



## Assessment of functional circulation in selected mixed-use buildings in Ikoyi, Lagos State

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### Abstract

Mixed-use buildings are gaining popularity in urban areas, combining residential, commercial, and recreational facilities within a single complex. However, the effectiveness of circulation systems within these buildings remains understudied, particularly in Lagos State, Nigeria. This study addresses the lack of research on functional circulation in mixed-use building design in Ikoyi, Lagos State. It aims to evaluate circulation system effectiveness, integration of land uses, and the impact of circulation design on user experience. The study aims to assess functional circulation in mixed-use buildings in Ikoyi, Lagos State, focusing on system effectiveness, land use integration, and user experience impact. Quantitative analysis, including structural surveys and statistical methods like mean interval and relative significant index, was employed to assess circulation patterns. The study revealed variations in circulation system efficiency across case studies, with case study i showing higher efficiency in elevators, parking areas, and outdoor spaces compared to case study ii. The relative significant index emphasized the importance of building layout, vertical circulation, and horizontal circulation systems. Improving elevator efficiency, optimizing parking areas and outdoor spaces, and incorporating flexible design principles in horizontal circulation systems are recommended to enhance mixed-use building functionality in Lagos State. More comprehensive approach to circulation design is essential for successful mixed-use developments.

**Keywords:** Functional Circulation, Mixed use building, Building design, Ikoyi

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### 1. Introduction

Mixed-use building is a design strategy that aims to integrate different activities and services in different regions of the city (where there is a lack of space, a high cost of land, a key location, and high economic value) into a complex structure with interconnected usability and functionality. Mixed-use building entail both residential facilities, commercial facilities with recreational facilities and it mostly owned by a single developer. Mixed-use building can also be seen as multi-functional building consisting of several building masses which are integrated and have different uses (Lubis *et al.*, 2021) <sup>[11]</sup>. Based on International Building Code and The Building Construction and Safety Code, a mixed-use building as a building or structure that contains two or more occupancies that are distinct from each other in terms of their use and characteristics. Urban requirements, restrictions, and a thriving economy are among the Nigerian elements promoting the emergence of mixed-use structure to address the myriad issues brought on by urbanization, mixed-use developments are a crucial tool. Mixed-use buildings, which combine various functions and energy conservation, can meet human needs and provide comfort in urban areas (Mansi *et al.*, 2021) <sup>[12]</sup>.

The Circulation system serves as an essential interconnected infrastructure that facilitates movement and connectivity within a building, encompassing functional, economic, flexibility, and comfort considerations (Firmansyah, 2020) <sup>[6]</sup>. Changes in circulation in a building can give new meaning to the function of a space, influenced by factors such as tradition, culture, and social surroundings (Darmayanti & Bahaudin, 2020) <sup>[4]</sup>.

Functional circulation in mixed-use development refers to the design and layout of pathways within the development that efficiently accommodate the movement of people and goods while supporting the diverse activities taking place within the space. Mixed-use urban development should consider spatial and functional relationships at various scales, logistics, and nuisance mitigation, with vertical symbiosis linking various pathway within the system (Ryckewaert *et al.*, 2021) <sup>[18]</sup>. Building density, functional mix, and access networks are key morphological elements in relation to forms of urbanity (Peimani & Kamalipour, 2022) <sup>[17]</sup>. Functional circulation concept focuses on creating a cohesive network of routes that connect different components such as residential, commercial, and recreational areas, ensuring ease of access and promoting interaction between various functions. Functional circulation considers factors such as pedestrian flow, vehicular traffic, accessibility for individuals with disabilities, and the efficient distribution of services such as elevators and staircases. The goal is to optimize the overall functionality and usability of the mixed-use development, enhancing the experience for residents, visitors, and businesses alike.

Mixed-use buildings complicate building structure and can be limited by local development plans, which may not always meet the needs of the changing urban environment and society (Bradecki, 2019) <sup>[3]</sup>. Local spatial mismatches in five Chinese megacities indicate overcrowded or underutilized urban spaces, affecting socio-economic activities (Xia *et al.*, 2020) <sup>[20]</sup>. Local regulations of building functionality remain the most significant challenge encountered in mixed-use development, but the proportion of challenges has decreased (Metzinger, 2021) <sup>[13]</sup>. Therefore, the study focusses on the assessment of functional circulation in mixed use building design around Lagos State, Nigeria. with specific objectives such as evaluating the effectiveness of circulation systems within mixed-use buildings in Ikoyi, Lagos State, considering factors such as pedestrian flow, vehicular movement, and accessibility, assessing the integration of different land uses (residential, commercial, recreational) within mixed-use buildings and their influence on circulation patterns and efficiency and the impact of circulation design on the overall user experience and satisfaction within mixed-use developments in Lagos. By leveraging on these established objectives, the study seeks to propose solution and recommendation for effective functional circulation in mixed-use development around Lagos state and the world at large.

## 2. Literature Review

### 2.1. Mixed Use Building

A mixed-use building is a type of urban development that incorporates multiple functions or land uses within a single structure or complex. These buildings typically combine a mix of residential, commercial, office, retail, recreational, or institutional spaces within a single building or integrated development. Mixed-use development combines residential, commercial, and cultural uses into one space (Han *et al.*, 2021) <sup>[8]</sup>. Mixed-use buildings are objects of more than one use, allowing access to at least two groups of users, benefiting from the presence of the other one (Bradecki, 2019) <sup>[3]</sup>. Mixed-use building design combines various functions in one building, considering the needs of the area, surrounding environment, and building user, while incorporating energy conservation principles (Lubis *et al.*, 2021) <sup>[11]</sup>. Mixed-use

development is essential for a sustainable, high-quality urban lifestyle, promoting fewer automotive trips, shorter travel times, smaller dwelling units, enhanced walkability, and a stronger sense of community (Driskill & Elliott, 2020) <sup>[5]</sup>. Mixed-use development in upper middle class residential zones can enhance quality of life and contribute to the transformation of cities into creative cities (Arbab, 2021) <sup>[2]</sup>. Mixed-use development is essential for a sustainable, high-quality urban lifestyle, with factors like design, walkability, and community spirit influencing compatibility of land-use (Driskill & Elliott, 2020) <sup>[5]</sup>. Mixed-use building design considers the needs of the area, surrounding environment, and building user, and aims to meet human needs and provide comfort (Lubis *et al.*, 2021) <sup>[11]</sup>.

### 2.2 Circulation pattern in mixed use development

Circulation patterns in mixed-use developments serves as a key role in shaping the functionality, accessibility, and overall success of these complex urban environments. These patterns include the pathways and routes that facilitate movement within and around the development, accommodating various modes of transportation and connecting different land uses such as residential, commercial, and recreational areas. Effective circulation design is essential for promoting pedestrian activity, reducing vehicular congestion, and fostering a sense of connectivity and vibrancy within the community. Mixed land-use circulation planning and detailed environment design can reduce traffic congestion and improve efficiency in high-density areas (Song *et al.*, 2019) <sup>[19]</sup>. A range of studies have explored the architectural circulation patterns in mixed-use buildings. Lee (2022) <sup>[10]</sup> found that these patterns are shifting towards non-consumption tendencies, with an emphasis on circular and three-dimensional connections. Element such as spatial composition, circulation plans (building pathway) and central space are one of the key influence circulation pattern in mixed-use building (Lee, 2022) <sup>[10]</sup>. Distinct circulation types such as linear, curved, and grid-based circulation pattern with varying levels of wayfinding difficulty are identified (Natapov *et al.*, 2020) <sup>[14]</sup>. Focused on the use of circular plans in single-family houses, showing their potential for maximizing outdoor views and fitting into the surrounding landscape. Further explored the integration of circular and flexible building concepts, emphasizing the importance of user benefits in multi-family housing.

In mixed use building several circulation patterns are integrated such as vertical circulation system which involves transportation systems like elevators provide efficient access to different floors within the building, accommodating residents, employees, and visitors. Staircases which offer alternative vertical movement options, promoting physical activity and providing emergency egress routes. Vertical circulation in multi-story buildings, including stairs, escalators, and elevators, is a key factor in optimizing the design and ensuring successful functioning (Ogunyemi *et al.*, 2022) <sup>[16]</sup> Horizontal Circulation pathway which involves Corridors and Hallway create Internal pathways that connect various spaces within the building, including residential units, offices, retail areas, and amenities. Based on (Abdulqader & Ahmed, 2020) <sup>[1]</sup> well-designed pathways contribute to an intuitive understanding of the space, helping occupants easily locate specific rooms or amenities. Atriums which include Large, open spaces within the building that serve as focal points and facilitate horizontal movement

between different levels while providing natural light and visual connections. Consideration is to be given to factors such as the width of corridors, the placement of doors, and the arrangement of spaces. wider corridors allow for smoother traffic flow and accommodate diverse user needs, including individuals with mobility aids (Yakovlev, 2020) [21]. Pedestrian Circulation pathway such as sidewalks and walkways which include external pathways surrounding the building that connect entrances, parking areas, and adjacent streets, encouraging pedestrian access and interaction. Poor design, scarce walking infrastructure, and obstacles on sidewalks negatively impact pedestrian flow as observed in Cuenca, Ecuador (Hermida *et al.*, 2019) [9].

Plazas and Courtyards with open spaces within the building complex that serve as gathering areas and pedestrian thoroughfares, often featuring seating, landscaping, and amenities. Lateral openings in urban courtyards can negatively impact air quality, but some configurations can improve it, contributing to improved urban planning for health protection (Gronemeier & Sühling, 2019) [7]. Vehicular Circulation pathway include driveways and access roads with Internal and external routes designed to accommodate vehicular traffic, including drop-off zones, parking ramps, and service entrances. Mixed-use urban environments with increased complexity increase driver demand, with slower reaction times observed in driving simulators when cyclists are present (O'Hern *et al.*, 2019) [15]. Parking Facilities with On-site parking structures or lots that provide parking spaces for residents, employees, and visitors, with designated circulation lanes and access points.

Mixed-Use Circulation pattern such as shared spaces which include multi-functional areas within the building that accommodate various uses and users, such as mixed-use lobbies, atriums, and communal amenities. Transit Connections pathway integration with public transit systems, including bus stops, subway stations, or light rail platforms, providing convenient access for residents and commuters. Mixed-use development is essential for a sustainable, high-quality urban lifestyle, and land-use compatibility is now a matter of design, not distance, rather than isolation of noise, pollution, and hazards (Driskill & Elliott, 2020) [5].

### 3. Study Methodology

The study methodology uses quantitative method of study analysis to assess the functional circulation pattern within the various case study. Structural surveys pattern were employed using distributed questionnaires as a means of research techniques. The study also relies on the responds of the questionnaires and interview respondent as a basic source of its data. The study area comprises of mixed-use building within Ikoyi, Lagos state. The questionnaires employed both opened and closed ended question. The questionnaires were also divided into various section with each section obtaining various key finding. Section A which obtained the demographic information of the respondent such as age, sex and section B which obtained respondent knowledge on the effectiveness of the available circulation systems within the case study employed using only closed end question and scale of measurement. Section C which also obtained information-based on the circulation pattern available within the case study and its effectiveness. Section D which assesses the overall impact of circulation design of respondent satisfaction. The total questionnaires distributed within the various case study was 103, the total collected questionnaires

were 71. Statistical analyses such as mean which include the mean interval (Strongly Inefficient (1: 1.80), Inefficient (1.80: 2.60), neither efficient nor inefficient I (2.60: 3.40), Efficient (3.40: 4.20) and v with Highly Efficient (4.20: 5)) and relative significant index were used to analyze the overall respondent based on the finding.

### 3.1. Case Study I: King Tower Ikoyi, Lagos State

Kings tower is a mixed-use building with 22 storey office building located in Ikoyi Lagos Nigeria. It was previous known as the union bank building. It was constructed in the year 1979. The tower is a landmark in Lagos and is suited on Alfred Rewane Road, one of the busiest roads in the city, it offers a wide view of the Lagos skyline and Lagos Lagoon. The building has a total floor space of 38,000 square meter with offices retail spaces and parking facilities. It is a home to several prominent companies like Deloitte, Standard Chartered bank and Eco- bank. The building was extensively renovated in 2017 which include an upgrade to the building façade, common areas and elevator facilities as well as the addition of new amenities such as recreational facilities. It architectural merit of kings tower include efficient lighting system, adequate natural lightning, proper building insulation, better energy efficient heating, ventilation and air conditioning system, (HVAC) and proper water conservation system.



Fig 1: Kings Tower Exterior View

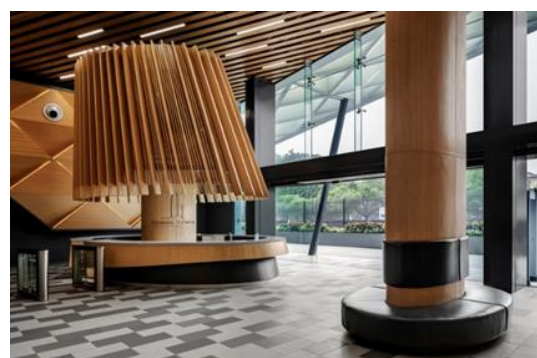


Fig 2: King Tower Interior View

### 3.2 Case study ii: YMCA building, Ikoyi

The Young Men's Christian Association building is a mixed-use building comprises of a 5- storey building located at Awolowo road in Ikoyi, Lagos state. The building host various building spaces such as a residential building, a hotel facilities office and retail spaces. Constructed by G. Cappa

limited. It also hosts several business spaces such as Bamitonia Company a Parking garage. HSF wellness center, Victory Travel & Tours Ltd, Tulip and Goldberg Ltd, also SPAR retail store. also, a recreational space for sport activities. The building has a total of about 250 room spaces include offices spaces.



Fig 3: Exterior and interior YMCA building (source: etco-nigeria.com)

## 4. Discussion of Study Finding

### 4.1. Efficiency of functional circulation system within the case study

Table 1: Efficiency of functional circulation system within the case study's

SN	Circulation systems	Case study i (N= 41)	Case study ii (N= 30)
		Mean interval	Mean interval
1	Corridor and Hallways	4.12	3.71
2	Elevator	4.32	2.95
3	Staircase	3.89	3.69
4	Atrium	3.41	4.26
5	Sidewalks and Walkways	4.73	4.39
6	Parking area	4.26	1.81
7	Plazas and Courtyards	3.64	2.67
8	Driveways and Access Roads	4.81	2.51
9	Shared Spaces	3.83	2.63

The analysis of the efficiency of functional circulation systems within the case study reveals variations in the mean intervals across different circulation elements within the case study. Both case studies show relatively high efficiency in corridors and hallways, with mean intervals of 4.12 and 3.71 for case study i and ii, respectively. Indicate effective layout and design for movement and navigation within the mixed-use building. For Elevator, case study i demonstrates higher efficiency in elevators with a mean interval of 4.32, compared to 2.95 in case study ii. Both case studies exhibit similar efficiency in staircases, with mean intervals of 3.89 and 3.69 for case study i and ii, respectively indicating comparable functionality for vertical circulation via staircases. Case study ii shows higher efficiency in atriums with a mean interval of 4.26, compared to 3.41 in case study i. This indicates a more functional and well-designed atrium in case study ii. Both case studies also demonstrate high efficiency in sidewalks and walkways, with mean intervals of 4.73 and

4.39 for case study i and ii, respectively. Showing effective design for pedestrian circulation outside the buildings. Case study I also shows higher efficiency in parking areas with a mean interval of 4.26, compared to 1.81 in case study ii. indicating better functionality and design for parking in case study i. Case study i exhibits higher efficiency in plazas and courtyards with a mean interval of 3.64, compared to 2.67 in case study ii. This suggests better design and functionality of these outdoor spaces in case study 1. Case study 1 also demonstrates higher efficiency in driveways and access roads with a mean interval of 4.81, compared to 2.51 in case study ii. This indicates less efficiency design and functionality for vehicle circulation in case study ii. Both case studies also show relatively similar efficiency in shared spaces, with mean intervals of 3.83 and 2.63 for case study 1 and 2, respectively. This suggests comparable functionality and design for shared use areas.

## 4.2 Significant impact of functional circulation system on occupancy flow and accessibility in case study

### 4.2.1. Impact of circulation systems on occupancy flow and accessibility within the mixed-building in case study 1

**Table 2:** Impact of occupancy flow and accessibility within the mixed-building in case study 1

SN	Functional Circulation System	Case Study 1	Ranking
		RSI	
1	Building layout and orientation	0.899	1
2	Vertical circulation such as elevators and staircase	0.814	2
3	Horizontal circulation such as corridor/Hallways and atriums	0.753	3
4	Pedestrian Circulation such as Sidewalks, Walkways, Plaza and Courtyards	0.682	4
5	Vehicular Circulation such as driveways, access roads and parking facilities	0.629	5
6	Mixed-Use Circulation such as shared space	0.563	6

The analysis of the relative significant index (RSI) for the impact of functional circulation systems within the mixed-building of case study 1 in Table 2, shows that the building layout and orientation have the highest impact on occupancy flow and accessibility, with an RSI of 0.899 and ranking first. This suggests that the overall design and orientation of the building play a crucial role in determining how occupants flow through and access different areas of the building. Vertical circulation elements such as elevators and staircases follow closely behind, with an RSI of 0.814 and ranking second. This indicates that the efficiency and design of vertical circulation systems significantly impact how occupants move between different levels of the building.

Horizontal circulation elements such as corridors, hallways, and atriums rank third, with an RSI of 0.753, highlighting their importance in facilitating horizontal movement within the building. Pedestrian circulation, including sidewalks, walkways, plazas, and courtyards, ranks fourth, indicating their role in providing accessible pathways for pedestrians. Vehicular circulation elements such as driveways, access roads, and parking facilities rank fifth, suggesting their impact on vehicular flow and accessibility. Mixed-use circulation spaces, including shared spaces, rank sixth, indicating their lesser impact on overall occupancy flow and accessibility within the mixed-building.

### 4.2.2. Impact of circulation systems on occupancy flow and accessibility in case study 2

**Table 3:** Impact of occupancy flow and accessibility within the mixed-building in case study 2

SN	Functional Circulation System	Case Study 1	Ranking
		RSI	
1	Horizontal circulation such as corridor/Hallways and atriums	0.967	1
2	Building layout and orientation	0.931	2
3	Pedestrian Circulation such as Sidewalks, Walkways, Plaza and Courtyards	0.88	3
4	Vertical circulation such as staircase	0.833	4
5	Vehicular Circulation such as driveways, access roads and parking facilities	0.817	5
6	Mixed-Use Circulation such as shared space	0.621	6

Figure 3, which shows the impact of functional circulation systems within the mixed-building of case study ii was also carried out it shows that horizontal circulation elements such as corridors, hallways, and atriums have the highest impact on occupancy flow and accessibility, with an RSI of 0.967 and ranking first. This suggests that the design and efficiency of horizontal circulation systems play a crucial role in facilitating movement within the building. Building layout and orientation follow closely behind, with an RSI of 0.931 and ranking second, indicating their importance in determining the overall flow and accessibility of the building. Pedestrian circulation elements such as sidewalks, walkways, plazas, and courtyards rank third, with an RSI of 0.880, highlighting their role in providing accessible pathways for pedestrians. Vertical circulation elements such as staircases rank fourth, with an RSI of 0.833, suggesting their impact on vertical movement within the building. Vehicular circulation elements such as driveways, access roads, and parking facilities rank fifth, indicating their influence on vehicular flow and accessibility. Mixed-use circulation spaces, including shared spaces, rank sixth, indicating their lesser impact on overall occupancy flow and accessibility within the mixed-building.

## 5. Conclusion

The assessment of functional circulation in mixed-use building design, as evidenced by the case studies of King Tower in Ikoyi, Lagos State (case study 1) and the YMCA building in Ikoyi (case study 2), highlights several key findings. Firstly, both case studies demonstrate effective layout and design in corridors and hallways, indicating smooth movement and navigation within the buildings. However, discrepancies arise in elevator efficiency, with case study i showcasing higher efficiency compared to case study ii. This suggests a need for improvement in vertical transportation design in the latter. Furthermore, case study ii excels in atrium efficiency, indicating a more functional design in this aspect. Additionally, both case studies effectively accommodate pedestrian circulation outside the buildings through sidewalks and walkways. Parking areas show significant differences, with case study i exhibiting better functionality and design. Plazas, courtyards, driveways, and access roads also demonstrate varying levels of efficiency between the two case studies. The analysis of the relative significant index (RSI) emphasizes the importance of building layout and orientation, vertical circulation elements, and horizontal circulation systems in

both case studies, highlighting their impact on occupancy flow and accessibility within mixed-use buildings.

Based on these findings, recommendations can be made to enhance the functional circulation systems in mixed-use building designs. Firstly, improving elevator efficiency and vertical circulation design can enhance the overall accessibility and flow of occupants between different levels of the building. Additionally, optimizing parking areas and outdoor spaces such as plazas and courtyards can improve functionality and user experience. Furthermore, incorporating flexible and adaptable design principles in horizontal circulation systems, such as corridors and hallways, can enhance efficiency and accommodate diverse user needs. Overall, a holistic approach to design that considers the specific needs and functionalities of each circulation element is crucial in creating efficient and accessible mixed-use buildings.

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