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Rethinking Urban Mobility Through Public Parking Facilities in Yaounde : A Case Study of Mokolo, Yaounde

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Abstract: The article highlights the necessity for sustainable urban mobility solutions in Yaounde, driven by rapid urbanization and increasing vehicle ownership. It presents a case study of a multi-storey public parking facility in the Mokolo neighborhood, aimed at alleviating traffic congestion and addressing unregulated roadside parking. This facility will incorporate mixed-use programming, advanced parking technologies, and a design inspired by traditional Cameroonian baskets. It will feature a "clando" transit station, 120 parking spaces on the ground and first floors, 700 spaces for private vehicles on the upper levels, commercial units, rooftop recreational areas, and infrastructure for electric vehicles (EVs). An economic analysis suggests a viable return on investment within 29 years, while impact assessments indicate potential reductions in congestion and contributions to sustainable development. The proposal underscores the crucial role of well-designed parking facilities in enhancing mobility and revitalizing urban landscapes, with recommendations for adaptability in other cities across Cameroon and Sub-Saharan Africa.

Keywords: *Urban Mobility, Public Parking, Sustainable Architecture, Transport Planning, Multistorey Parking.*

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I. INTRODUCTION

Over half of the world's population resides in urban areas, creating significant mobility challenges. (UN-Habitat, 2020). The United Nations projects that the global urban population will rise to approximately 6.68 billion by 2050, with 15.9 % living in urban areas by 2030, increasing to 22.3 % by mid-century. Africa is increasingly influential in this demographic shift. This urbanization is driving challenges such as congestion and pressure on transport infrastructure, while global car ownership grows rapidly. The vehicle fleet grew from about 98 million in 1960 to nearly 1.5 billion in 2019, with forecasts predicting it could reach 2.5 billion by 2050, according to the International Transport Forum. Africa saw a 32 % increase in motorization from 2015 to 2020, even though its per capita vehicle ownership is still below the global average. Effective parking management is crucial for enhancing accessibility and alleviating congestion (UN, 2020). Yaounde, the capital of Cameroon, is not exempt from this global issue, as it continues to face mounting mobility constraints that necessitate strategic parking solutions integrated into broader sustainable urban planning.

This article presents the various findings of our study, specifically, it highlights the outcomes of the research conducted. First, we will present the analysis of urban mobility challenges in Yaounde, focusing on traffic congestion, roadside parking issues, and overall parking demand in Mokolo. Next, we will outline the site evaluation and selection criteria, which guided the choice of a location for the proposed multi-storey public parking facility. This will be followed by the conceptual design approach, detailing the key architectural, structural, and sustainability principles integrated into the project. Finally, we will present the impact assessment report, evaluating the facility's potential contributions to traffic flow improvement, urban integration, and sustainable mobility in Mokolo, Yaounde.

II. OVERVIEW OF THE URBAN MOBILITY LANSCAPE AND PARKING SITUATION IN YAOUNDE

According to (Ndzana, 2019), the city of Yaounde has approximately 4 million inhabitants and this population should reach 5.6 million by 2035 as shown in **Figure 1**

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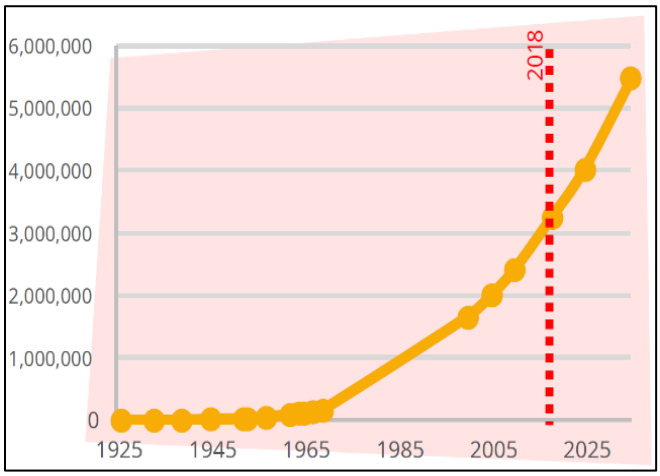

Fig 1 Demographic Evolution of Yaounde
(Source: Ndzana, 2019)

A significant issue posed by the swiftly increasing population in Yaounde is the difficulties related to mobility.

The urban mobility landscape in Yaounde is characterized by a reliance on collective taxis and motorcycle taxis, which are often irregular and provide varying levels of comfort. Private car users face significant congestion, leading to increased travel times **Figure 2,** and fuel consumption. Many residents are also compelled to walk long distances on uncomfortable or non-existent sidewalks. The current mobility system is economically inefficient, with high costs for collective taxi rides.

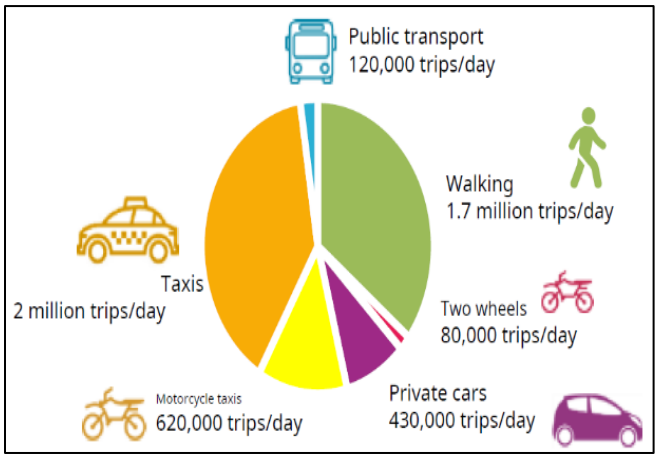

Fig 2 Number of Trips Per day in the City of Yaounde
(Source: Ndzana, 2019)

The urban mobility landscape in Yaounde reflects several critical challenges and characteristics:

➢ *Pedestrian Mobility*

Pedestrian mobility in Yaounde is significantly impacted by various factors that contribute to safety concerns and overall walkability. Walking is a primary mode of transport in the city, accounting for nearly 35 % of daily trips. However, the infrastructure for pedestrians is inadequate, with a lack of proper sidewalks, unsafe pedestrian facilities, and chaotic traffic conditions posing major threats to safety, as shown in **Figure 3.**

Fig 3 Pedestrian Path Obstruction

➢ *Present Public Parking Solutions in the City of Yaounde*

Public parking in Yaounde is primarily done along roadsides, with designated spaces marked by council officials to serve as parking, as shown in **Figure 4**. However, this parking system often leads to traffic congestion and challenges in urban mobility. Due to insufficient designated parking facilities, many drivers frequently park on major roads, intersections, and pedestrian walkways, as shown in **Figure 4** and **Figure 5**. This behavior reduces road capacity and disrupts traffic flow. Parking attendants from the local councils supervise these areas, charging fees for parking and providing a receipt.

Fig 4 Legal Parking Slots at a Junction

(a)

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(b)

Fig 5 (a) Illegal Parking on a Secondary Road, (b) Legal Parking Slots on Pedestrian Paths

In Yaounde, the lack of sufficient parking facilities forces many drivers to park illegally along roadsides, intersections, and even pedestrian walkways. As a result, city council officials strictly enforce parking regulations by sealing improperly parked vehicles, as shown in **Figure 6**. When a driver parks in an unauthorized location, officials use metal clamps or wheel locks to immobilize the vehicle, preventing its movement until fines are paid. This enforcement measure is intended to reduce congestion, maintain order, and discourage illegal parking, but it often frustrates motorists who struggle to find legal parking spaces. The situation highlights the urgent need for more structured parking solutions, such as multi-storey parking facilities, to accommodate the growing number of vehicles and ease roadside congestion.

Fig 6 Regulatory Applications for Illegal Parking

III. EXISTING POLICY AND PLANS FOR URBAN DEVELOPMENT IN YAOUNDE

Yaounde, the capital of Cameroon, has implemented various policies and plans to guide its urban development and address challenges associated with rapid urbanization.

An exemplary strategic initiative aimed at enhancing urban mobility in Yaounde is the **Yaounde Sustainable Urban Mobility Plan (SUMP)**, which was established in **2020** by the **Yaounde City Council** in collaboration with external organizations, including the **European Commission and the French Development Agency (AFD).**

This plan was developed with the support of international organizations, including the European Commission and the French Development Agency. The Sustainable Urban Mobility Plan (SUMP) aims to enhance urban mobility by promoting public transportation, improving pedestrian infrastructure, and alleviating traffic congestion. It outlines strategies for integrating various modes of transport and optimizing traffic management systems. The Sustainable Urban Mobility Plan for Yaounde indicates that the current average travel time in Cameroon is 29 minutes, and it is expected to rise to 58 minutes by 2035 if there are no improvements in mobility conditions.

The strategies proposed to resolve the mobility challenges in Yaounde focus on improving traffic flow, enhancing public transport, and making walking safer.

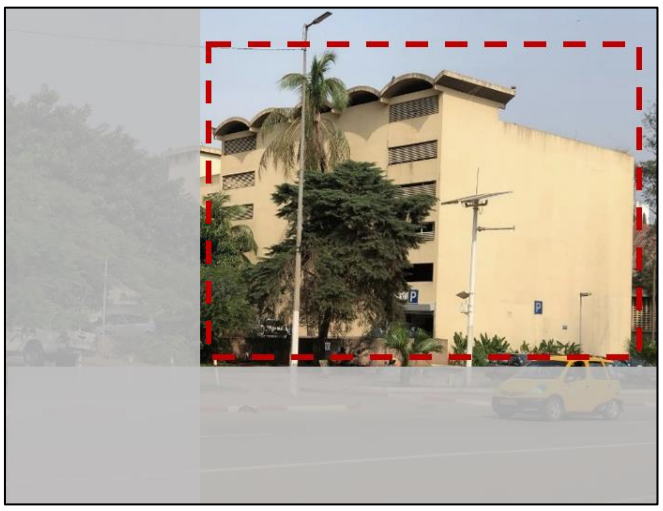

Fig 9 Multistorey Parking Facility, First Ministerial Building, Yaounde

This facility is an important case study for assessing the effectiveness of multi-story parking structures in Yaounde. By analyzing its strengths and limitations, we can gain insights into its impact on urban mobility and identify key lessons for future parking infrastructure development in the city of Yaounde.

➢ *Strengths*

- The facility provides 400 parking spaces, significantly reducing the demand for roadside parking in the central administrative district.
- The facility includes clear signage, such as speed limits (10 km/h), directional indicators, and parking space numbers, ensuring smooth navigation and reducing accidents.
- Situated in the heart of the administrative district, the parking facility is highly convenient for government employees and visitors, reducing unnecessary vehicle circulation in search of parking.
- Being a government facility, the parking area benefits from round-the-clock security, providing safety for both vehicles and users.

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➢ *Limitations*

Despite offering 400 spaces, the demand for parking in the area far exceeds the available capacity, leading to persistent parking issues and overspill into nearby streets.

The facility primarily serves government employees and official visitors, limiting its accessibility to the general public and failing to address broader parking challenges in Yaounde.

- The facility does not incorporate modern parking solutions such as real-time occupancy monitoring, automated ticketing, or digital payment options, which could improve efficiency and help with maintenance.
- While the facility has one entry and two exits, congestion still occurs during peak hours, particularly due to the high volume of vehicles accessing the limited parking spots.

IV. PRESENTATION OF OUR CASE STUDY AREA

Mokolo is a vital commercial hub in Yaounde, with its market officially subdivided into seven sectors, each specializing in different types of merchandise and services. These include sections for foodstuffs, clothing, electronics, small trades, books and stationery, as well as meat and fish products. The market is managed by elected representatives and overseen by municipal officials to ensure organized operations **Figure 10** shows our case study area in Mokolo, relative to our selected site.

Fig 10 Mokolo Case Study Area Delimitation
(source: Google Earth Pro)

➢ *Analysis of Current Mobility in Mokolo, Yaounde*

Mokolo, one of the most densely populated and commercially active districts of Yaounde, faces significant urban mobility challenges. The area is characterized by high pedestrian and vehicular traffic, some narrow roads, informal street vending, and inadequate parking facilities.

- *Traffic Congestion*

This congestion is primarily driven by the high volume of private vehicles, taxis, motorcycles, and "wheelbarrow pushers," which serve as the primary modes of transport for users and goods in the commercial district, as shown in **Figure 11**. This is also because Mokolo links several areas of Yaounde, such as Messa, Tsinga, and Briquiterie.

Fig 11 Traffic Congestion in Mokolo

- *Public Transport and Motorized Mobility*

Public transport in Mokolo is largely dominated by taxis, motorcycle taxis, and minibuses. Motorcycle taxis offer flexible and fast mobility solutions, but they also pose traffic hazards due to reckless driving and insufficient regulation. The presence of designated public transport vehicles locally called "clando" stops in several areas of Mokolo forces vehicles to stop randomly, leading to further disruptions in traffic flow, as shown in **Figure 12**.

Fig 12 Public Transport Parking Points in Mokolo

- *Pedestrian Mobility and Safety*

In Mokolo, getting around on foot can be quite a challenge. The sidewalks, often bustling with street vendors, parked and mobile vehicles, are so overcrowded that pedestrians find it difficult to navigate safely, as shown in **Figure 13**. This vibrant street life, while full of energy, limits mobility for those trying to walk through the area. This forces pedestrians onto the roads, increasing the risk of accidents. The lack of pedestrian-friendly infrastructure, such as footbridges and protected walkways, makes walking in the area unsafe, particularly for vulnerable groups such as children and the elderly.

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Fig 13 Pedestrian Path Invasion by Vendors and Vehicles in Mokolo

- *Parking and Roadside Encroachment*

One of the most critical urban mobility issues in Mokolo is the shortage of parking spaces. Roadside parking is common, with vehicles occupying both formal parking spaces designated by council officials and informal parking spots along major streets. In addition, the presence of unregulated street vending further encroaches on available road space, leaving limited room for vehicular circulation. This situation results in frequent traffic standstills and conflicts between drivers, traders, and pedestrians, as shown in **Figure 14**.

Fig 14 Parking Situation in Mokolo

➢ *Site Presentation*

Our chosen location, as shown in **Figure 15**, is the existing "Gare Routière Ouest" in Mokolo, which has a surface area of **4949 m².** This bus station, managed by the Yaounde 2 council, has been operational since 1995 in the Mokolo district. The area buzzes with activities, featuring a mix of people, travelers, vehicles, motorcycles, and "wheelbarrows", all contributing to a dynamic atmosphere. Nearby galleries, housing various commercial activities, further enrich the scene as travelers await their departures.

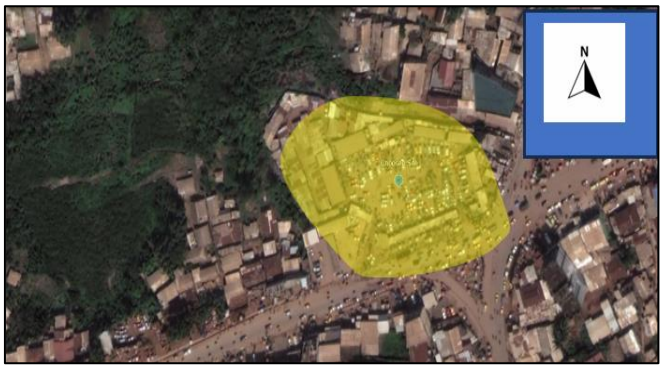

Fig 15 Site Location
(Source: Google Earth)

➢ *Justification of Choice of Site*

We were based on the following criteria for selecting the "Gare Routière Ouest" (Western Bus Station) of Mokolo as the site for our multi-storey public parking facility:

- *Accessibility*:

The "Gare Routière Ouest" occupies a strategic position with excellent connectivity to major arterial roads, including the road to Nkolbisson, Avenue Ahmadou Ahidjo, and Elig-Effa. This location already functions as a transport hub, making it an intuitive destination for drivers and naturally integrating with existing traffic patterns. The site's established role in Yaounde's transportation network would ensure immediate familiarity for users.

- *Traffic Flow and Congestion Levels:*

This area experiences significant daily congestion due to the convergence of intercity buses, taxis, and private vehicles. Current informal parking arrangements around the bus station contribute substantially to traffic bottlenecks. A structured parking facility here would directly address existing congestion problems by organizing vehicle storage more efficiently at a known congestion hotspot.

- *Land Availability and Zoning Regulations:*

The Western Bus Station area likely already has appropriate transportation and commercial zoning designations, potentially simplifying regulatory approval processes. The existing transportation use creates a compelling planning argument for intensifying and improving transportation infrastructure at this location.

- *Environmental and Social Impact:*

Repurposing this already-developed transportation site to include private vehicle parking options minimizes new environmental disruption compared to developing green spaces. The community already accepts transportation use at this location, reducing potential resistance. A well-designed public parking facility could improve pedestrian conditions by removing haphazardly parked vehicles from walkways.

- *Economic Viability:*

The consistent flow of travelers using the bus station creates a built-in customer base for parking services. The commercial activity surrounding the bus station would benefit from improved parking, creating a virtuous economic cycle.

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Additionally, travelers leaving their vehicles while carrying out their commercial activities or purchases in the market represent a source of long-term and Short-term parking revenue.

- *Security:*

As an established transportation hub, the site already has some security measures, which include a police station that could be enhanced rather than built from scratch. The continuous activity and foot traffic in the area provide natural surveillance, deterring criminal activity. The defined entry and exit points of the bus station create a logical framework for implementing controlled access to the parking facility.

This location represents an opportunity to transform an existing, sometimes chaotic transportation node into a modern, organized facility that enhances urban mobility while addressing current parking challenges in Mokolo.

➢ *Location and Context*

- *Geographic Location*

The proposed multi-storey public parking facility will be located at the "Gare Routière Ouest" (Western Bus Station) in Mokolo, Yaounde, Cameroon, **Figure 16,** about 3.5 kilometres from the city centre. This strategic site connects the busy commercial district with residential neighbourhoods and is close to major roads, enhancing access to the broader transportation network.

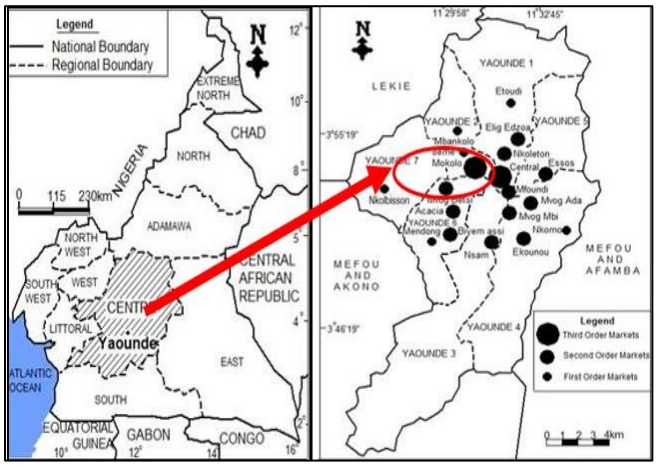

Fig 16 Geographical Location of the Mokolo District

- *Surrounding Environment*

Our site features a dynamic commercial and transportation landscape. To the east lies the bustling Mokolo Market, while various commercial activities are located to the west. The site includes high-traffic corridors to the south and residential neighborhoods to the north.

- *Security context*

The location features security measures, including a police station and some municipal authorities **Figure 17** to oversee the activities of the park. The constant flow of activity and pedestrian traffic in the vicinity offers natural oversight, discouraging unlawful behavior. Marked entry and exit points of the bus park provide a sensible structure for introducing regulated access to the parking facility.

Fig 17 "Gare Routiere-Yaounde Ouest" Administrative Building

➢ *Social and Cultural Analysis*

- *Social Context*

Our selected site, which currently serves as a transportation hub, features several commercial activities such as food and drink sales, **Figure 18,** which reinforce social connections between users.


Fig 18 Commercial Activities on Our Selected Site

- *Cultural Context*

Our chosen site, located in a major commercial district of Yaounde, consists of individuals from various tribes of Cameroon, who either come to carry out their business activities, travel, or make purchases.

➢ *Environmental Analysis*

- *Climate Analysis*

Yaounde experiences an equatorial climate. Its geographical position results in a unique climate known as the "transition type," which features four seasons of varying lengths: a lengthy dry season from December to February; a brief rainy season from March to June; a short dry season from July to August; and an extended rainy season from September to November. The maximum and minimum temperatures are shown in **Figure 19**, with highs reaching 33 ºC in February and lows dropping to 16 ºC in July, August, and November. The average annual temperature ranges from 20 ºC to 25 ºC. Rainfall in Yaounde is inconsistent and plentiful, averaging 1,700 mm per year. Over the last decade, rainfall patterns have varied, with fluctuations between years of deficit and surplus due to climate change.

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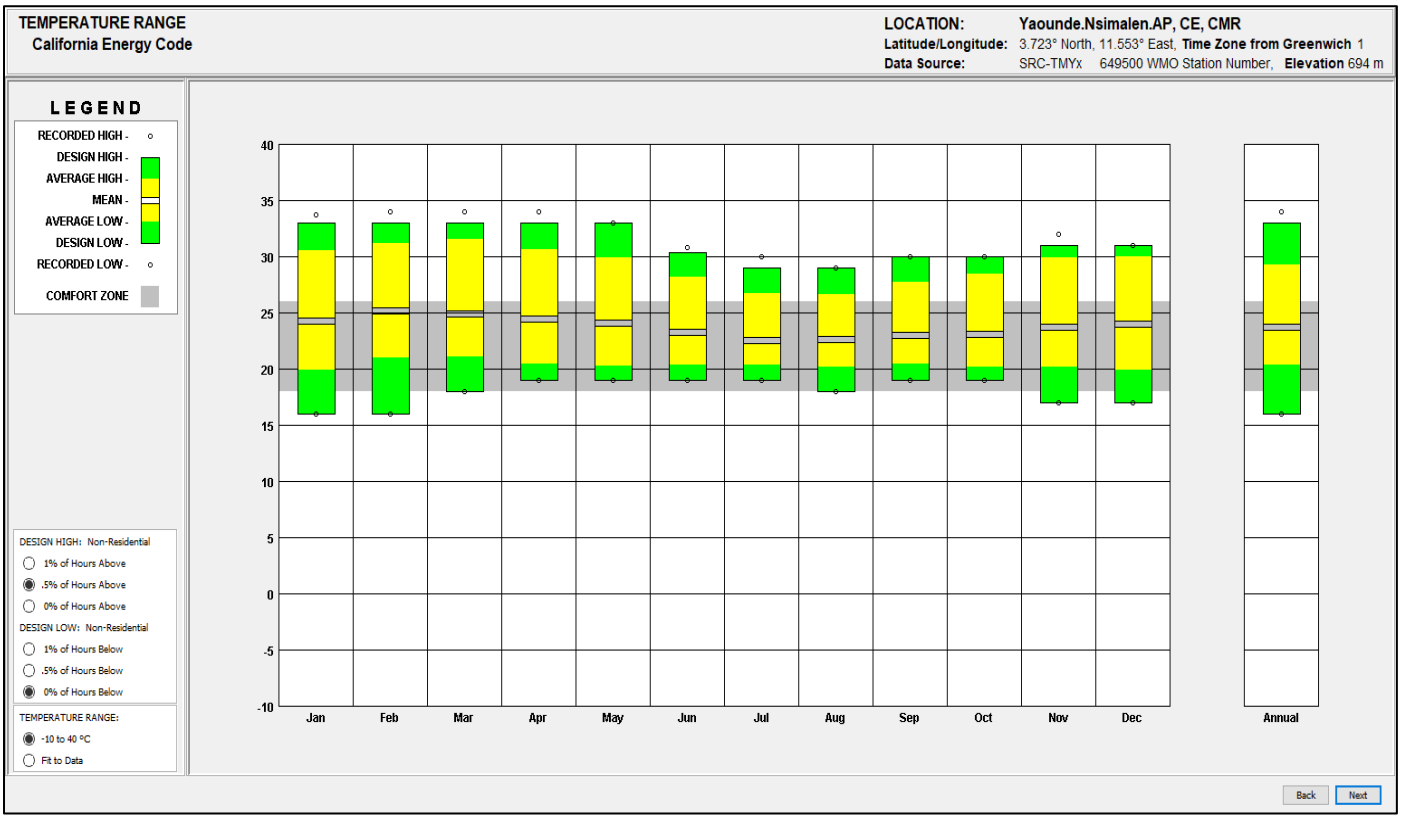

Fig 19 Maximum and Minimum Temperatures in Yaounde (Climate Consultant)

The average humidity is 80%, fluctuating between 35% and 98% throughout the day. Humid winds often come from the southwest. The strong winds depicted in **Figure 20** also originate from the southwest. Solar radiation levels range from 360 to 400 w/m²/h.

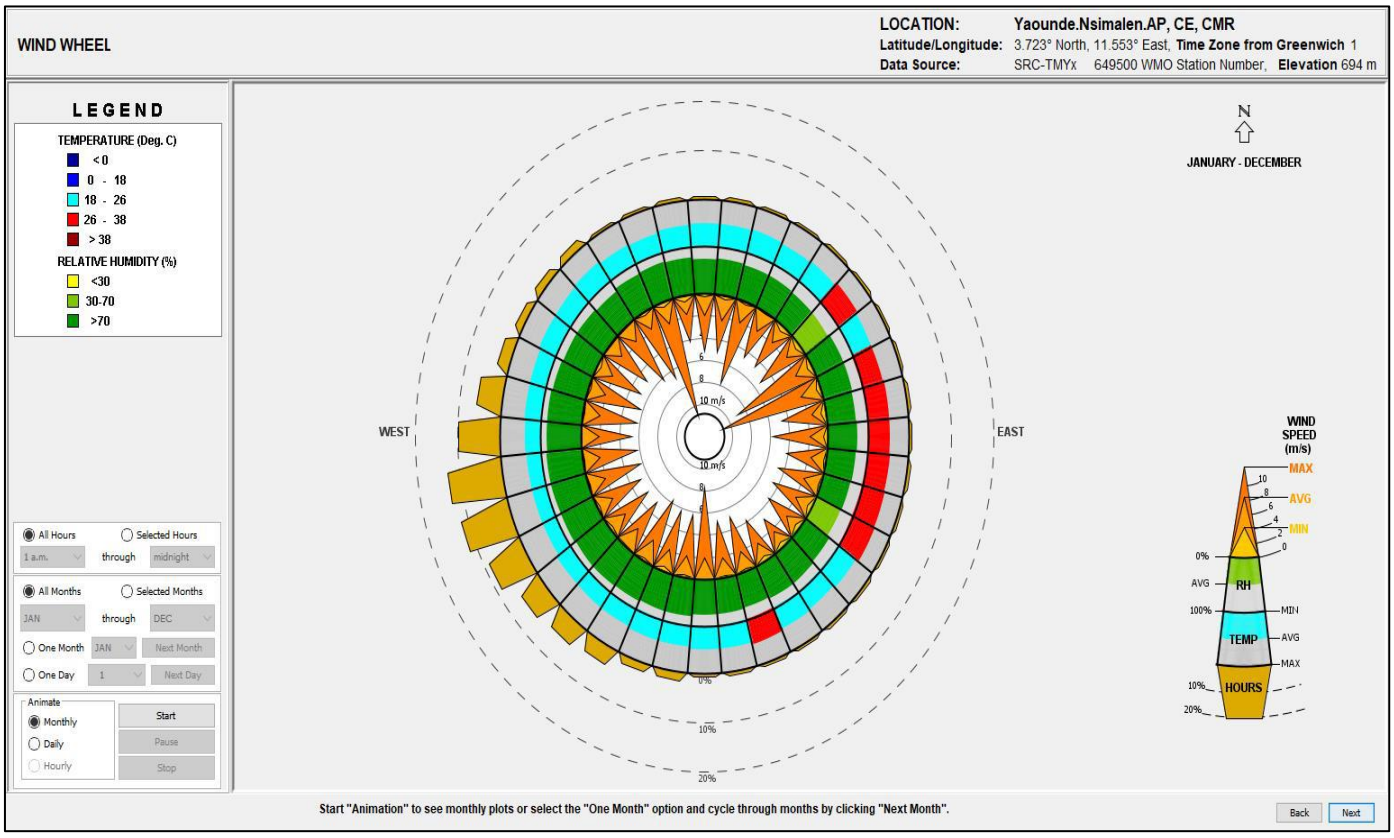

Fig 20 Wind Directions in Yaounde (Climate Consultant)

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- *Topography Analysis*

The site has a relatively level terrain, as shown in **Figure 21**, offers favorable construction conditions, and minimizes site preparation costs.

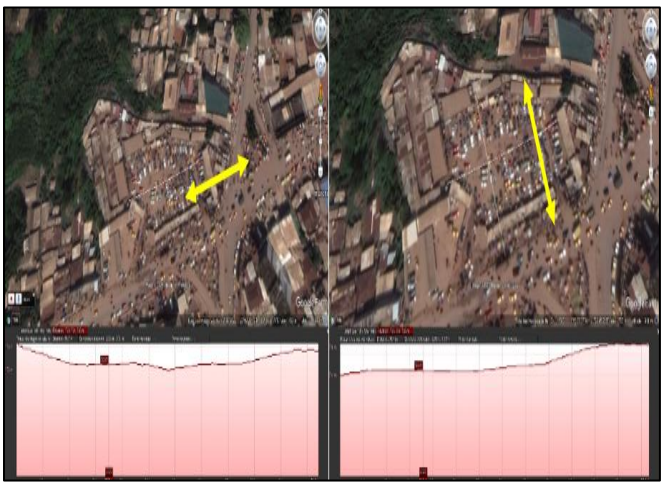

Fig 21 Site Topography Analysis on Google Earth Pro

- *Natural features*

The selected site serves as an urban transportation hub, limiting natural features in its immediate vicinity. However, the surrounding areas include vegetation and a river located approximately 50 m from our site, as shown in **Figure 22**.

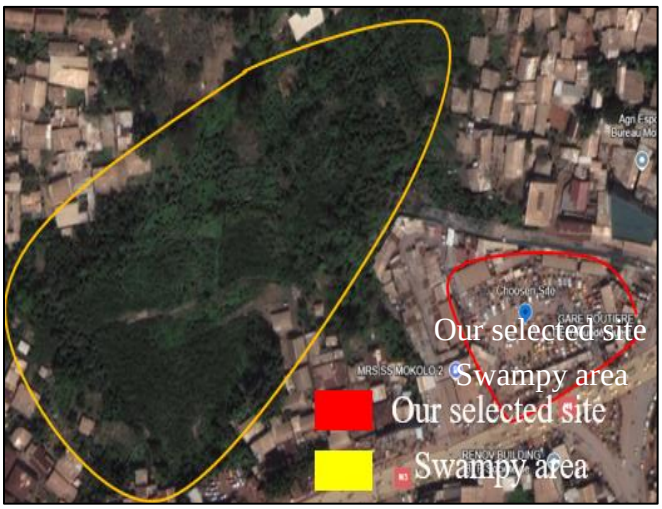

Fig 22 Vegetation Location from our Site

➢ *Accessibility*

- *Traffic Flow*

The "Gare Routière Ouest in Mokolo, Yaounde" experiences severe congestion daily due to the convergence of intercity taxis and the limited space available for their transport activities. The lack of a structured parking organization exacerbates the situation, as informal parking arrangements block lanes and disrupt traffic flow. The park has 1 entry and 1 exit with 1 major road for the circulation of vehicles, **Figure 23,** which is insufficient regarding the number of vehicles accommodated by the site. **Figure 24** illustrates the traffic flow at the "Gare Routière Ouest in Mokolo, Yaounde".

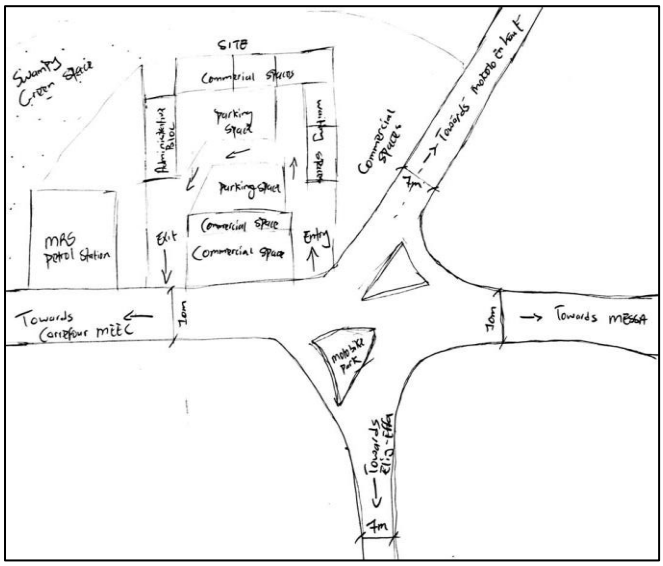

Fig 23 Hand Sketch Realized on Site to Indicate the Traffic flow and Other Activities on our Site and its Surroundings

Fig 24 Traffic Flow at the "Gare Routiere Ouest - Mokolo"

V. PROJECT PROCESS

This section outlines the design process for the proposed multi-storey public parking facility in Mokolo, Yaounde, developed to address the urban mobility challenges identified in earlier chapters. Mokolo is one of the most congested and commercially active zones in Yaoundé, where unregulated roadside parking contributes to traffic congestion, limited pedestrian flow, and visual disorder.

The project aims to provide a functional, sustainable, and responsive parking structure that not only addresses the need for organized vehicle storage but also enhances the urban environment and promotes sustainable urban mobility.

➢ *Analysis*

The analysis phase forms the foundation of the architectural design process for the proposed multi-storey public parking facility in Mokolo, Yaounde. Based on the methodology defined in Chapter 2, this phase emphasizes translating contextual needs, spatial requirements, and structural realities into informed design decisions. It is organized into three main subcomponents: functional analysis, which identifies and organizes the essential uses and user

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flows within the facility; dimensional analysis, which specifies the spatial parameters according to standards and site-specific demands; and structural considerations, which assess the technical feasibility, load-bearing systems, and material strategies necessary to ensure the building's stability and long-term performance. These assessments serve as the foundation for the design. They ensure that the architecture is relevant to its surroundings and meets technical standards.

- *Functional Analysis*

The spatial organigram is a conceptual planning tool used to define and visualize the relationship between different functional zones within the parking facility. It organizes the building's components in a hierarchical and spatially coherent manner, ensuring a smooth flow of users, efficient use of space, and compliance with operational and safety standards.

The functional analysis of the proposed multi-storey public parking facility is structured through a spatial organigramme as shown in **Figure 25**, **Figure 26** and **Figure 27**, which organizes the building's various functions based on user needs, flow logic, and operational efficiency. This organized diagram illustrates the connections among various areas and activities, promoting efficient movement, distinct zoning, and maximum effectiveness.

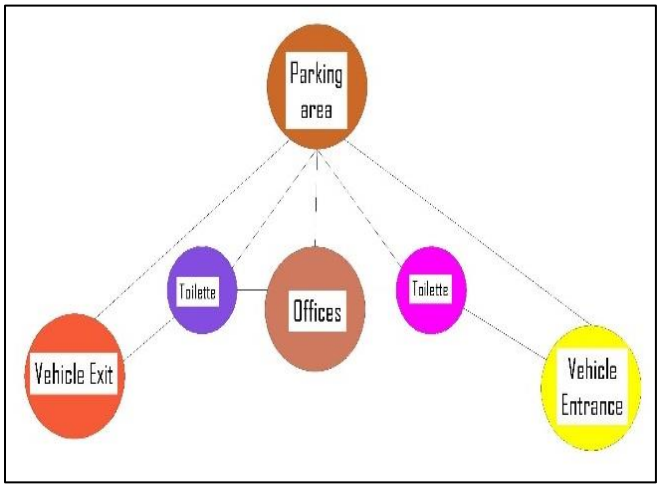

Fig 25 Ground Floor Bubble Diagram

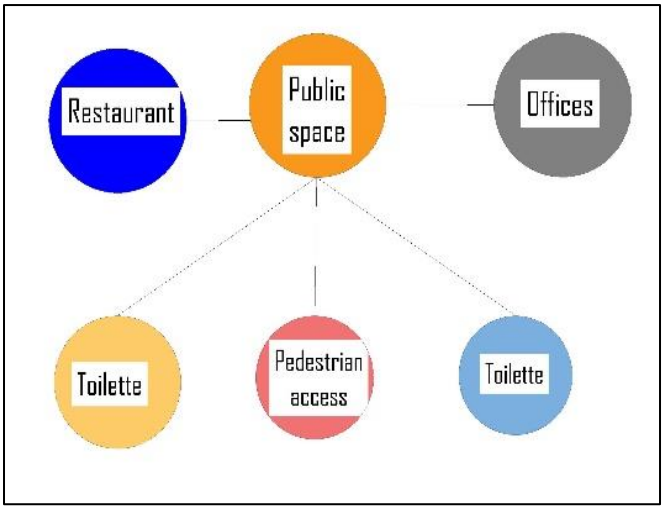

Fig 26 First Floor Bubble Diagram

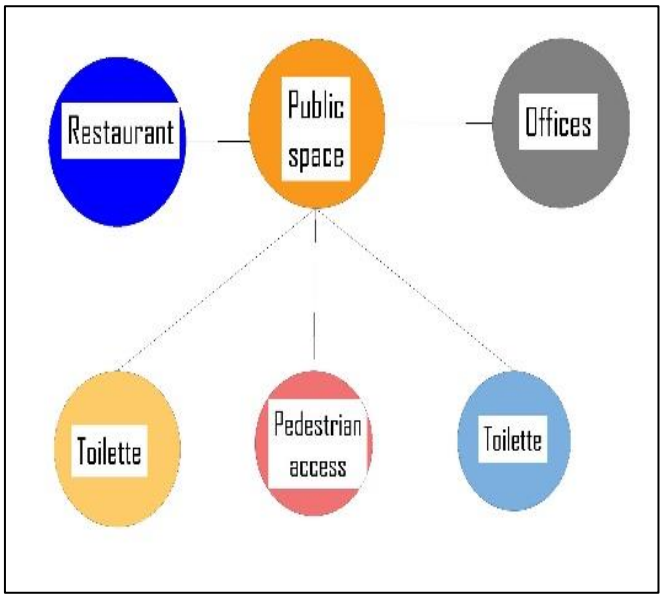

Fig 27 Roof Top Bubble Diagram

- *Dimensional Analysis*

This section outlines the key spatial dimensions considered in the design of the proposed multi-storey public parking facility in Mokolo. We aim to foster functionality, safety, and compliance with established parking standards while also thoughtfully addressing the site's constraints. The dimensions were thoughtfully determined through digital modeling and layout testing to enhance space utilization, circulation, and accessibility. The design concept for the proposed multi-storey parking facility in Mokolo, Yaounde, blends modern architecture with local cultural identity. It aims to create a striking structure that addresses functional needs while enhancing the vibrant urban landscape. By transforming the typical parking facility, it seeks to become both a practical solution for users and a cultural landmark in the area.

➢ *Idea and Generative form of the Project*

The project transforms a parking facility into a vibrant public space reflecting Mokolo's community. Its vehicle-shaped layout promotes flow, while a textured façade inspired by woven baskets highlights local commerce. A special entrance honours women's contributions to the economy. The rooftop garden, shaped like a star from the Cameroonian flag, symbolizes unity. An external staircase influenced by the Centre Pompidou enhances movement, complemented by traditional roofing and natural materials for climate responsiveness, connecting mobility with memory and community.

- *Vehicle-Inspired Floor Plan*

The facility's floor plan is shaped by the shape of cars, featuring soft curves and rotational geometry inspired by the design of automobiles, as shown in **Figure 28**. This design promotes smooth vehicle flow, minimizing sharp turns and congestion while emphasizing the building's mobility-focused purpose.

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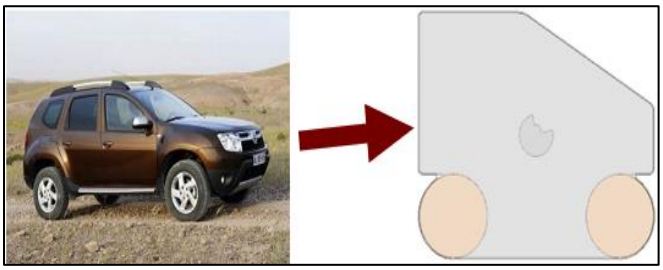

Fig 28 Building's Vehicle Shape Diagram

- *Woven Market Basket-Inspired Façade*

The building envelope draws inspiration from the traditional baskets carried by the women to the market. The façade features vertical and horizontal elements that mimic woven baskets, offering natural ventilation for parking decks while honoring local trade traditions. This weaving pattern adds aesthetic appeal and connects the structure to the community's daily life. **Figure 29** illustrates the woven façade development.

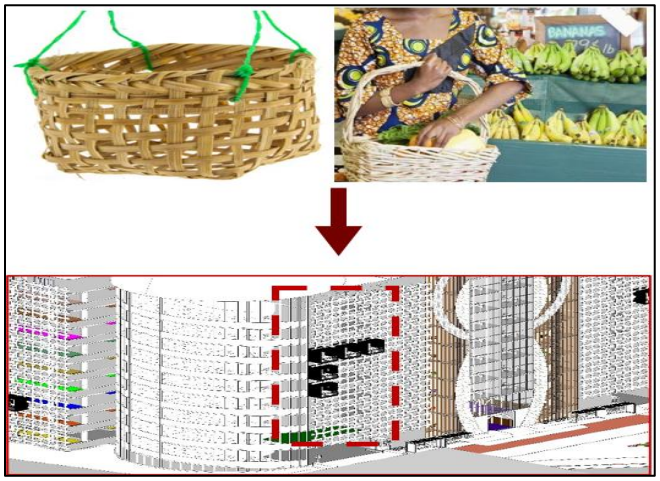

Fig 29 Woven Basket Façade

- *Symbolic Entrance – Woman Carrying a Basket*

At the pedestrian entrance, a structural form represents a woman carrying a basket on her head, **Figure 30** connecting the project to Mokolo's women, who are vital to the neighborhood's commercial and social life. This element is expressed through structural framing, resembling a woman's silhouette, serving as a cultural landmark and tribute to feminine resilience and urban contribution.

Fig 30 Woman Carrying a Basket, Symbolic Entrance

- *Star-Shaped Rooftop Garden*

The green area on the rooftop showcases the five-pointed star found in Cameroon's national flag, representing national unity and pride. as shown in **Figure 31**. It enhances the environment with vegetation and seating, providing a tranquil retreat above Mokolo's busy streets.

Fig 31 Roof Top Star Shape Representation

- *Traditional Cameroonian Roof Forms*

The design features elements inspired by traditional Cameroonian roofs, adding a touch of heritage to the modern structure as illustrated in **Figure 32**

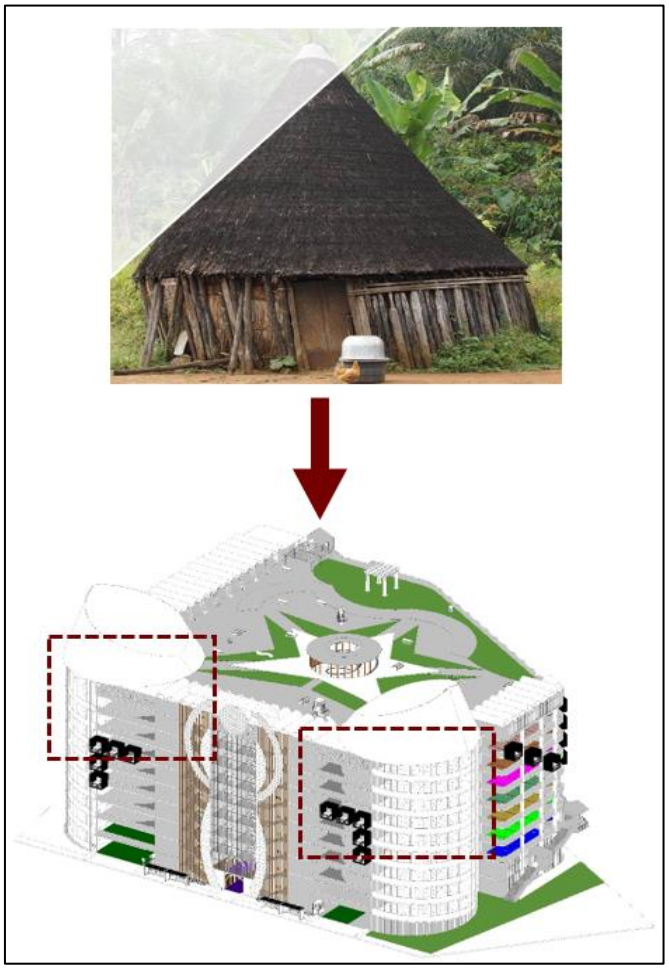

Fig 32 Traditional Roof Development Diagram

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➢ *Conceptual Approach*

The design concept of the proposed multi-storey parking facility is fundamentally inspired by the shape and dynamics of a vehicle, the very object the structure is meant to house. This symbolism serves not only as a metaphor but also performs a functional role, influencing the spatial layout, circulation patterns, and aesthetic character of the building.

The vehicle inherently embodies qualities of movement, directionality, compactness, and flow, which are reinterpreted architecturally throughout the facility. The curvilinear shapes and organic lines inspired by the contours of automobiles inform the design of circulation ramps, the fluid arrangement of parking spaces, and even the visual rhythm of the building's façade.

This conceptual approach establishes a unified design language that integrates practicality with identity. It strengthens the connection between form and function, where the spatial geometry not only supports intuitive vehicle movement but also amplifies the architectural symbolism of the project. By drawing the structure's form from that of a vehicle, the building becomes a tribute to mobility, transforming an ordinary parking area into a distinct and significant element of urban infrastructure. **Figure 33** demonstrates the progress of the structure.

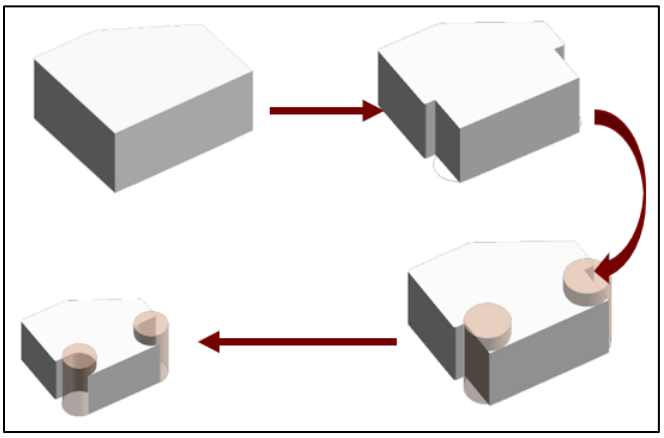

Fig 33 Building's Shape Development

➢ *Architectural and Sustainable Design Approach*

This section presents the architectural and sustainable strategies adopted for the proposed multi-storey public parking facility in Mokolo, Yaounde. Rooted in contextual awareness and sustainability principles, the design approach seeks to respond to urban mobility challenges while promoting environmental responsibility, user comfort, and architectural harmony. Through thoughtful spatial planning, material selection, passive design techniques, and integration with the urban fabric, the project aims to deliver a functional, durable, and culturally sensitive parking structure that enhances both mobility and the city's aesthetic landscape.

- *Urban Integration*

The multi-storey parking facility in Mokolo integrates seamlessly into the urban environment, addressing spatial and mobility dynamics. With high commercial activity, dense foot traffic, and intersecting transport networks, the design aligns with existing circulation patterns and access corridors.

The facility features three access points, two for vehicles with 2 vehicles entering at the same time and 2 exiting at the same time (entry and exit) and one for pedestrians 4 m wide, as seen in **Figure 34**. This layout reduces conflicts and ensures smooth transitions with adjacent streets. The building's shape and materials reflect the local environment, balancing traditional and contemporary elements for visual harmony **Figure 35**.

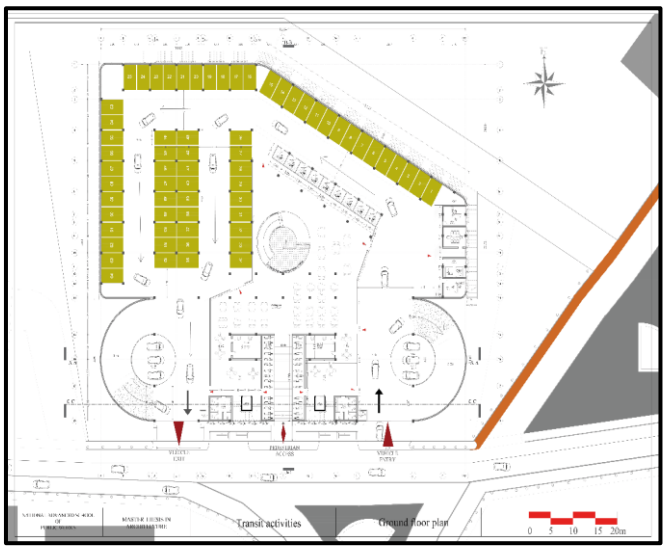

Fig 34 Ground Floor Plan Illustrating Access Points

Fig 35 Perspective View of the Facility

The facility is strategically connected to the Mokolo market's east, west, and south entrances, serving as primary access points for both vehicles and pedestrians. The urban analysis and master plan **Figure 36** highlight a hierarchical road system of primary, secondary, and tertiary streets, as shown in **Figure 37**, **Figure 38**, **Figure 39** respectively, featuring cross-sectional studies that integrate pedestrian sidewalks and dedicated bicycle lanes. These elements promote sustainable mobility and encourage a shift from motorized transport.

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In support of long-term sustainable urban integration, the proposed master plan presents a designated site at the northern entrance of Mokolo for a potential 3 storey parking structure keeping the same principle as our parking facility for the South, East and West Entrances to the Mokolo market. This future facility aims to intercept vehicles entering from the north, reducing the need for cars to traverse the core market zone. Such a decentralized parking approach is intended to relieve pressure on internal market streets, enhance walkability, and promote equitable urban access.

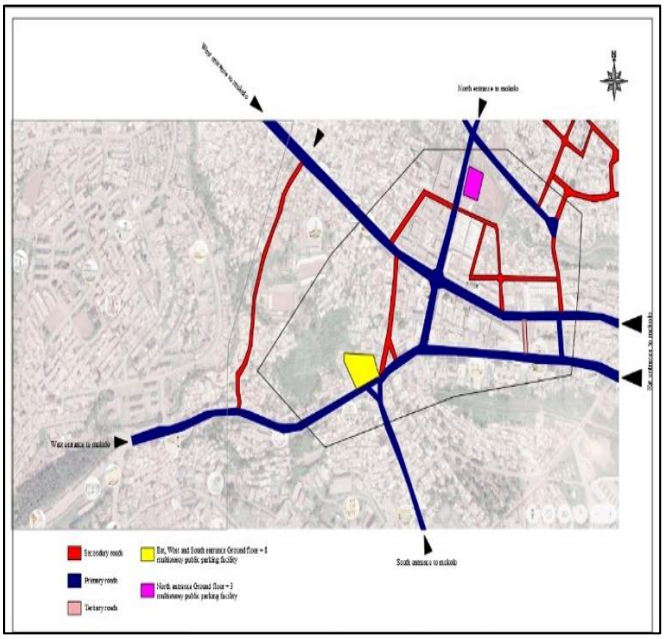

Fig 36 Urban Analysis Master Plan

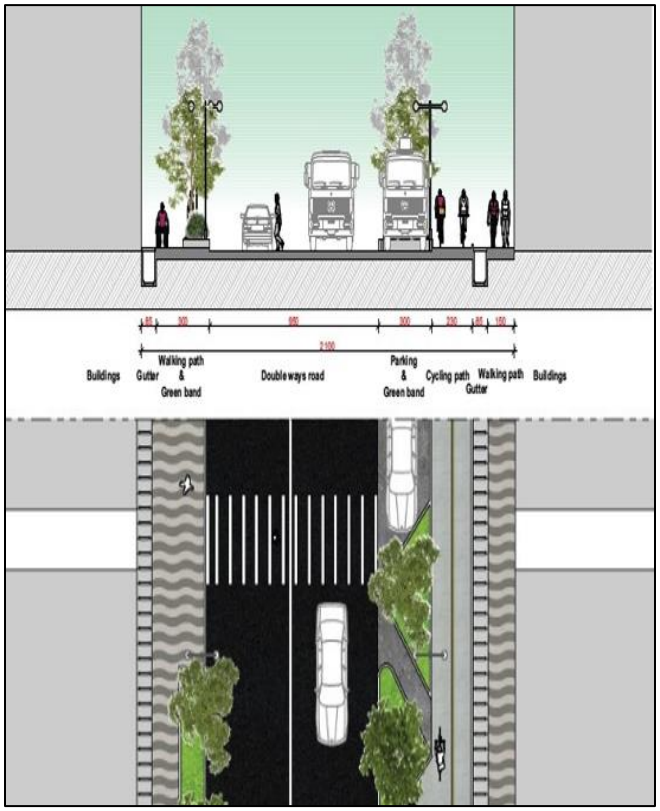

Fig 37 Primary Road Top View and Section

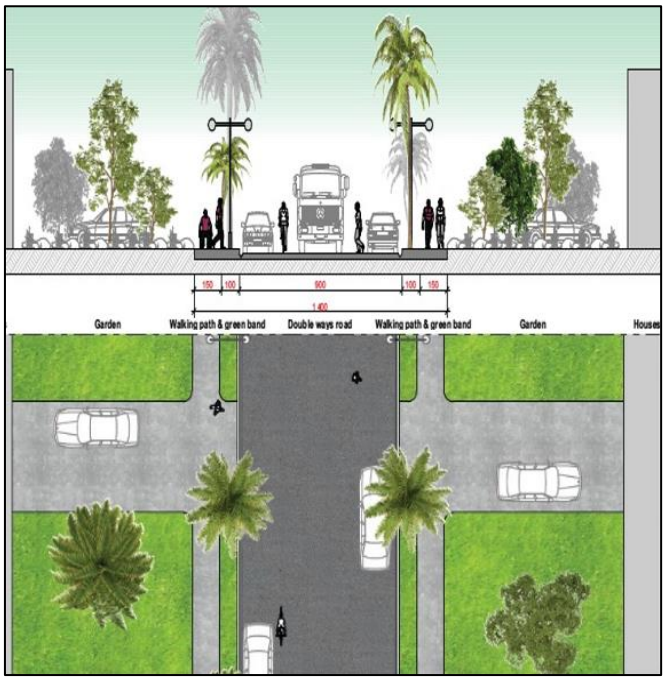

Fig 38 Secondary Roads

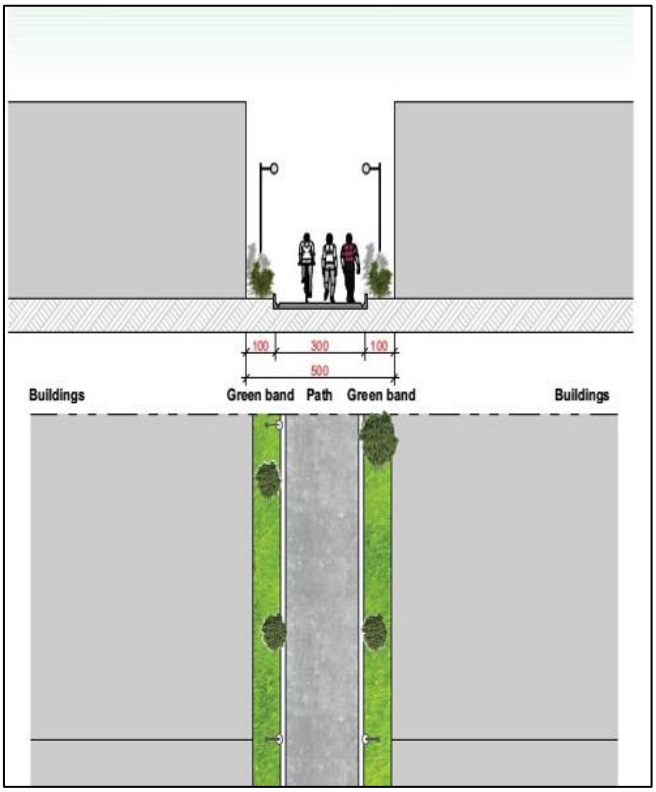

Fig 39 Tertiary Roads

- *Sustainable Design Integration*

The project integrates environmentally friendly strategies to enhance energy efficiency and minimize ecological impact. By maximizing natural daylight through open façades and utilizing cross ventilation, the building ensures adequate airflow throughout its spaces, **Figure 40**. It also features green elements such as rooftop and indoor gardens, **Figure 41** that contribute to cooling, stormwater absorption, and the enhancement of the microclimate. In

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addition, rooftop rainwater harvesting systems promote water conservation. Solar panels installed on the roof capture renewable energy, reducing the building's dependence on the national power grid and lowering operational energy costs. Collectively, these strategies strengthen the sustainable principles of the design.

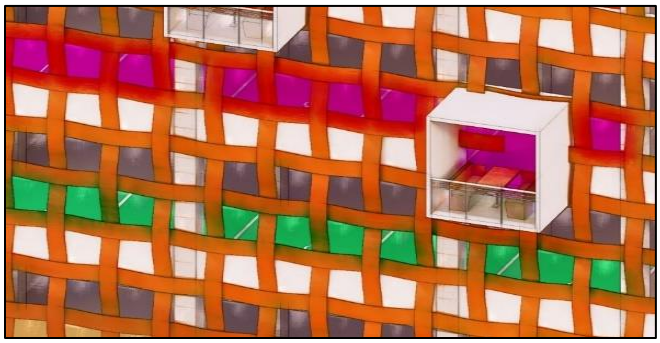

Fig 40 Open Facade Illustration

Fig 41 Roof Top View

- *Traffic Flow and Operational Efficiency*

The layout of the multi-storey parking facility is designed to ensure smooth vehicular and pedestrian circulation. Vehicle flow is managed through one-way traffic lanes and 7 m wide vehicular ramps with a 9.82 % slope, which allows for easy manoeuvring and reduces congestion across levels. Parking bays are dimensioned for optimal access and efficiency.

Since it's a **semicircular ramp**, the ramp length L is the half circumference **ramp width**:

- **Effective radius (centerline of ramp path)** = 12 m
- Arc length of a semicircle = $\pi \times r$

$$L = \pi \times 12 = 37.70 \text{ m (approx.)}$$

$$\text{Slope (\%)} = \left(\frac{\text{Vertical Rise}}{\text{Ramp Length}}\right) \times 100$$

$$\text{Slope} = \left(\frac{3.70}{37.70}\right) \times 100 \approx 9.82\%$$

To facilitate vertical circulation, the facility integrates a variety of access points, **Figure 42**.

- ✓ **A central circular pedestrian ramp** connects all floors and is designed with a 12% slope to accommodate **users with reduced mobility**, wheelchair users, parents with strollers, and cyclists.
- ✓ **Two internal staircases** provide convenient access between floors and are located near key pedestrian zones.
- ✓ **One external staircase** serves as an additional vertical connection and emergency exit.
- ✓ **4 elevators** are incorporated to further support accessibility and comfort, particularly for those with mobility constraints or carrying goods.

Furthermore, the 7 m wide vehicular ramps are also designed to allow shared use by pedestrians, ensuring redundancy in circulation routes and flexibility in movement. This integrated circulation strategy ensures the facility is inclusive, fluid, and functionally efficient for all users, from drivers to pedestrians.

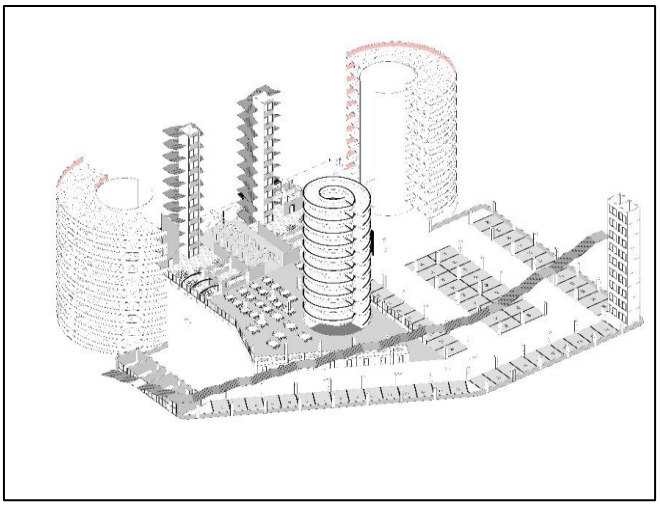

Fig 42 Axonometric View

- *Safety and Security*

The parking facility's design emphasizes both active and passive safety features. The open façade system serves a dual purpose by improving visibility and security. By allowing natural light to enter and ensuring clear lines of sight, the design effectively discourages criminal activity and promotes a feeling of safety within the facility, particularly during times of low light. The façade's woven architectural style, paired with regular openings and partial enclosures, guarantees adequate transparency.

To prevent accidents caused by vehicular overrun, the building's outer edges are protected by 1.2 m high half-walls, providing a physical barrier without hindering views or airflow. These features work together with surveillance systems, clear signage, and controlled access points to establish a secure and user-friendly parking space. **Figure 43** illustrates an exploded view showing the building's structure in relationship to the woven facade elements.

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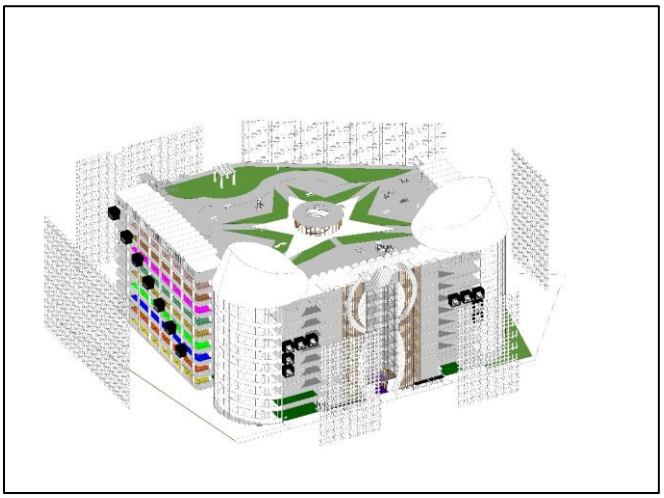

Fig 43 Perspective View

- *Mixed-use*

The proposed multi-storey public parking facility integrates a variety of urban functions, making it a mixed-use structure that caters to the dynamic needs of Mokolo's commercial environment. The ground floor and first floor are dedicated to accommodating the existing transit "clando" station, including a waiting area coupled with a restaurant for passengers as shown in **Figure 44**.

Each level also includes office spaces for council market officials, facilitating on-site administration and coordination within the commercial hub. Additionally, cantilevered terraces on each floor serve as waiting areas, offering shaded, comfortable spaces for users and visitors.

At the rooftop level, a public space is developed to host playgrounds, recreational areas, and community events, creating an urban oasis above the bustling market **Figure 45**. The rooftop also features a restaurant, allowing families or companions to wait comfortably while others shop at the Mokolo market. This multifunctional programming transforms the facility from a mere parking structure into a vibrant, community-oriented hub that enhances both mobility and urban life.

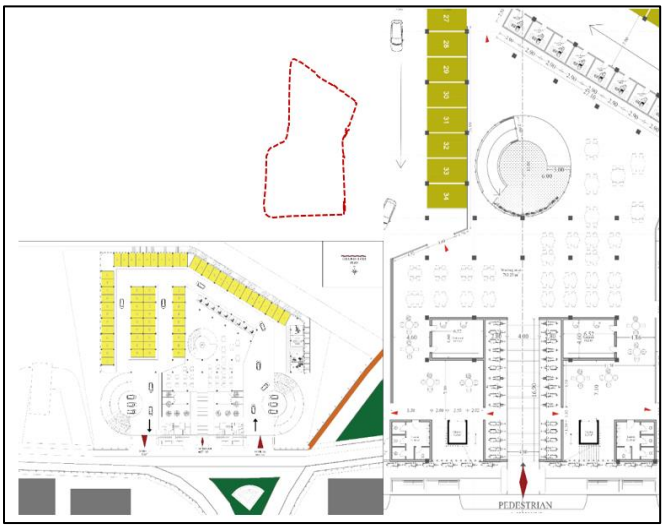

Fig 44 Ground Floor Plan

Fig 45 Roof Top Views

- *Technology Integration*

To improve efficiency, accessibility, and user experience, the proposed facility incorporates several technology-driven solutions. A smart parking system is introduced, enabling real-time monitoring of parking space availability, automated ticketing **Figure 46**, and mobile payment solutions, thereby reducing congestion and enhancing user convenience.

In line with sustainable mobility goals, the facility is equipped with electric vehicle (EV) charging stations to support the growing demand for eco-friendly transportation. Moreover, car lift technology is integrated to optimize vertical circulation and minimize the need for extensive ramp systems. This not only saves valuable space but also enhances accessibility, especially in high-density urban environments like Mokolo.

Collectively, these technologies contribute to the efficiency, sustainability, and future readiness of the parking structure.

Fig 46 Car Exit View

- *User Experience Comfort*

The facility prioritizes user comfort through design features such as natural lighting, wide drive and pedestrian lanes, clear signage, rest zones, **Figure 48** and accessible sanitary facilities. Circulation spaces are well-ventilated and illuminated to improve safety and user well-being, **Figures 47**.

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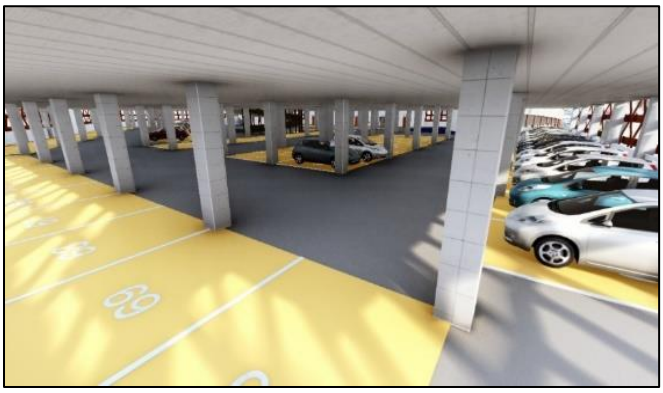

Fig 48 Parking Space Interior View

Fig 47 Terrasse View

- *Durability*

The durability of the facility is ensured through a combination of resilient materials and smart design strategies. The woven basket-inspired façade is constructed with aluminum finished in a wood texture, offering the aesthetic of tradition with the strength, corrosion resistance, and low maintenance of metal, ideal for Yaounde's climate. Beyond the façade, the structure uses reinforced concrete for slabs, columns, and ramps, ensuring high load-bearing capacity and long-term structural stability, **Figure 49**. Ventilated open facades minimize moisture buildup, while non-slip flooring, weather-resistant finishes, and protected service areas all contribute to minimizing wear and ensuring the facility remains safe, efficient, and durable over time.

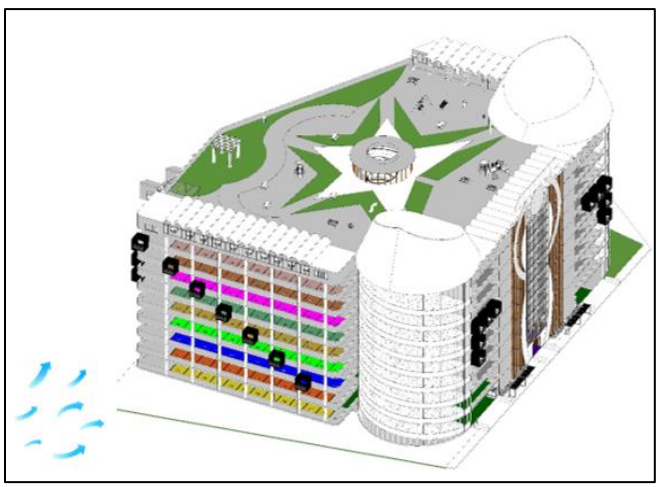

Fig 49 Perspective View

- *Aesthetic*

The aesthetic approach balances functionality with visual appeal as shown in **Figure 50**. Inspired by Cameroonian cultural motifs and everyday objects such as the traditional baskets and the star from the national flag, the façade features dynamic patterns and colors that reflect local identity.

Fig 50 Perspective Front View

VI. COST ESTIMATION

The cost estimation of the proposed multi-storey public parking facility is based on the official guidelines of the *NATIONAL ORDER OF CAMEROON ARCHITECTS (NOCA)*. According to Article 4.1.3.4 of NOCA's General Administrative Clauses, building works are classified into four categories based on their complexity, with corresponding cost rates per square meter.

Given the project's structural and architectural features, including mixed-use functions, circulation systems, and sustainable elements, it qualifies as **Category 2 (Standard)**, estimated at **300,000 FCFA/m².**

With a total built-up surface area of **4949 m²**, the estimated construction cost is calculated as follows:

$$36{,}443\ m^2 \times 300{,}000\ FCFA/m^2 = 10{,}932{,}900{,}000\ FCFA$$

Thus, the **total estimated construction cost** for the facility is approximately **11 billion FCFA**, exclusive of taxes, consultancy fees, and unforeseen contingencies. This estimation serves as a financial benchmark for project planning and budget allocation.

VII. IMPACT ASSESSMENT

This section presents the practical assessment of the impacts resulting from the proposed multi-storey public parking facility in Mokolo, Yaounde. The assessment evaluates the sociocultural, economic, architectural, and environmental effects, as well as the project's overall alignment with urban development objectives. It also includes a SWOT analysis to identify key strengths, weaknesses, opportunities, and threats related to the facility.

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➢ *Sociocultural Impact*

The facility improves social order in the Mokolo market area by organizing vehicular movement, reducing roadside parking, and enhancing pedestrian safety. The inclusion of public spaces, such as playgrounds, rooftop leisure areas, and resting terraces, fosters community interaction and inclusivity. The integration of symbolic traditional forms, such as the basket-inspired façade and rooftop star, strengthens cultural identity and local pride.

➢ *Economic Impact*

Economically, the proposed multi-storey public parking facility will stimulate both short-term and long-term financial and economic benefits. During the construction phase, the project injects significant capital into the local economy through material procurement and labour. Post-construction, the facility offers employment opportunities in maintenance, security, administration, retail, and mobility services, especially with the inclusion of restaurants, offices, and waiting areas within the structure.

This analysis estimates the economic feasibility of the multi-storey public parking facility at Mokolo, Yaounde, focusing on direct parking revenues from private users and "clando" taxi vehicles. The goal is to determine the return on investment (ROI) based on the usage assumptions and a revised construction cost of **10,932,900,000 FCFA**.

- *Assumptions*

✓ Day Parking Fee: 250 FCFA/hour
✓ Day Parking Hours: 6 AM – 6 PM (12 hours)
✓ Private Vehicles per Day: 350 (approximately)
✓ clando Vehicles per Day: 128, for 2 hours at 200 FCFA/hour
✓ Night Parking Fee: 500 FCFA per car
✓ Night Parking Vehicles: 100
✓ Construction Cost: 10,932,900,000 FCFA
✓ Running Costs: 10% of gross annual revenue

- *Daily Revenue Breakdown*

✓ Private Vehicles: 350 × 12 hrs × 250 FCFA = 1,050,000 FCFA/day
✓ Clando Vehicles: 128 × 2 hrs × 200 FCFA = 51,200 FCFA/day
✓ Night Parking: 100 × 500 FCFA = 50,000 FCFA/day

❖ **Total Daily Revenue: 1,151,200 FCFA/day**

- *Annual Revenue Calculations*

✓ Monthly Revenue: 1,151,200 × 30 = 34,536,000 FCFA
✓ Annual Gross Revenue: 34,536,000 × 12 = 414,432,000 FCFA
✓ Annual Net Revenue (After 10% Running Costs):

❖ **414,432,000 × 90% = 372,988,800 FCFA**

✓ Return on Investment (ROI)
✓ Construction Cost: 14,600,000,000 FCFA
✓ Annual Net Revenue: 372,988,800 FCFA
✓ Estimated ROI Period:

❖ **10,932,900,000 ÷ 372,988,800 ≈ 29.31 years**

➢ *Architectural Impact*

Architecturally, the project serves as a reference model for integrating modern urban facilities within culturally sensitive contexts. Its envelope design, inspired by local motifs, and its integration of traditional and sustainable elements contribute to architectural innovation in Cameroonian urban settings. It also sets a precedent for context-adapted and multi-functional infrastructure in dense urban zones.

➢ *Environmental Impact*

The project promotes sustainability through passive design strategies (natural ventilation, daylighting), incorporation of green roofs, and provision of EV charging stations. It helps to reduce heat island effects and lowers CO_2 emissions by discouraging parking along the roadside and encouraging coordinated car usage. Use of durable and recyclable materials like aluminum for the façade further enhances environmental responsibility.

VIII. CONCLUSION

This article aimed to address the pressing urban mobility challenges in Yaounde, due to poor parking management, using Mokolo as a case study, by proposing a sustainable multi-storey public parking facility. The findings highlight the project's ability to significantly reduce traffic congestion, organize informal parking practices, and enhance accessibility for users of both private and public transportation. The incorporation of smart parking technologies, mixed-use functionalities, and eco-friendly design elements further enhances the project's sustainability and its alignment with modern urban planning objectives.

By thoughtfully aligning the architectural design with contextual challenges and opportunities, including circulation patterns, commercial density, and cultural identity, the proposed facility provides more than just practical utility; it aids in revitalizing the urban environment. The economic forecasts, though cautious, suggest the long-term financial sustainability of the investment, particularly when additional revenue sources are factored in.

The findings support the notion that strategically designed public parking infrastructure, when integrated into broader mobility strategies and urban development frameworks, can enhance quality of life, mitigate environmental pressures, and promote fairer access to urban spaces. This study advocates for further investigation into scalable and adaptable parking solutions for other urban areas facing similar mobility and spatial difficulties.

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