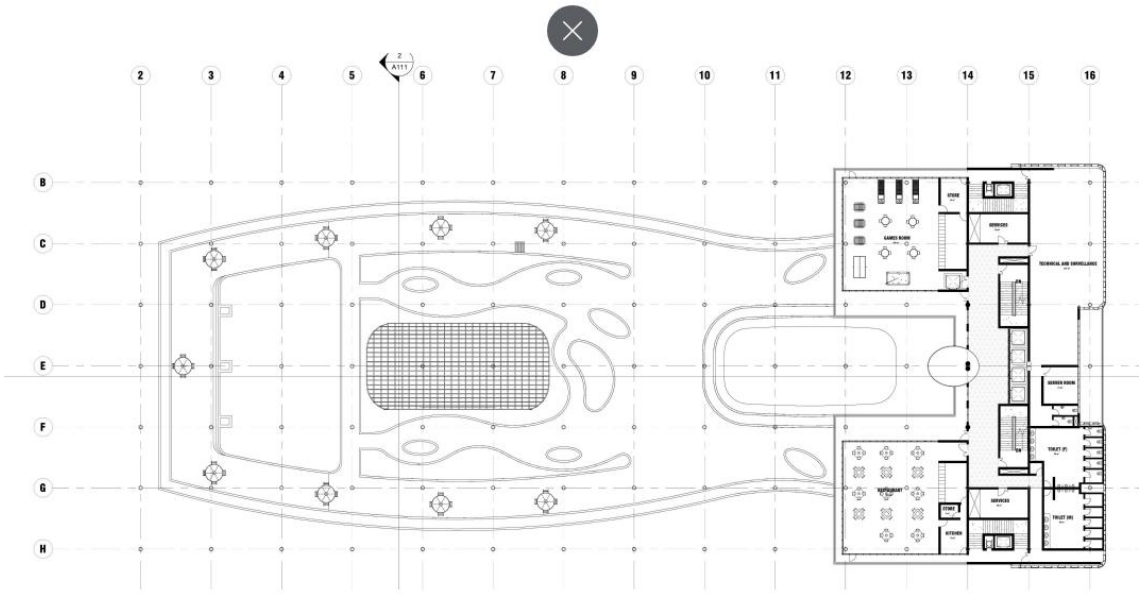
PROPOSED
MIXED- USE DEVELOPMENT
25 MAR 20
M.Sc. 2
3



TENTH FLOOR PLAN

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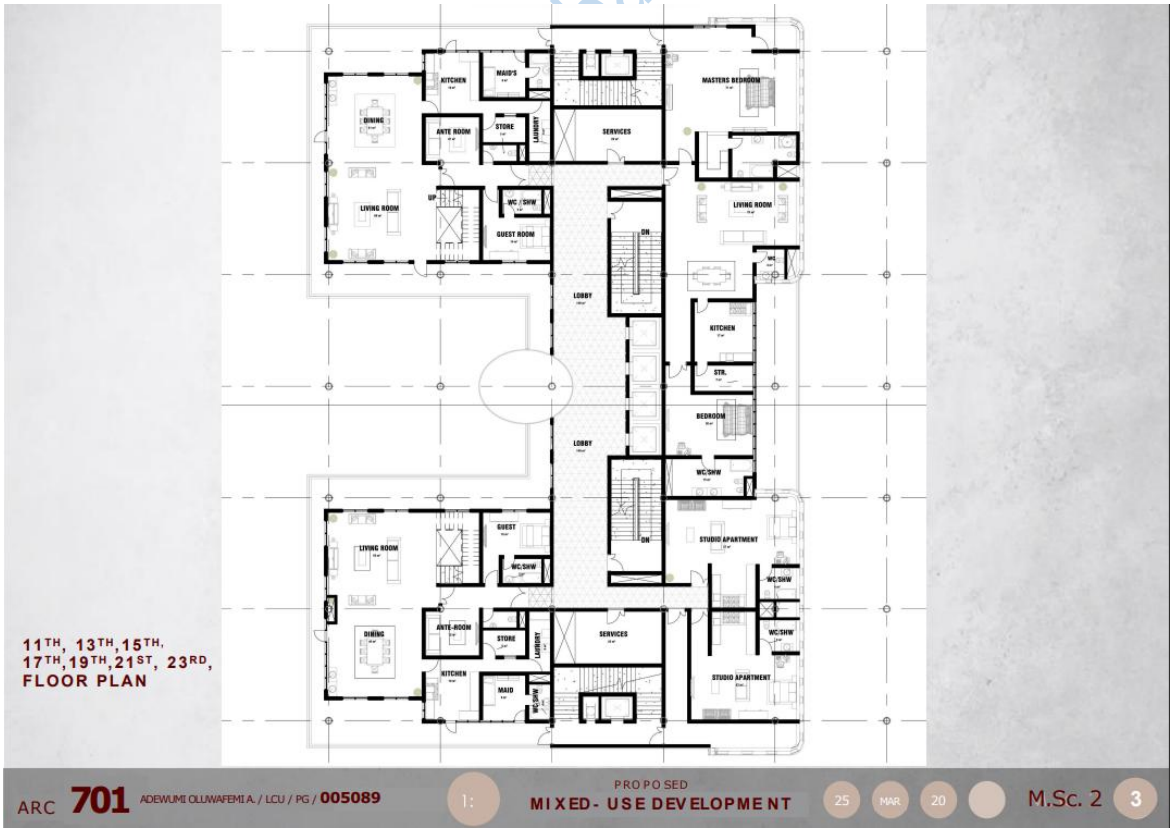
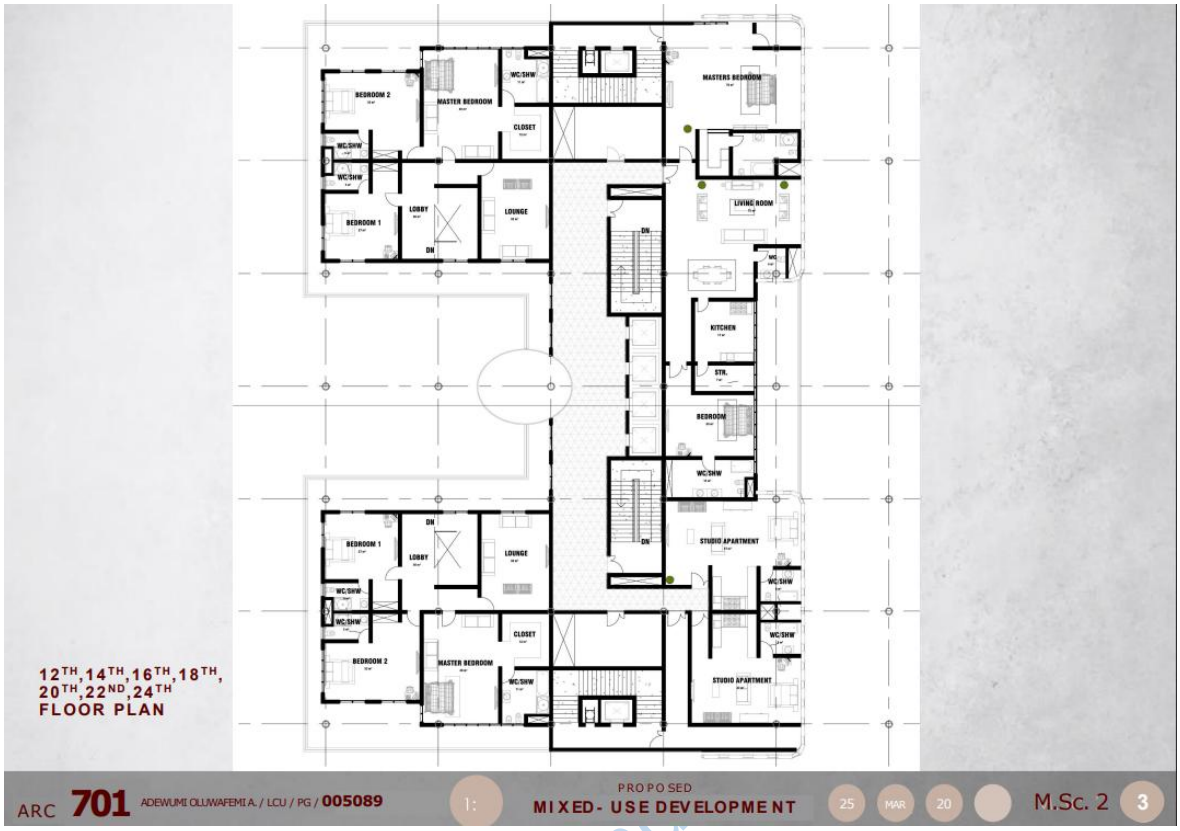


11TH, 13TH, 15TH, 17TH, 19TH, 21ST, 23RD, FLOOR PLAN

ARC 701 ADEWUMI OLUWAFEMI A. / LCU / PG / 005089 | 1: | PROPOSED MIXED- USE DEVELOPMENT | 25 MAR 20 | M.Sc. 2 | 3


BEDROOM 2
MASTER BEDROOM
WC/SHW
CLOSET
MASTERS BEDROOM
LIVING ROOM
WC/SHW
WC/SHW
BEDROOM 1
LOBBY
LOUNGE
DN
KITCHEN
STR.
BEDROOM
WC/SHW
STUDIO APARTMENT
WC/SHW
WC/SHW
CLOSET
BEDROOM 2
MASTER BEDROOM
WC/SHW
STUDIO APARTMENT
12TH,14TH,16TH,18TH,
20TH,22ND,24TH
FLOOR PLAN
ARC 701 ADEWUMI OLUWAFEMI A. / LCU / PG / 005089
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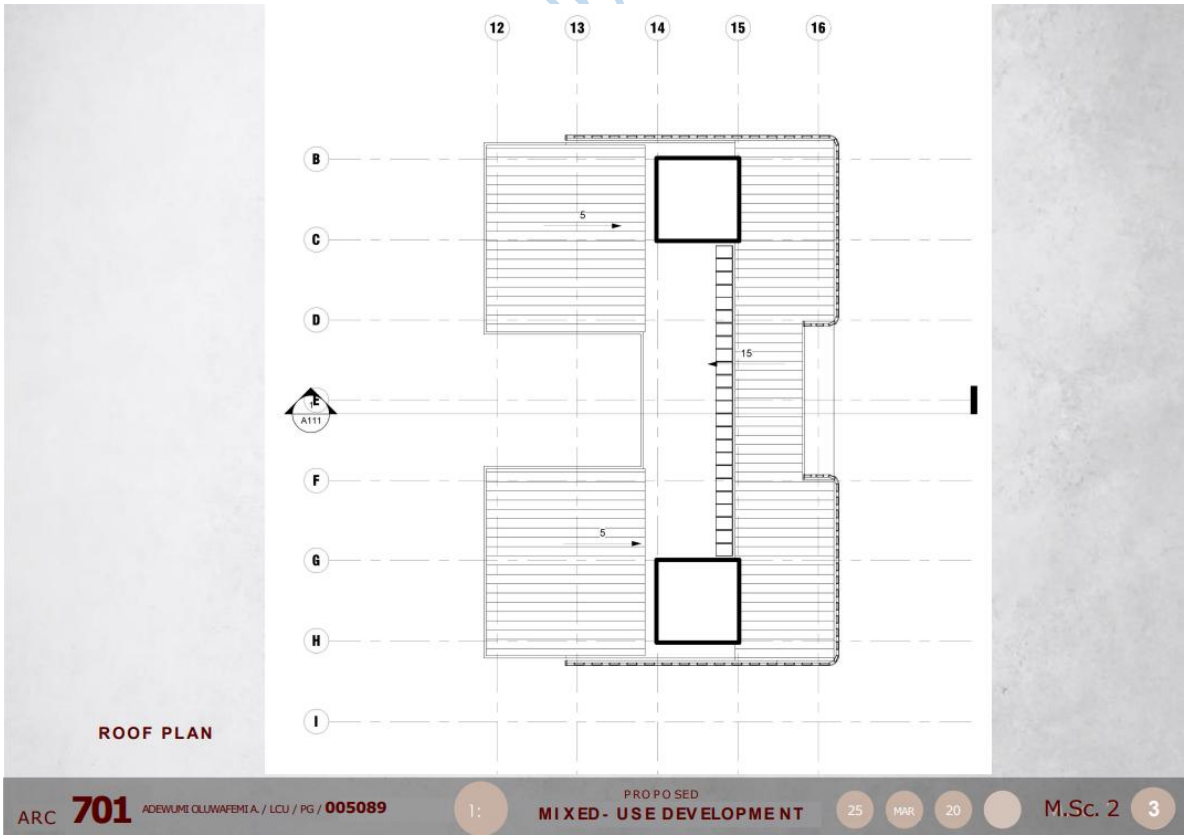
PROPOSED
MIXED- USE DEVELOPMENT
25 MAR 20
M.Sc. 2 3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ROOF PLAN
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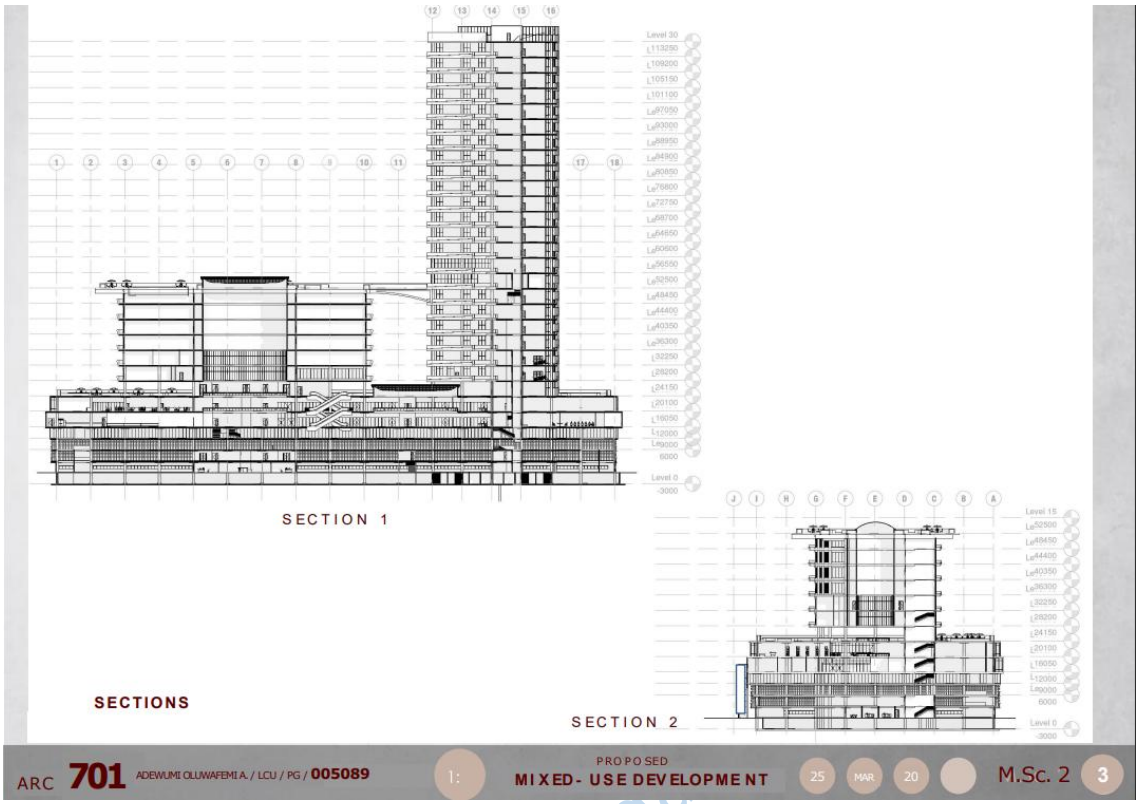
MIXED- USE DEVELOPMENT
25 MAR 20
M.Sc. 2 3


SECTION 1
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ARC 701 ADEWUMI OLUWAFEMI A. / LCU / PG / 005089
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25 MAR 20
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ELEVATIONS
ARC 701 ADEWUMI OLUWAFEMI A. / LCU / PG / 005089
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PROPOSED
MIXED- USE DEVELOPMENT
25 MAR 20
M.Sc. 2
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ELEVATIONS

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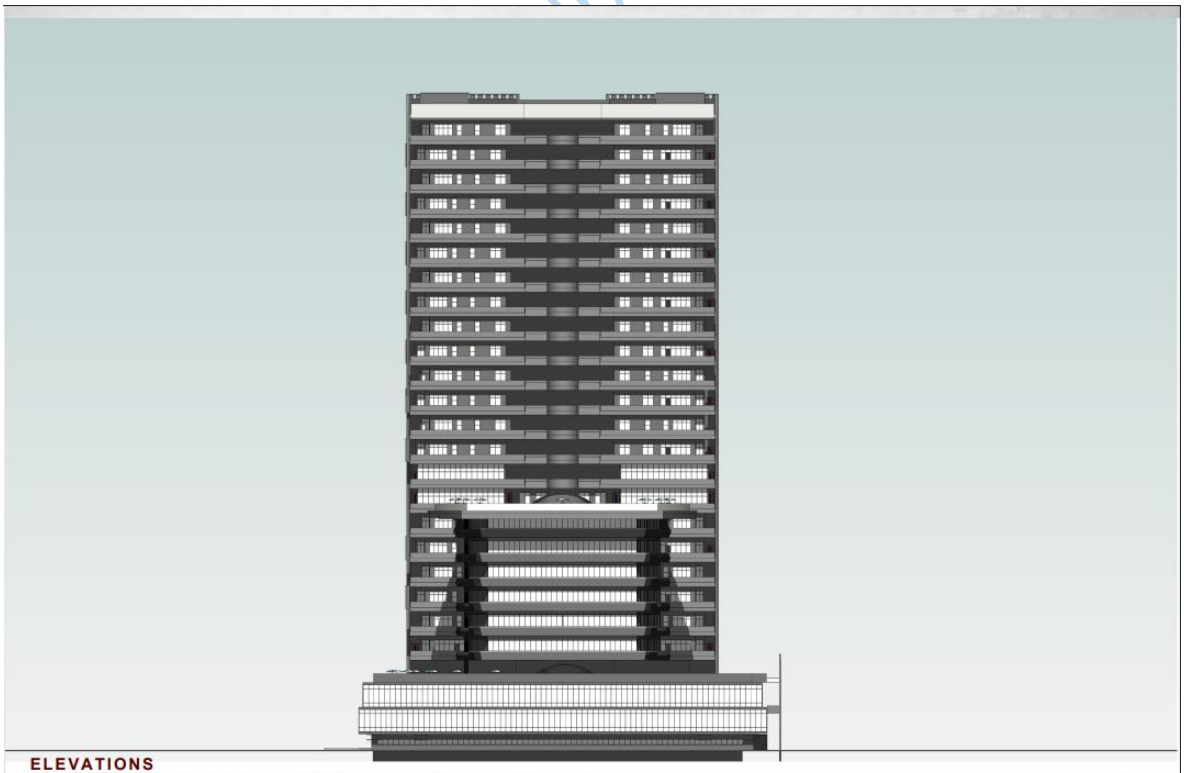

ELEVATIONS

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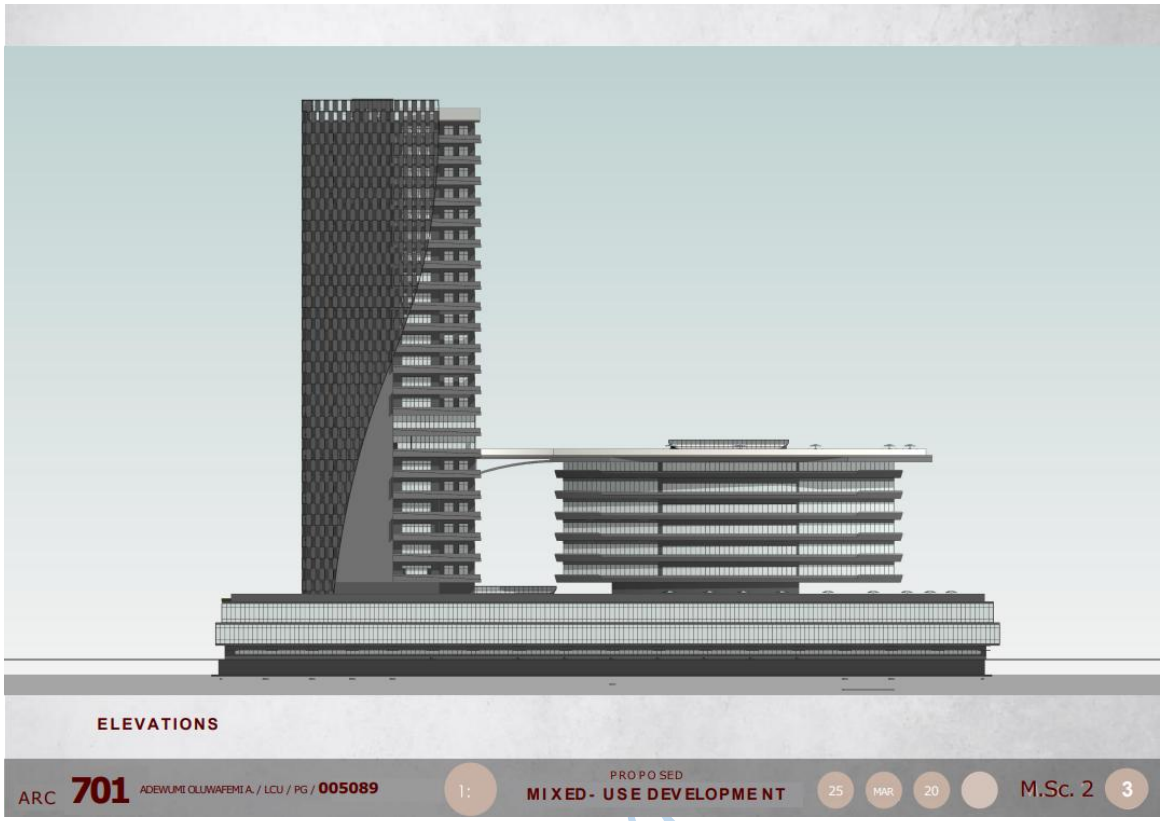
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PROPOSED
MIXED- USE DEVELOPMENT
25 MAR 20
M.Sc. 2
3

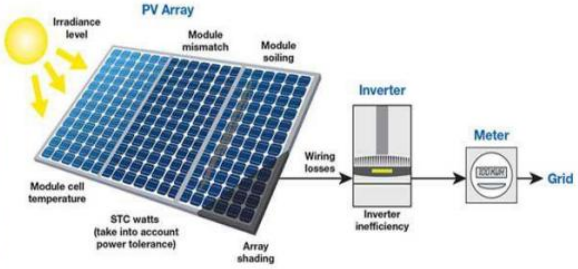

3DS
ARC 701 ADEWUMI OLUWAFEMI A. / LCU / PG / 005089
1:
PROPOSED
MIXED- USE DEVELOPMENT
25 MAR 20
M.Sc. 2
3


3DS
ARC 701 ADEWUMI OLUWAFEMI A. / LCU / PG / 005089
1:
PROPOSED
MIXED- USE DEVELOPMENT
25 MAR 20
M.Sc. 2
3


3DS
ARC 701 ADEWUMI OLUWAFEMI A. / LCU / PG / 005089
1:
PROPOSED
MIXED- USE DEVELOPMENT
25 MAR 20
M.Sc. 2
3

A Photovoltaic system is designed to supply usable solar power by means of photovoltaics. It entails arrangements of several components including solar panel which absorbed and convert sunlight into electricity, a solar inverter that converts DC to AC and other accessories like charge controller, cables, batteries to store the currents etc

Photovoltaic (PV) modules are widely used for harnessing solar energy which ensure maximum output when their glass surface is clean. However, PV modules are open to dust, grime and other contaminations which get deposited on their surface causing reduction in transmittance and hence their efficiency reduces. It is therefore required to clean the glass surface of PV modules time to time either manually by labor or using some special arrangements such as automated systems.



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- 2021: Crescent Konsult Light House Estate Lekki, Lagos.
- (Freelance Project Architect)
- 2020-2021: Arkibest En-Konsult Limited Ibadan, Oyo State.
- (Project Architect)

- 2019-2020: AB-DT Partnership, Dugbe Ibadan, Oyo State.
- (Nysc)
- 2018: Ps Consultant Limited Ilorin, Kwara State
- (6months Industrial Training Attachment)

…… ……

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