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Efficiency And Circulation: Parameters For A Functional Multilevel Car Park Design In South Eastern Nigeria

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ABSTRACT

Multilevel car parks, are very essential for every public center in areas with fast growing population rate in South Eastern Nigeria. This studies examines the characteristics and essential parameters for creating a safe, effective multilevel parking lot in South Eastern Nigeria. Well-designed parking facilities are now vital due to the region's growing urbanization and vehicle traffic. The research explores how the circulation architecture and security measures interact to provide the best possible design framework. A mixed-method approach is used in the research, integrating quantitative and qualitative data gathering techniques. While traffic flow simulations and statistical modeling are part of the quantitative study, user interviews and surveys as well as surveys of parking facility management and local authorities are part of the qualitative component. The results show that the circulation pattern and general architecture of a multilevel parking lot in South Eastern Nigeria are closely related to the parking lot's security. Crucial elements encompass the positioning of security checkpoints, lighting, monitoring systems, and access management protocols; moreover, effective circulation design elements pertaining to automobile movement, parking space arrangement, and pedestrian accessibility. The study also highlights certain regional and cultural elements that are exclusive to South Eastern Nigeria and have an influence on parking choices and security concerns. Architects, urban planners, and policy makers are given recommendations on how to include these characteristics into the planning and administration of multilevel parking lots. This article adds to the expanding body of knowledge on the design of parking facilities in metropolitan environments by providing context-specific observations from South Eastern Nigeria. It is a vital tool for improving the region's general urban infrastructure as well as the user experience.

Keywords: Multilevel Car Park, Circulation, Security, Efficiency, South Eastern Nigeria.

INTRODUCTION

The rapid urbanization and population growth in South Eastern Nigeria have brought about a significant increase in the number of vehicles on the region's roads, (Monyei, 2018). This surge in vehicular traffic has led to a pressing need for efficient and secure parking solutions, particularly in urban centers of the eastern nigeria where available space is at a premium. As a response to this growing challenge, the design and management of multilevel car parks have emerged as a crucial urban infrastructure concern. Car parking systems were developed in the early 20th century in response to the need for storage space for vehicle, (Ede, Adepoju and Awoyera, 2015). By 1939, 23 million vehicles were registered across the United States. By the mid-20th century, the motor vehicle was in full control of the transportation scene, and has remained unchallenged since then, (Ben- Joseph, 2015).

The effective design of multilevel car parks goes beyond merely providing a space for vehicles. It encompasses a delicate balance between security, efficiency, and circulation – elements that are intimately intertwined, (Henderson N. et al., 2002). To create a successful multilevel car park in the South Eastern Nigerian context, designers must consider these parameters comprehensively.

Security, a paramount aspect of any parking facility, extends beyond safeguarding vehicles from theft and vandalism. In South Eastern Nigeria, as in many urban regions, security considerations also encompass ensuring the safety of users and maintaining a secure environment. This involves deploying measures such as surveillance systems, well-placed lighting, access control, and security personnel. Understanding how these security measures interact with the overall design is essential.

As economies develop, the population of the world also increases day by day and this is most observable in towns and cities. Due to this increase in population car ownership has consequently increased. Hence, in commercial areas like the shopping malls, cinema halls, banks, etc, where people would want to travel by their own vehicles, each car will need a proper parking space resulting in an increased parking demand. (Sethy et al, 2020). Shen (1997) claimed that population growth and increasing living standards of people are the major causes for the rise in the number of cars in the cities. Due to the affordable price of small city cars and free or nominal charges for parking, most people prefer to travel by private cars over public transit. Research indicates that the average volume of traffic related to parking during peak time can reach 30%–50% of total traffic (Shoup, 2006).

Parking spaces are very important to cities. Every person who owns a vehicle needs a space for parking. As the number of vehicles grows, need of space for parking increases. Since the 1960s, car parking has become a major user of developable land. A city must have enough parking spaces to provide their residents and their visitors a place to park their car. Since cars are a main factor in transportation, a city must meet the needs of the drivers. If people can't find a place to park, or if they have to pay too much for parking, these people probably won't come back to your city to do some more shopping, dining or spending money in any other way. Also residents must have enough places to park their car nearby their house and workplace. Sufficient and suitable parking facilities should be provided in convenient locations to reduce potential conflict between pedestrians and vehicles. Parking garages are most commonly associated with densely developed urban centres and represent a significant investment in providing for a parking facility. The increased demand in parking as identified by Sethy (2020) can be adequately addressed with the introduction of a multi- storey car park. A multi-storey car park is a building (or part thereof) which is designed specifically to be for automobile parking and where there are a number of floors or levels on which parking takes place. It is essentially a stacked car park. Multi-storey car parks, underground or basement car parks, and car parks in a multi-function building are common. Often, visitors gain their first impressions of a town from its car park, as this may be the first building with which they come into contact. The inferences are obvious. Although multi-storey car parks are mainly found in city and town centres, they also feature in airports, retail centres, conference centres, hotels, housing developments, places of employment (both offices and factories), places of entertainment, railway stations, and sports facilities. A good number of disastrous events may ensue from incessant parking along the roadside due to unavailability of proper parking facility (Monyei, 2018). Issues arising could include traffic congestion, accidents from vehicles running into stationery vehicles, fire outbreaks and also terrorist's targets seeing parked vehicles around populated areas can be used as priming devices and places to hide explosives.

Circulation, as usually applied in architecture is the way people move through and interact with a building (Britannica Online Encyclopedia, 2021). It can also be defined as movement through space, this idea of movement through space is one of the central themes in architectural theory, design, and practice. Le Corbusier suggested that to experience architectural space truthfully, it is necessary to walk about and through the building (Le Corbusier, 1962).

Vehicle circulation routes should be logical, safe and easy to follow. The basic circulation element for a parking structure is the continuous ramp with parking on both sides of the drive aisle. In continuous ramp structures, some of the parking floors are sloped in order for traffic to circulate from one level to another. Only on a sloping site that permits direct access to each level from the exterior roadways are ramps unnecessary; but they still may be desirable for internal circulation.

The basic criteria for choosing a circulation system are the simplicity or complexity of the system and the architectural compatibility. Ingress and egress capacities are also a consideration in the selection of a circulation system. Some circulation systems provide the opportunity for level façades which may be desirable, Bharat J. et al., (2018). Studies by Chaudhury et al. (2006) and Sadatsafavi et al. (2016) highlight the importance of a parking ramp slope of 5% or less is preferred, although parking ramp slopes up to 7% are tolerated by the public in very dense urban areas. Parking ramp slopes should not exceed a 6.67% slope, which is the maximum parking slope permitted in the International Building Code (IBC). The acceptable ramp slope must also conform to the current City Building Code. Parking layouts are either inhibited or uninhibited depending on the influence that other disciplines have upon them. An inhibited layout is where parking has to fit between a predetermined disposition of vertical services and structure, such as the basement car park of a building. In such situations, designers have little opportunity to develop a fully effective layout and must do the best that they can. An 'uninhibited' layout is one where the designer has a 'clean slate' on which to work; where the only limiting factors are those of static capacity and the dimensional restrictions imposed by the site.

Security, or the lack of it within some car parks, is a major issue with the parking public. The statistics indicate, however, that personal danger is more perceived than actual. Feelings of insecurity can be engendered when walking through a dimly lit car park late at night not dissimilar to those developed when walking through, say, a dark street on a dull evening. The actual danger is minimal, but the perceived danger creates fears that, if not allayed, could result in the car park being shunned by many motorists. The advent of CCTV has seen a great leap forward in car park security. However, it cannot see around bends or corners. Curvi-linear or circular aisles are restricted in this respect. More curves mean more cameras, more screens, more staffs and more expenses. Feelings of security are also enhanced by a reduction of internal vertical structure.

Structures spanning clear over each column are preferable to those where columns and shear walls are located adjacent to the aisles, behind which potential felons can lurk. It has been proven, by competitive construction over the years that properly designed clear-span structures are no more expensive to construct than those with internal columns.

Because curbs can be a potential tripping hazard, curbs in all pedestrian areas (at the end of parking rows, around stairs and elevators, dead corners, etc.) are strongly discouraged. The faces and edge of curbs that remain should be painted traffic yellow to enhance visibility. Glass-backed elevators and glass enclosed and/or open stairways, visible to the adjacent street, are highly recommended for enhanced security. Security fencing should be installed below stairwells to eliminate the possibility of a person hiding under the stairs. Lighting that enables users to see and be seen is one of the most important security features of a parking structure.

Other important aspects of security design outlines that Short span construction is not recommended. In short span construction, the columns are placed more closely together; thereby adding additional obstructions to lines of sight; Security fencing at the ground level should not be climbable. Security fencing ensures pedestrians enter/exit the facility only at designated pedestrian points; Landscaping should not provide hiding places; Security cameras are a deterrent to criminal activity; Panic alarms and two-way communication systems are recommended in prominent locations on each level. In general, assure that as much openness as possible is provided in the design to improve sight lines, eliminate hiding places, and enhance perceived security.

Carmona (2002) connote that circulation is the most vital aspect of planning and designing of any public building, pointing out that the identification and analysis of a traffic pattern in a multilevel car park is very necessary. Not to be overlooked, it is the role that good architectural and interior design can play in enhancing efficiency within the centre. Human circulation within the interior and exterior of a public building if not properly organized tend not only to create a disorder state but also endanger human lives, especially when there is conflict with vehicular circulation (Tylor & Spicer, 2007). He further opined that the circulation of vehicles within a public building is a major concern as a failure to achieve proper resolution of the movement of vehicles will hamper efficiency. Devies et al, (2008) stated that spatial planning in architectural design is the creation of functional layouts or sequences of rooms or spaces as required by the brief.

Efficiency in a multilevel car park relates to the seamless flow of both vehicles and users. The efficient utilization of space, time, and resources is pivotal in creating a user-friendly experience. In South Eastern Nigeria, where congested urban centers are common, efficient parking solutions can significantly reduce traffic congestion and frustration among users.

Circulation design within multilevel car parks dictates the movement of vehicles and pedestrians within the facility, Dandrige et al, 2001). It involves considerations such as the layout of parking bays, traffic flow, entry and exit points, and pathways for pedestrians. Proper circulation design not only enhances the ease of use but also contributes to the overall safety and efficiency of the parking structure, (Lawson B et al, 2011).

This article seeks to delve into the intricate relationship between security, efficiency, and circulation in the design of multilevel car parks in South Eastern Nigeria. It aims to provide a comprehensive understanding of the parameters that underpin a functional car park within this specific regional context. The findings of this research can guide architects, urban planners, and policymakers in developing innovative solutions that cater to the unique needs and challenges of the region.

The study will employ a mixed-method research approach, combining qualitative data collection through interviews and surveys with quantitative analysis using traffic flow simulations and statistical modeling. By doing so, it aims to offer practical recommendations and insights that are not only academically valuable but also applicable in the real-world context of urban development in South Eastern Nigeria. The subsequent sections of this article will provide an in-depth exploration of the various parameters related to security, efficiency, and circulation, culminating in a comprehensive framework for designing functional multilevel car parks in the region.

Aim

The aim of this paper is to carefully investigate and describe the vital parameters for designing a secured, efficient, and well-circulated multilevel car parks in South Eastern part of Nigeria. As well as providing a valuable insights and recommendations for urbanization in this region.

RESEARCH METHOD

In this study, on "Security Efficiency and Circulation: Parameters for a Functional Multilevel Car Park Design in South Eastern Nigeria," a qualitative approach combining case studies and literature review was employed. The case studies will involved an in-depth examination of existing multilevel car parks, focusing on their design, security features, and circulation patterns. Through on-site observations, interviews with stakeholders, and analysis of relevant documentation, a nuanced understanding of the strengths and weaknesses of current designs was obtained. The literature review delved into scholarly works, industry publications, and best practices in multilevel car park design, emphasizing security considerations and efficient circulation.

FINDINGS

The MTN head office multi-storey car park located at Falomo, ikoyi Lagos is owned by the MTN Communication Network Head Office in Lagos, built by ACCL architects in the year 2007. The multi-storey car park is within the environs of the Lagos State Waterways Authority head office, just by the lagoon. It consists of seven floors, having the roof top as an open air bar and event center. Each floor of the multi-storey car park is designed to accommodate about 90 cars parked conveniently.

At every level and on every floor, there are sprinklers which line up the entire soffit. Each floor has rows of fire-sprinkler water-piping running its entire length at equal Spacing. The sprinkler discharge outlets are fitted to the pipes at regular intervals of about four meters spacing. Along with the sprinklers are various fire alarm points are fitted at the entrances to the stairwell.

Plate 1: showing the slide elevation view of the MTN head office multilevel car park, Lagos.
Source: Ezepue, (Retrieved October 20th, 2023)

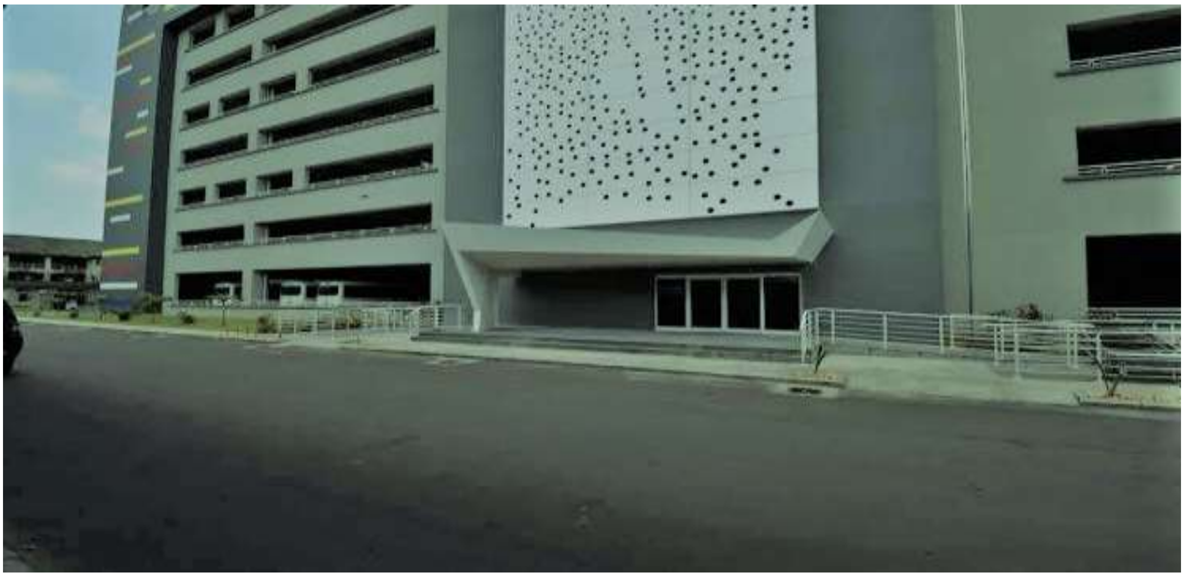

Plate 2: showing the approach view of the MTN head office multilevel car park, Lagos.
Source: Ezepue, (Retrieved October 20th, 2023)

The zenith bank multi level parking facility located at Victoria Island Lagos is owned by the zenith bank plc with a number of five floors. The multi-storey car park is located directly opposite the Zenith Bank on Victoria Island, Lagos.

The multi-storey car park utilizes a split level ramp system in its design consisting basically of four floors, with the fifth also designated for parking. The entire structure is basically concrete and steel, having its structural frame in steel sections and the floors of precast concrete.

The main frame work of the multi-storey car park is built in steel sections. Other features such as the floors, stairwell etc. is in concrete, though the steel is the dominant construction material. The stairwells

are located at the corners of the structure. The stair system is the continuous dogleg revolving around a central load bearing core wall. The stairwells are open to the air, having hollow tubular steel baluster.
The entire structure is designed to have fire safety features. Along the steel stanchions are fire hydrants attached for high pressure water supply in the case of a fire outbreak. The stairwells are also well distributed for this reason.

Plate 3: showing the approach view, Zenith Bank Multi Level Parking, Lagos.
Source: Ezepue, (Retrieved October 20th, 2023).

Plate 4: showing the side view, Zenith Bank Multi Level Parking, Lagos.
Source: Ezepue, (Retrieved October 20th, 2023).

During the research conducted at the multi storey car parks at Lagos as aforementioned, the following findings were noted:

Security Measures:

- Observation of security measures in the existing multilevel car parks revealed varying levels of security infrastructure.
- Security checkpoints were present at the entrances, but the effectiveness of these measures varied.
- Surveillance systems, such as CCTV cameras, were widely deployed, but their maintenance and coverage were inconsistent.
- Security personnel were present in some facilities, but their visibility and responsiveness were not uniform across all car parks.

Efficiency and Space Utilization:

- Parking bay layouts were found to be diverse, with some facilities employing angled parking, while others utilized perpendicular parking.
- A few car parks had effective traffic flow design, including features like one-way lanes and clear signage that enabled a smoother parking experience. Due to insufficient space use and inadequate traffic flow design, several facilities were congested and inefficient.

Circulation and Pedestrian Access:

- Observations showed that, there were differences in the pedestrians access within the multilevel car park. Some had designated pedestrian zones, while others had an unclear and unsafe pedestrian zones.
- The availability of stairwells, escalators, and elevators to facilitate user mobility varied from one facility to another.
- It was also observed that, the parking structures traffic patterns and organization affected the overall circulation and ease of accessibility.

User Preferences and Regional Considerations:

- Users' feedback indicated their preferences which includes, shaded packing areas, and locations close to shops and markets.

- Improved mobility and accessibility were requested by users in multilevel car parks.

Maintenance and Cleanliness:

- There were variation in the standard of maintenance, certain car parks showed better levels of cleanliness and upkeep.

- It was shown that better user experiences were associated with proper maintenance.

CONCLUSION

This article explores the design and operation of multilevel car parks in South Eastern Nigeria, it offers valuable insights for architects, urban planners, and policymakers. The studies suggests a multifaceted approach, including security checkpoints, surveillance systems, lighting, and security personnel, to improve functionality and user experience. These elements not only protect vehicles but also play a key role in the overall safety and security, a crucial consideration in the region.

However, in South Eastern Nigeria, efficient multilevel car park design is important for user satisfaction and minimizing congestion especially in public areas, such as markets, churches and even offices. The design should integrate user-friendly features and technological solutions, that ensures the safe movement of vehicles and pedestrians. Also understanding unique cultural and regional factors can inform the design and management of multilevel car parks.

Furthermore, future design of multilevel car parks in South Eastern Nigeria should consider security, efficiency, circulation, and user preferences. Moreover, this holistic approach can enhance urban infrastructure, traffic management, and overall well-being the residents. By addressing the parameters of security, efficiency, and circulation, functional multilevel car parks can cater to the region's dynamic needs and enhance the quality of living for urban inhabitants.

RECOMMENDATIONS

From our research findings and the detailed exploration of parameters for an effective multilevel car park design in South Eastern Nigeria. We deduced the following recommendations to assist in the design, management, and improvement of multilevel car parks in the area. We recommend that

1. A holistic approach which considers the relationship between security, circulation and efficiency should be encouraged. Considering the fact that, if you address an aspect and leaving out others can lead to suboptimal results. Integration planning is the key.

2. Multilevel car parks should implement security measures such as surveillance cameras, constant security personnel and lighting. They should also maintain and update their security infrastructure regularly to ensure its efficiency. Also to ensure secured access points, placement of security checkpoints should be considered.

3. Traffic flow design helps to minimize congestion and also enhance user satisfaction. Clear signage, one-way lanes and user – friendly technologies plays a significant role to help achieve this goal. The efficient use of space should be prioritized within the multilevel car parks, this is through well – planned parking bay layouts.

4. The layout and traffic direction should be considered within the facility to avoid bottlenecks. Also to ensure a safe and seamless movement of within the multilevel car parks clear pathways and designated zones for pedestrians and vehicles.

5. User-friendly features such as mobile apps should be created for finding available spaces or reservations and also to enhance overall user experience. User preferences should be responded to by providing shaded parking areas and convenient access to local amenities from the car park.

6. Regular maintenance schedules should be enforced to keep multilevel car parks clean and well maintained. This is because, a clean environment contributes to user safety and satisfaction.

7. Users should be educated on proper parking etiquette, safety measures and traffic flow using user-friendly instructions and through signage in multilevel car parks.

8. Due to the evolving regional and cultural factors peculiar to South Eastern Nigeria, continuous assess and adapt for multilevel car park designs should be done.

9. To ensure that that the urban development goals align with designs, collaborations should be fostered among urban planners, architects, local authorities and stakeholders in the development and management of multilevel car parks.

10. Periodical evaluation of the users satisfaction and functions of the multilevel car parks through performance assessment and periodical evaluation. This is done to make improvement based on the responses gotten..

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