Volume 11, Issue 7, July– 2026 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1049

Integrating Student Housing and Urban Regeneration: A Sustainable Multipurpose Housing Model for Bonas, Yaoundé

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Publication Date: 2026/08/03

Abstract: Rapid urbanization and increasing university enrolment have intensified the demand for quality student accommodation in many Sub-Saharan African cities. In Yaoundé, Cameroon, the Bonas neighborhood surrounding the University of Yaoundé I has evolved into a dense informal student settlement characterized by overcrowding, inadequate sanitation, insecurity, and limited public infrastructure. These conditions negatively affect students' academic performance, well-being, and quality of life while contributing to unplanned urban growth. This study proposes a sustainable multipurpose student housing complex as an integrated architectural response to these challenges. Using site analysis, precedent studies, user needs assessment, and contextual architectural design methods, the project develops a mixed-use housing model that integrates residential accommodation with academic support spaces, commercial facilities, recreational areas, green public spaces, and community infrastructure. The design adopts passive environmental strategies, biophilic principles, flexible spatial organization, and sustainable urban planning concepts to improve environmental performance and social interaction. The proposed development demonstrates how student housing can function not only as residential infrastructure but also as a catalyst for urban regeneration, improved pedestrian connectivity, enhanced community integration, and sustainable neighborhood development. The study highlights the potential of integrated student housing as a scalable urban development strategy for rapidly growing university cities in Cameroon and other Sub-Saharan African countries.

Keywords: *Urban Housing, Student Housing, Sustainable Architecture, Urban Regeneration, Mixed-Use Development, Student Well-Being.*

How to Cite: Kelvin Ojong Etengeneng Oneke; Makomra Valentine; Ngome Johnson Ngome (2026) Integrating Student Housing and Urban Regeneration: A Sustainable Multipurpose Housing Model for Bonas, Yaoundé. *International Journal of Innovative Science and Research Technology*, 11(7), 2520-2551. https://doi.org/10.38124/ijisrt/26jul1049

I. INTRODUCTION

Rapid urbanization has intensified the demand for housing and infrastructure in many developing countries, particularly in Sub-Saharan Africa, where urban growth often exceeds the capacity of formal planning systems. In Cameroon, Yaoundé has experienced sustained population growth driven by rural-urban migration and expanding higher education institutions. One of the most affected neighborhoods is Bonas, located adjacent to the University of Yaoundé I, which has evolved into the city's principal student residential area. However, this growth has largely occurred through informal and uncoordinated development, resulting in overcrowded housing, poor sanitation, inadequate infrastructure, and declining environmental quality.

Student housing plays an essential role in academic success and well-being. Studies have shown that inadequate accommodation, limited recreational facilities, poor ventilation, and insecurity negatively influence students' academic performance, mental health, and quality of life. Despite the growing student population in Yaoundé, most existing accommodation consists of privately developed rental buildings that provide basic shelter but fail to address students' broader educational, social, and environmental needs.

Globally, student housing has evolved from traditional dormitories into integrated mixed-use developments that combine residential, academic, commercial, and recreational functions. These developments not only improve student living conditions but also contribute to neighborhood vitality, environmental sustainability, and urban regeneration. Such

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1049

integrated housing models remain largely absent in Cameroon, where purpose-built student accommodation is limited.

This study proposes a sustainable multipurpose student housing complex for Bonas as an integrated architectural response to the area's housing and urban challenges. The project combines residential accommodation with academic support facilities, commercial spaces, recreational areas, and green public spaces while incorporating passive environmental design strategies adapted to Yaoundé's climatic conditions.

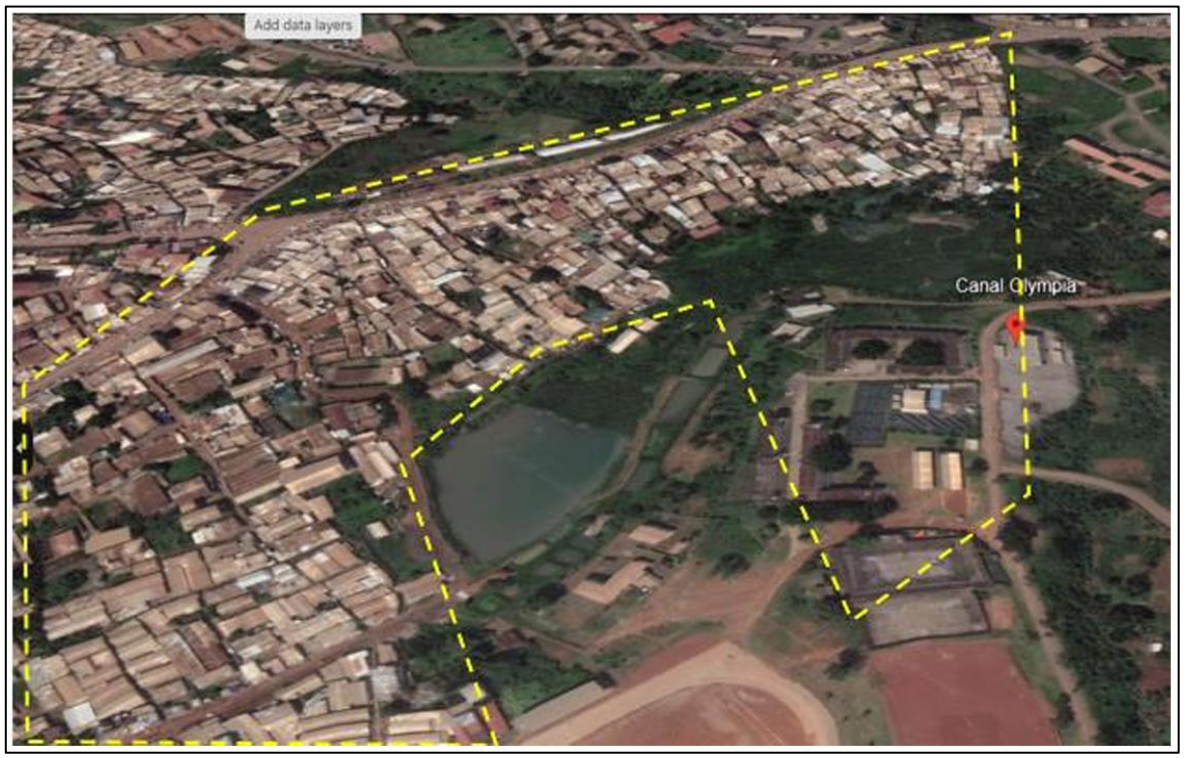
The objectives of this study are to:

- Assess the existing student housing challenges in Bonas;
- Identify sustainable design principles suitable for high-density university neighborhoods;
- Develop a mixed-use student housing complex that integrates residential, commercial, academic, and recreational functions; and
- Evaluate the potential contribution of the proposed development to student well-being and sustainable urban regeneration.

By demonstrating how architecture can simultaneously address housing shortages and improve the surrounding urban environment, this study provides a replicable framework for sustainable student housing development in Yaoundé and other rapidly urbanizing university cities in Sub-Saharan Africa.

II. PRESENTATION OF OUR CASE STUDY AREA

Bonas is a university-oriented neighborhood located within the Yaoundé III Municipality in the Center Region of Cameroon and the wider Ngoa-Ekélé educational district. Its proximity to the University of Yaoundé I has transformed it into a major student settlement, with hostels, residences, restaurants, shops, printing services, religious facilities, and other student-oriented activities, housing over 5,400 students along with civil servants and workers in a dense, cosmopolitan environment. Map 1 shows our case study area in Bonas, relative to our selected site.



Map 1 Bonas Case Study Area Delimitation
(Source: Google Earth Pro)

A. Analysis of Current Housing and Infrastructure Challenges in Bonas, Yaoundé.

High pedestrian activity, mixed land uses, rising building density, limited public open space, narrow access roads, informal commercial activities, and growing pressure on existing infrastructure characterize the area. Understanding these conditions is essential to developing an architectural response that addresses both students' housing needs and the neighborhood's broader urban challenges.

➢ *Student Housing and Accommodation Conditions*

Bonas contains numerous private hostels and rental units serving students at the University of Yaoundé I and nearby institutions, as shown in Figure 1. However, many provide mainly sleeping accommodation with limited study, recreational, social, and support facilities.

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Fig 1 Existing Student Accommodation and Building Typologies in Bonas

➢ *Pedestrian Movement and Relationship with the University*

Bonas experiences heavy pedestrian traffic as students travel between their residences and the University of Yaoundé I. Figure 2 shows images of narrow or discontinuous walkways, parked vehicles, drainage channels, and roadside activities, which often force pedestrians to share space with vehicles. The proposed project should therefore prioritize safe, convenient pedestrian connections.

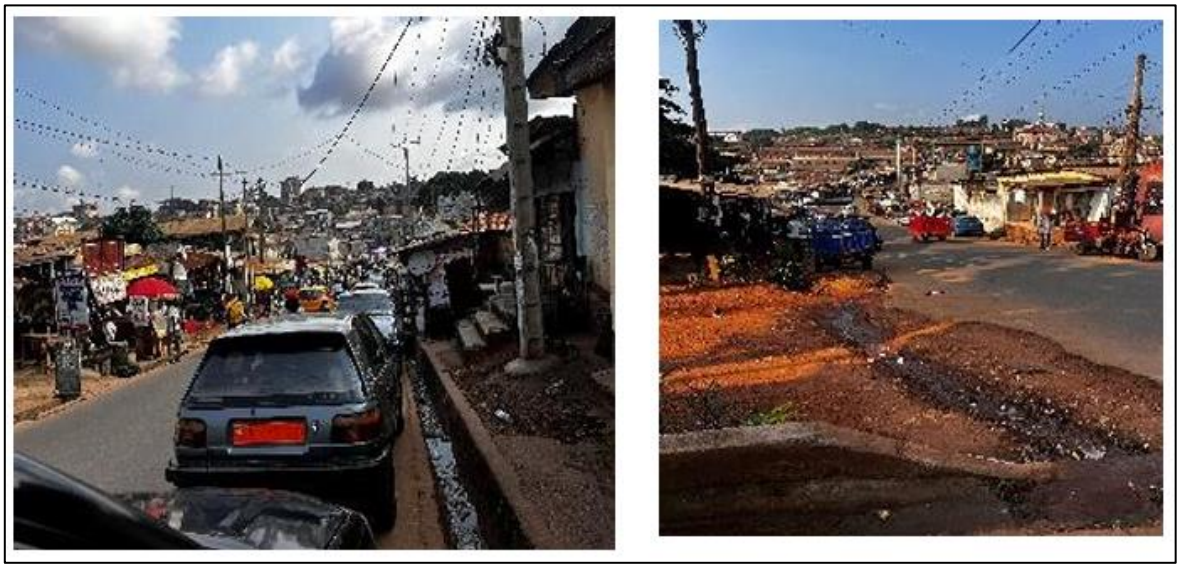

Fig 2 Pedestrian Movement and Connectivity Between the Project Sites and the University of Yaoundé I.

➢ *Commercial Activities and Mixed-use Land Use*

Bonas contains numerous shops, restaurants, printing services, and other businesses that support the student population. However, some commercial activities are poorly organized and may obstruct pedestrian and vehicular movement, as shown in Figure 3. The proposed project will integrate organized commercial spaces to provide essential services in a more structured environment.

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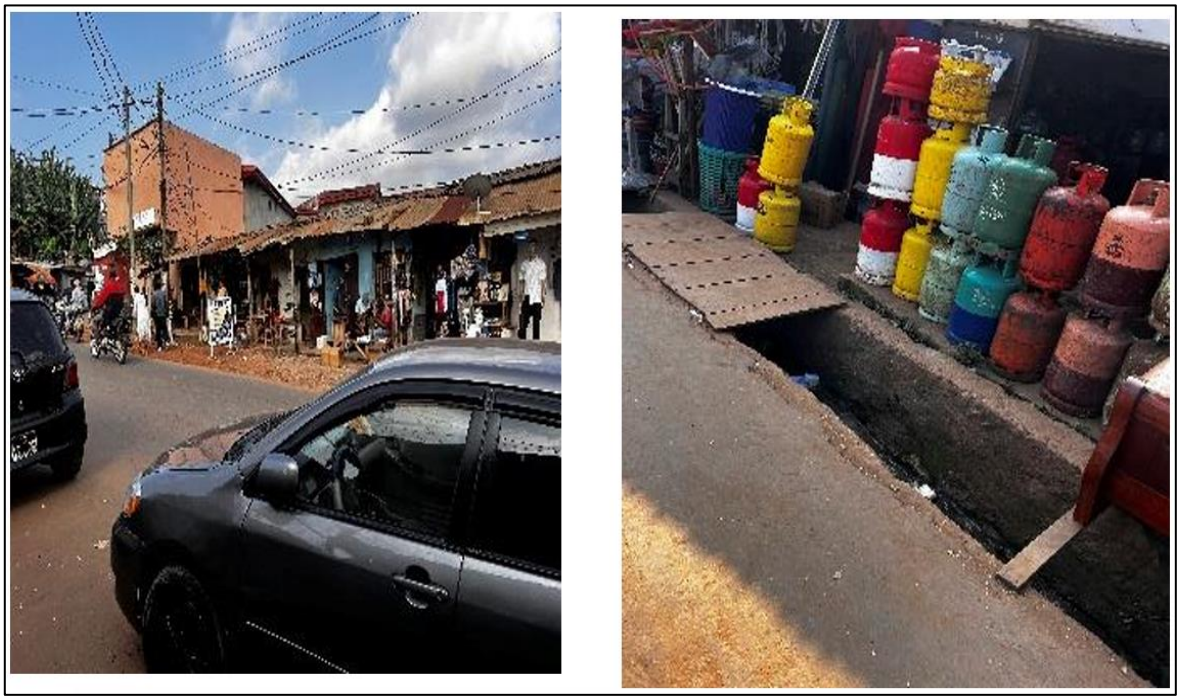

Fig 3 Existing Commercial and Mixed-Use Activities in Bonas.

➢ *Vehicular Access, Parking, and Circulation*

Vehicular movement in Bonas includes private cars, taxis, motorcycles, and service vehicles. Figure 4 shows that limited on-site parking often leads to roadside parking and conflicts between vehicles and pedestrians. The proposed project should provide organized parking, drop-off areas, and clearly defined circulation for pedestrians, vehicles, service, and emergency use.

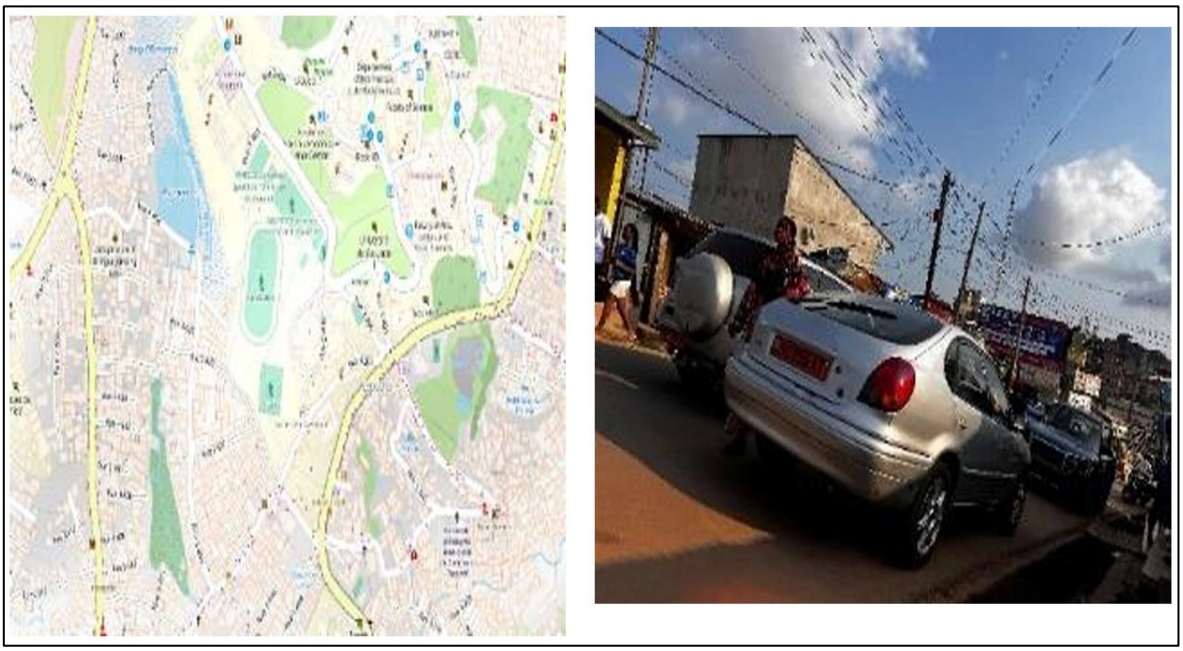

Fig 4 Existing Vehicular Passage

➢ *Urban Fabric and Building Morphology*

Bonas has diverse urban fabric comprising low-rise residences, multi-story hostels, and mixed-use buildings with varying heights, materials, and architectural styles. This has created a visually fragmented urban character as seen in Figure 5. The proposed development should establish a stronger architectural identity while responding appropriately to the scale of its surroundings.

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Fig 5 Existing Urban Fabric and Building Morphology in Bonas.

➢ *Public Open Space and Environmental Quality*

Open spaces and vegetation in Bonas are limited by increasing urban density. Challenges such as inadequate drainage, waste management, and insufficient shaded outdoor spaces also affect environmental quality. The proposed project should incorporate landscaped courtyards, recreational spaces, shaded areas, and sustainable stormwater management, as shown in Figure 6.

Fig 6 Existing Environmental Conditions and Public Open Spaces in Bonas.

➢ *Infrastructure Failure and Service Gaps*

The rapid, unplanned expansion of Bonas has completely outpaced the development of basic municipal services, such as potable water. Mini-cites have connections to the national water grid (CAMWATA), yet supply remains highly irregular. Many mini-cites lack adequate private toilets, leading to shared facilities that are often dilapidated or unusable. The Electrical installations in these informal residences are often substandard, as seen in Figure 7.

Fig 7 Existing Infrastructure in Bonas

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B. Site Presentation

Our chosen location, as shown in Figure 8, is in the heart of the Bonas district, a strategic hub directly adjacent to the University of Yaoundé I. The project site covers approximately. Managed under the urban jurisdiction of the Yaoundé 3 Council, this area has evolved since the mid-1990s into the primary residential core for the city's growing student population. The environment is characterized by an intense, dynamic atmosphere where academic life intersects with informal commerce. The scene is a constant mix of students, street vendors, and "benskineurs," all contributing to a high-density urban fabric. Nearby academic facilities, photocopier galleries, and local eateries further enrich the site, serving as vital touchpoints for students as they navigate their daily routines between housing and campus.

Fig 8 Site Location
(Source: Google Earth)

➢ *Justification of Choice of Site*

The selection of the site in Bonas, within the Yaoundé III municipality, for the proposed housing complex was guided by the following criteria:

- Accessibility and Connectivity: The site occupies a strategic position with excellent connectivity to major arterial roads, prioritizing a location within a 10- to 15-minute walking radius of the University of Yaoundé I to ensure seamless pedestrian commutes. It maintains direct access to secondary roads feeding into Avenue de l'Université and the Carrefour Obili axis, which are vital for efficient access by emergency and service vehicles.
- Existing Urban character: The physical character of Bonas reflects the coexistence of formal and informal urban development. Multi-story student hostels are interspersed with small commercial structures, informal markets, restaurants, printing shops, and residential buildings, creating a heterogeneous urban landscape. The architectural language is similarly fragmented. This lack of visual coherence contributes to an environment that appears congested despite its strategic location within the educational district. Rather than imposing an isolated architectural object, the proposed project aims to introduce a recognizable urban landmark that establishes a stronger identity for Bonas while respecting its existing socio-economic activities.
- Land Availability and Zoning Regulations: Selection is contingent on securing a plot that complies with the Yaoundé City Council (CUY) urban master plan. We prioritize brownfield sites that provide sufficient space for vertical, multipurpose infrastructure within the dense Bonas landscape, thereby streamlining the regulatory approval process by intensifying land use in an already developed zone.
- Economic Viability: The steady flow of students through the Bonas district creates a built-in customer base for the facility. The design leverages this proximity to generate revenue from ground-floor commercial units, such as cafeterias and study centers, creating a virtuous economic cycle that supports the local micro-economy.
- Environmental and Social Impact: Repurposing an already-developed site minimizes new environmental disruption compared with developing green spaces. The project ensures that the new complex preserves existing pedestrian pathways, such as those near the Fish Farm and Lake Maintenance Center, while minimizing noise or structural disruption to the surrounding academic community.
- Security and Safety: As an area characterized by high 24-hour activity, the site benefits from natural surveillance. Priority is given to a well-lit location that allows for controlled access points and the deployment of security personnel, providing a safe environment for students in a neighborhood often targeted for petty crime.

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The selection of the Bonas site is justified by several complementary factors that collectively support the feasibility and relevance of the proposed development. The proposed Multipurpose Student Housing Complex therefore represents more than residential development; it constitutes an urban intervention intended to transform an underutilized site into a vibrant educational community that supports learning, innovation, social cohesion, and environmental sustainability.

➢ *Location and Context*

- *Geographic Location*

The proposed multipurpose complex will be in the high-density Bonas neighborhood (Yaoundé III), Figure 9, directly adjacent to the University of Yaoundé I. Its strategic proximity to major educational institutions, including the University of Yaoundé I, the National Advanced School of Public Works (ENSTP), the National Advanced School of Post and Telecommunication (SUP'TIC), and several higher institutes, has significantly shaped its urban morphology. This positioning addresses the critical student housing shortage by providing a mixed-use space that combines residential units with local commerce. The site is highly accessible, with excellent walkability to the main campus and strong links to Yaoundé's road network, including the Château axes and Obili.

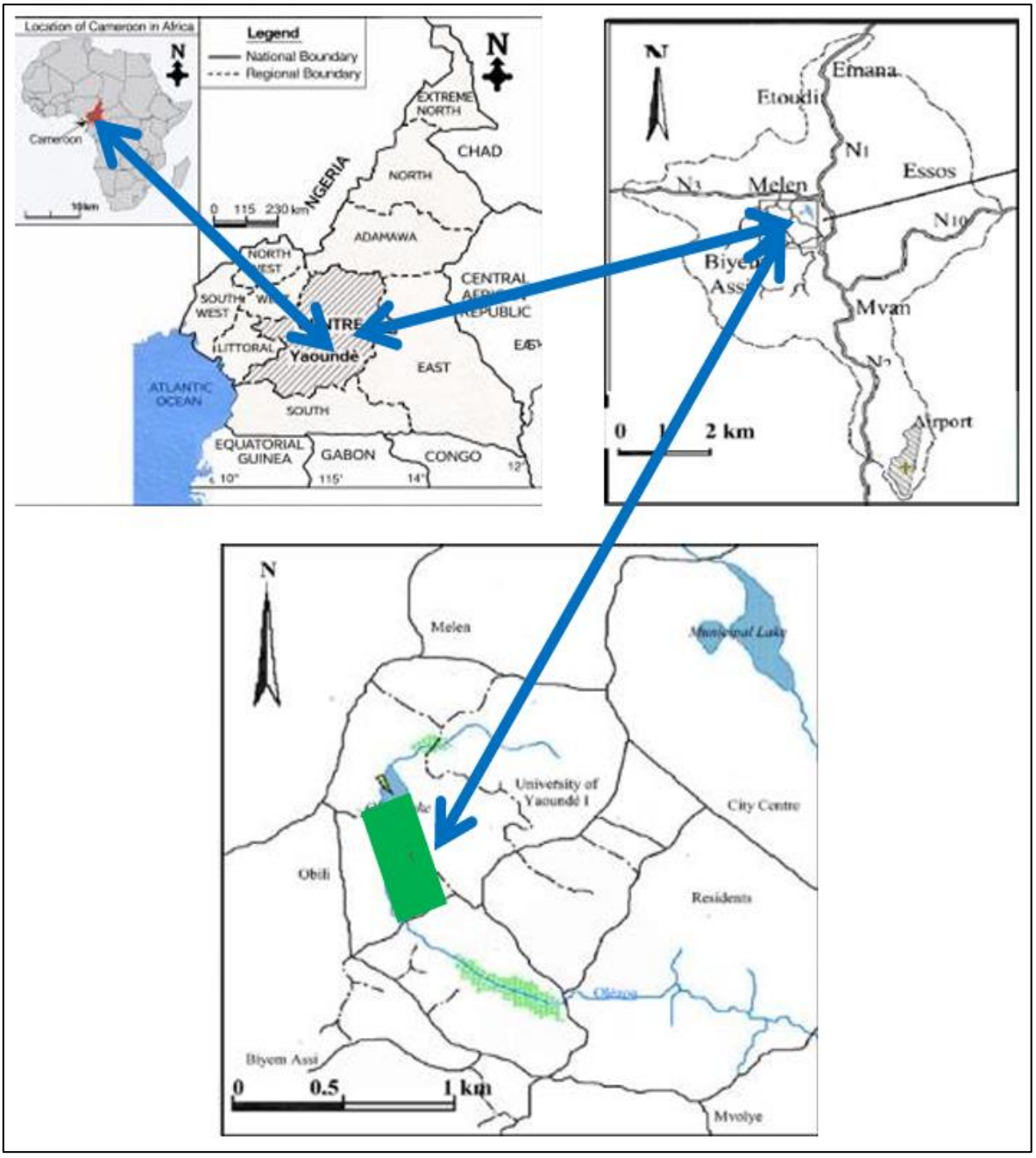

Fig 9 Geographical Location of Site
(Source: Wikipedia)

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➢ *Social and Cultural Analysis*

- *Social Context*

Our selected site, which currently serves as a vibrant student-centric area, features several commercial activities, such as food and drink sales and photocopy shops, which reinforce social connections between users, as shown in Figure 10.

- *Cultural Context*

Our chosen site, located in the heart of the Bonas district, Yaoundé's premier academic and student hub, serves a dynamic population primarily composed of students and faculty from across Cameroon's diverse regions. This location serves as a focal point for the University of Yaoundé I community, where individuals gather to pursue academic excellence and engage in research.

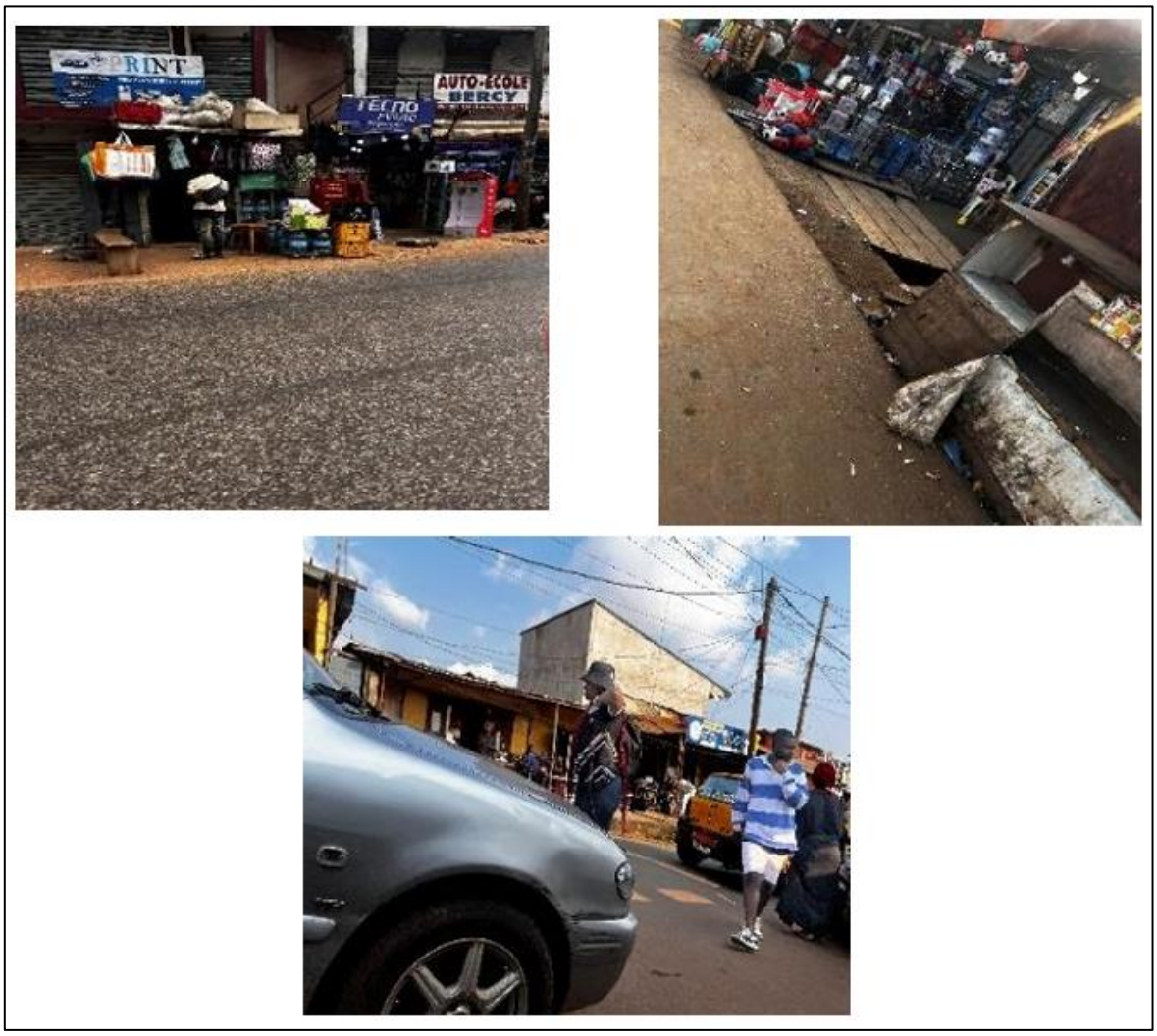

Fig 10 Commercial Activities on Our Selected Site

➢ *Environmental Analysis*

- *Climate Analysis*

Yaoundé has 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 (December-February)
✓ A brief rainy season (March - June)
✓ A short dry season (July-August)
✓ A long rainy season (September - November).

- *Temperature*

The maximum and minimum temperatures are shown in Figure 11, with highs reaching 33 °C in February and lows dropping to 16 °C in July, August, and November.

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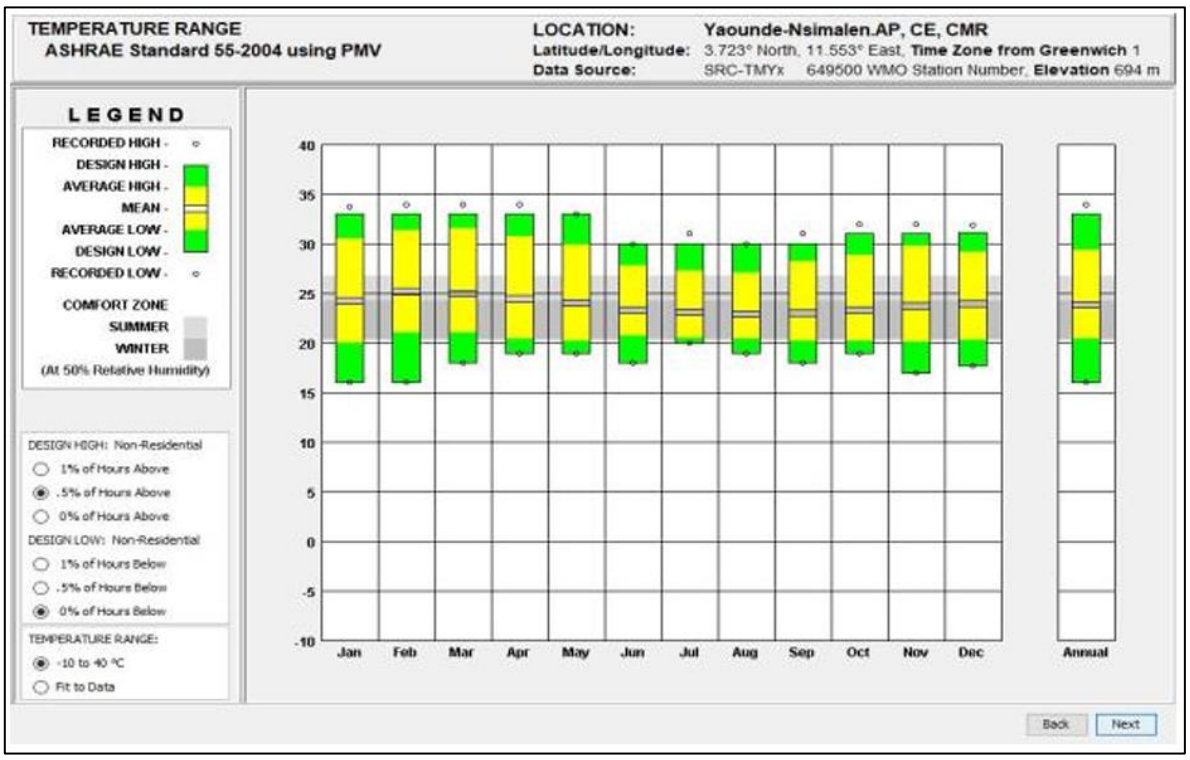

Fig 11 Maximum and Minimum Temperatures in Yaoundé
(Source: Climate Consultant)

- *Humidity*

In Yaoundé, it remains consistently high year-round due to its equatorial climate. As shown in Figure 12, the highest levels occur in July, reaching 86% (very high), while the lowest is recorded in January at 79% (Climate-Data.org, 2023; WMO, 2021). The average humidity in Yaoundé is 83%.

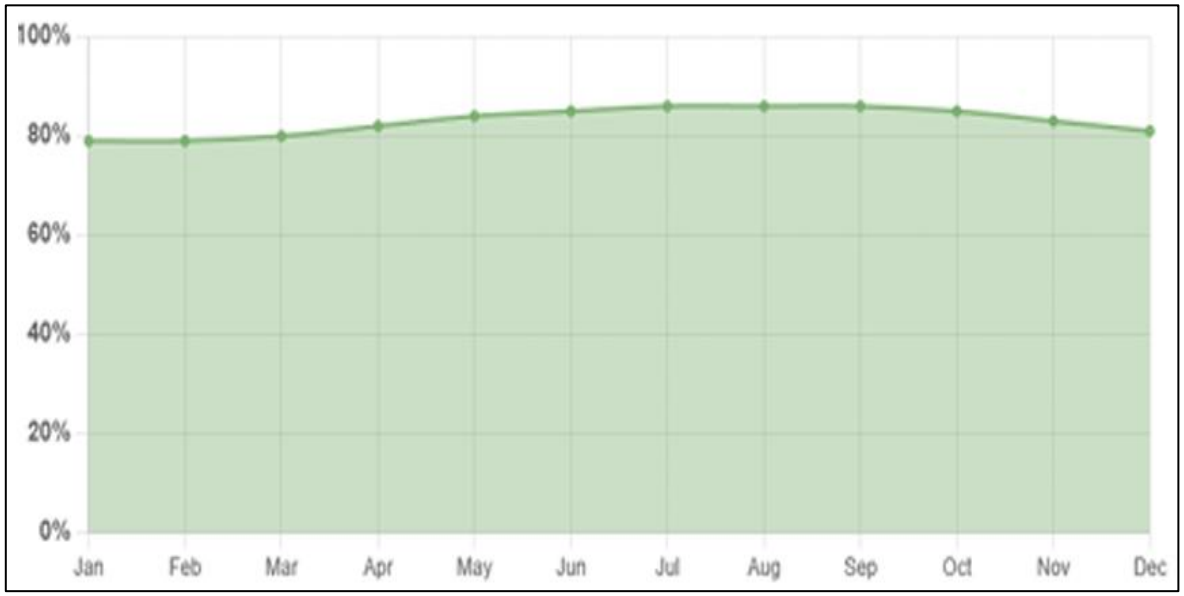

Fig 12 Average Humidity in Yaounde
(Source: Climate Data.Org, 2023)

- *Solar Radiation*

The global solar radiation on a horizontal surface in this area is 5.0 to 6.4kwh/m^2 per day, except on cloudy days, as seen in Figure 13.

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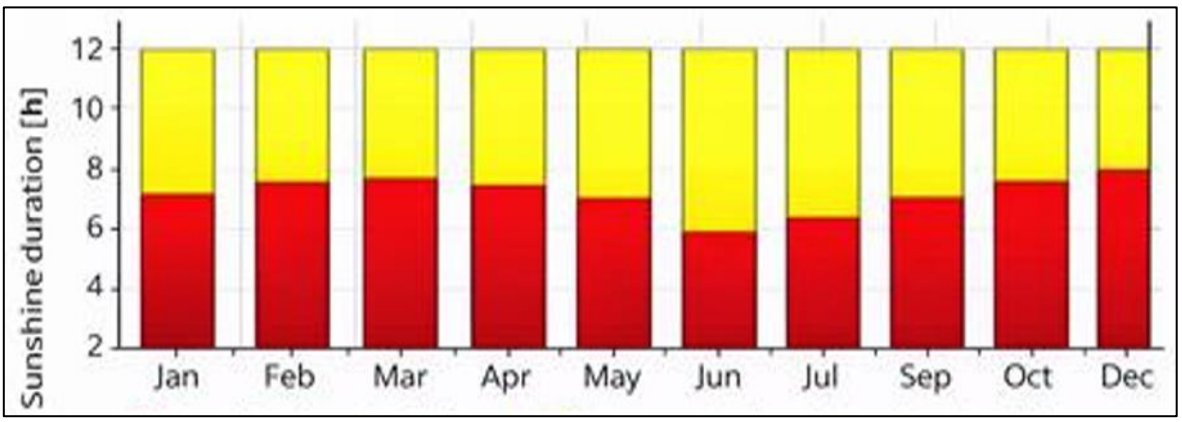

Fig 13 Average Humidity Monthly Sunshine in Yaounde
(Source: M.Kone, B. Mempouo, V.Kitio, 2015)

- *Wind Patterns*

Yaoundé's wind pattern varies seasonally with the West African Monsoon system:

✓ During the dry season (December-February), dominant northeasterly Harmattan winds flow from the Sahara toward the southwest.

✓ In the rainy seasons (March-June and September-November), prevailing winds switch to south-westerly, carrying moist Atlantic air inland.

✓ The short dry season (July-August) features more variable wind directions. Average annual wind speeds are modest between **2 - 4 *m/s*** (≈ **3 - 4 *mph***), with the windiest month in August and calmest in November (**average** ~**2**.4**mph**).

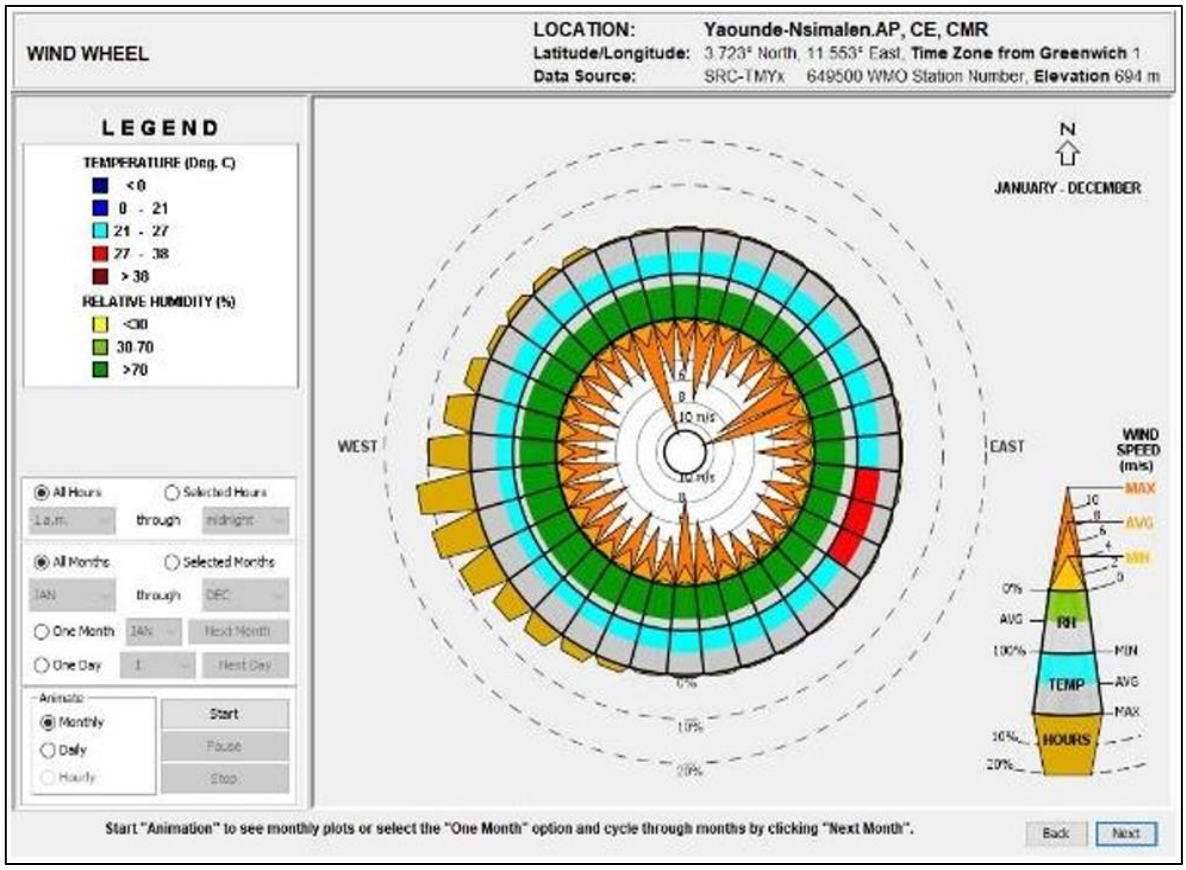

Fig 14 Wind Directions in Yaoundé
(Source: Climate Consultant)

- *Topography Analysis*

The site has flat level terrain, as shown in Figure 15, and offers favorable construction conditions that minimize preparation costs.

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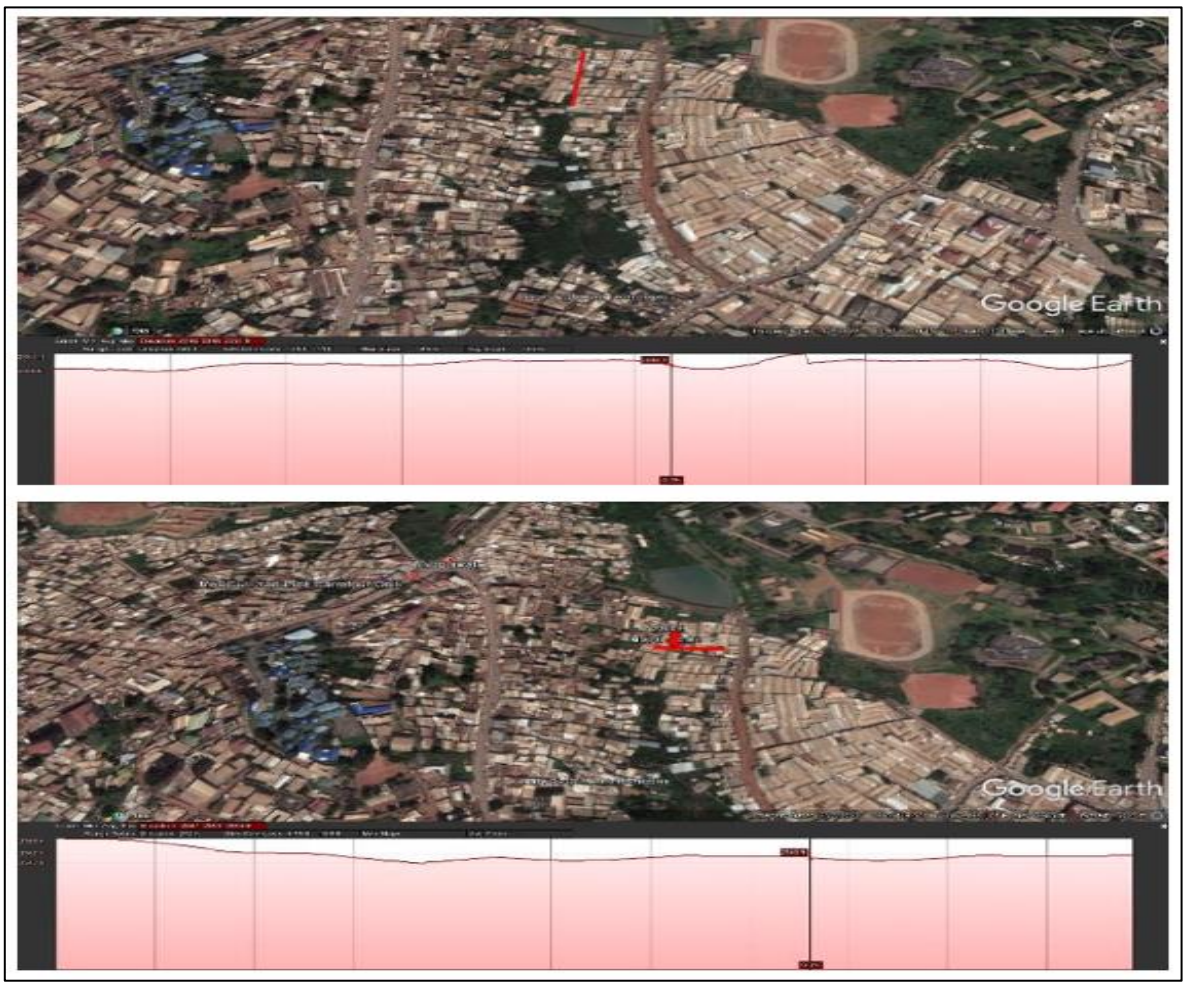

Fig 15 Site Topography and Analysis on Google Earth Pro

- *Natural Features*

The selected site is situated within a high-density urban fabric, which significantly limits the presence of expansive natural features in its immediate vicinity, as shown in Figure 16.

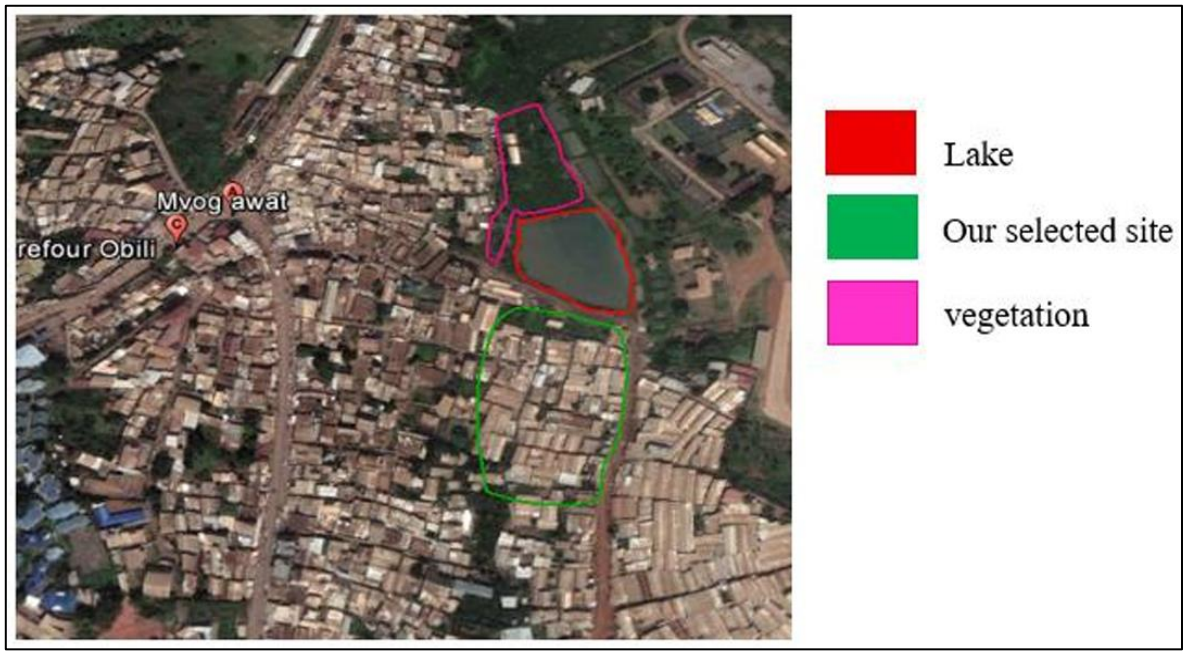

Fig 16 Vegetation Location at Our Site
(Source: Google Earth Pro)

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➢ *Accessibility*

Accessibility remains the determining factor in the success of this student housing complex. The site is accessible via a road network. To the north, it is served by a 20 m-wide major paved road (National Road number 3), a primary mobility corridor linking Bonas to other parts of Yaoundé. This axis ensures high visibility and heavy daily traffic from taxis, motorbikes, and local transport, providing a convenient option for students and civilians. To the south and southwest, it is served by 8m secondary roads. (Figure 17)

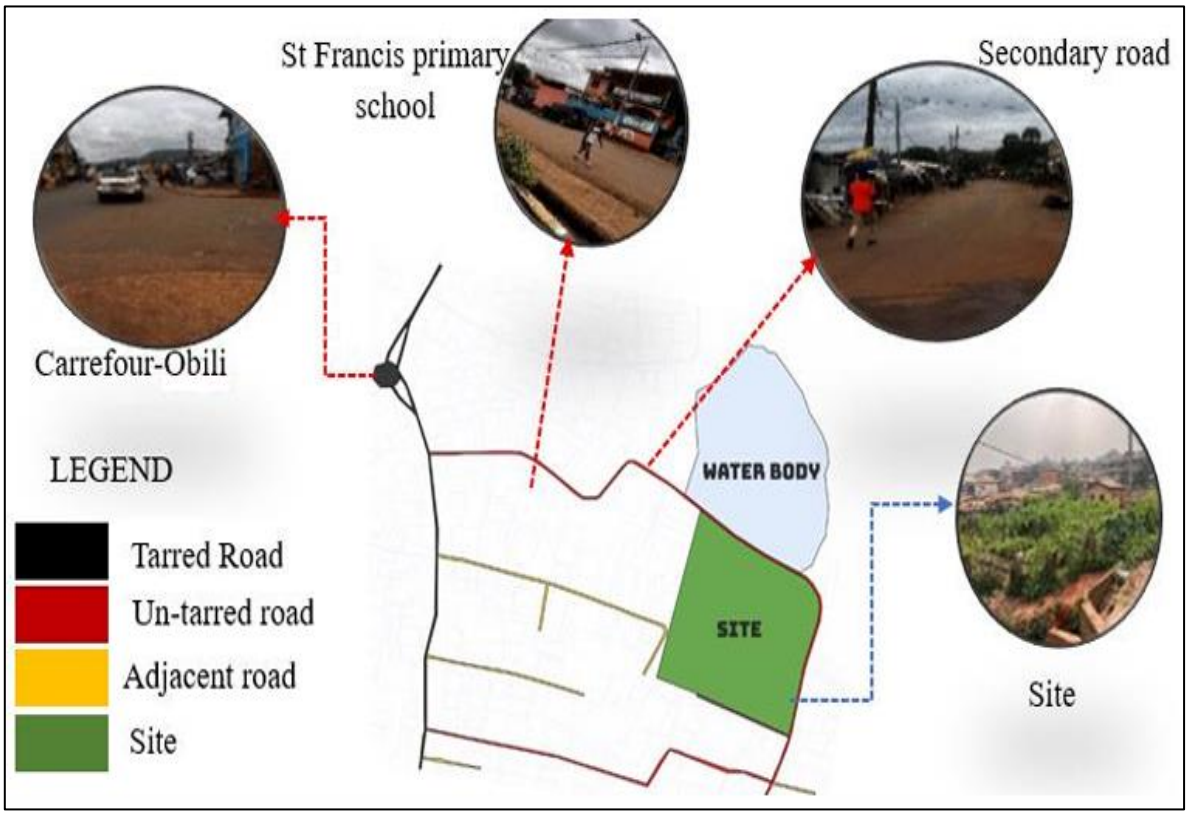

Fig 17 Accessibility to Site
(Source: Rayan Design)

III. DESIGN PHILOSOPHY AND CONCEPT DEVELOPMENT

Every successful architectural project begins with a clear design philosophy that guides decision-making throughout the design process.

For the proposed Multipurpose Student Housing Complex, the architectural philosophy is founded on the belief that student accommodation should no longer function merely as a residential facility but rather as a dynamic ecosystem that promotes education, innovation, social interaction, leadership, entrepreneurship, environmental stewardship, sustainability, inspiration, harmony, excellence, and personal development.

A. Vision and Concept

➢ *Vision*

The vision of this project, as shown in Figure 18, is to establish a contemporary student community that integrates residential life with education, commerce, recreation, healthcare, and environmental sustainability within a single

Mixed-use development. Rather than creating isolated dormitory buildings, the proposal aims to develop a living-learning ecosystem in which architecture supports intellectual growth, collaborative learning, leadership, community engagement, and inclusiveness.

By integrating academic support facilities, commercial spaces, green infrastructure, and recreational environments, the proposal aims to enhance students' quality of life while contributing to the regeneration of the surrounding urban fabric.

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Fig 18 Project's Vision

➢ *Design Objectives*

The design objectives for the proposed Multipurpose Student Housing Complex were informed by the findings of the contextual analysis, precedent studies, literature review, and student user-needs assessment. As shown in Figure 19, these objectives establish the principal performance criteria that guide the transformation of identified student needs into spatial, functional, environmental, and technological responses. To achieve this overall objective, the architectural proposal is guided by the following specific design objectives:

➢ *Concept Development*

For the proposed Multipurpose Student Housing Complex at Bonas, the concept was not conceived merely as an aesthetic metaphor imposed on the building. Rather, it was developed as an organizational framework to guide the project's master planning, functional zoning, circulation, massing, landscape, environmental response, structural expression, and architectural identity.

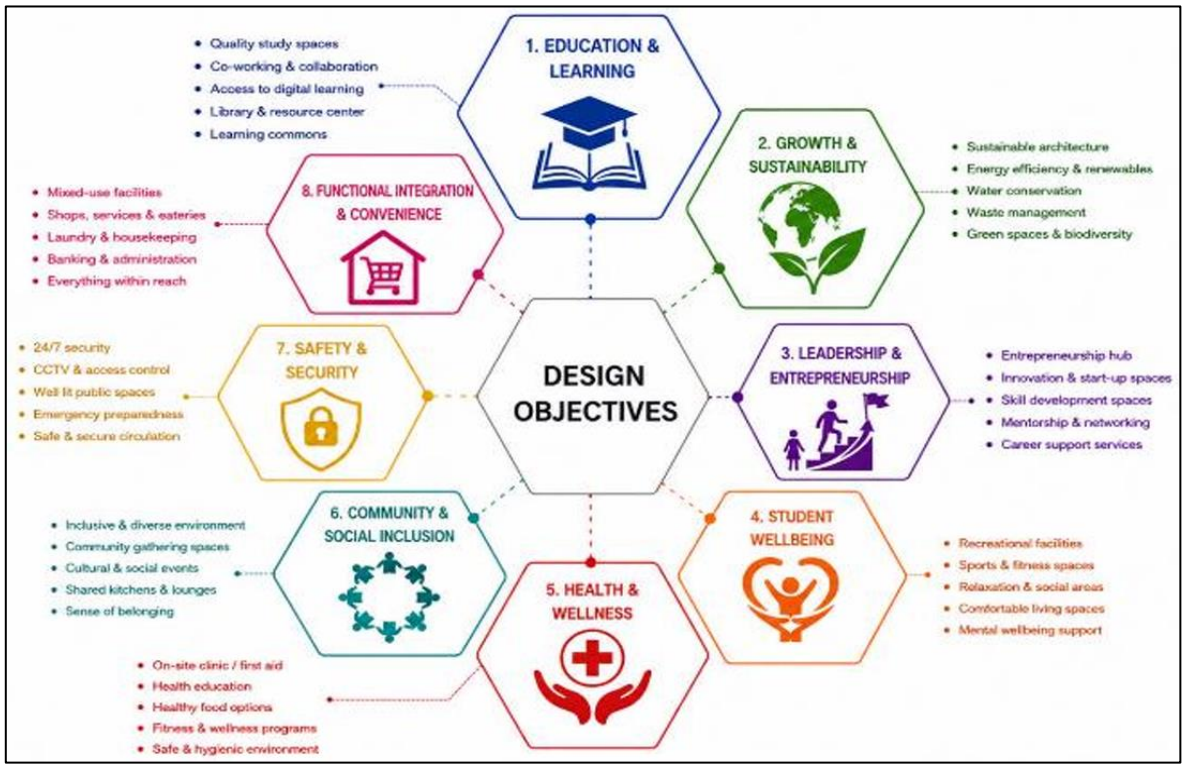

Fig 19 Objectives of the Project

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The central concept adopted for the project is the “Tree of Life and Growth”.

The tree was selected because it represents a living system characterized by foundation, connection, growth, adaptation, interdependence, shelter, regeneration, productivity, Leadership, inclusion, and harmony. These qualities correspond closely to the aspirations of a contemporary student housing environment.

Therefore, the Tree of Life and Growth is conceived not as a physical imitation of a tree but as a generative system that translates the principles of support, connectivity, interaction, environmental responsiveness, and growth into architecture.

- *Origin and the Design of the Concept*

The concept emerged from the convergence of four principal considerations (Figure 20)

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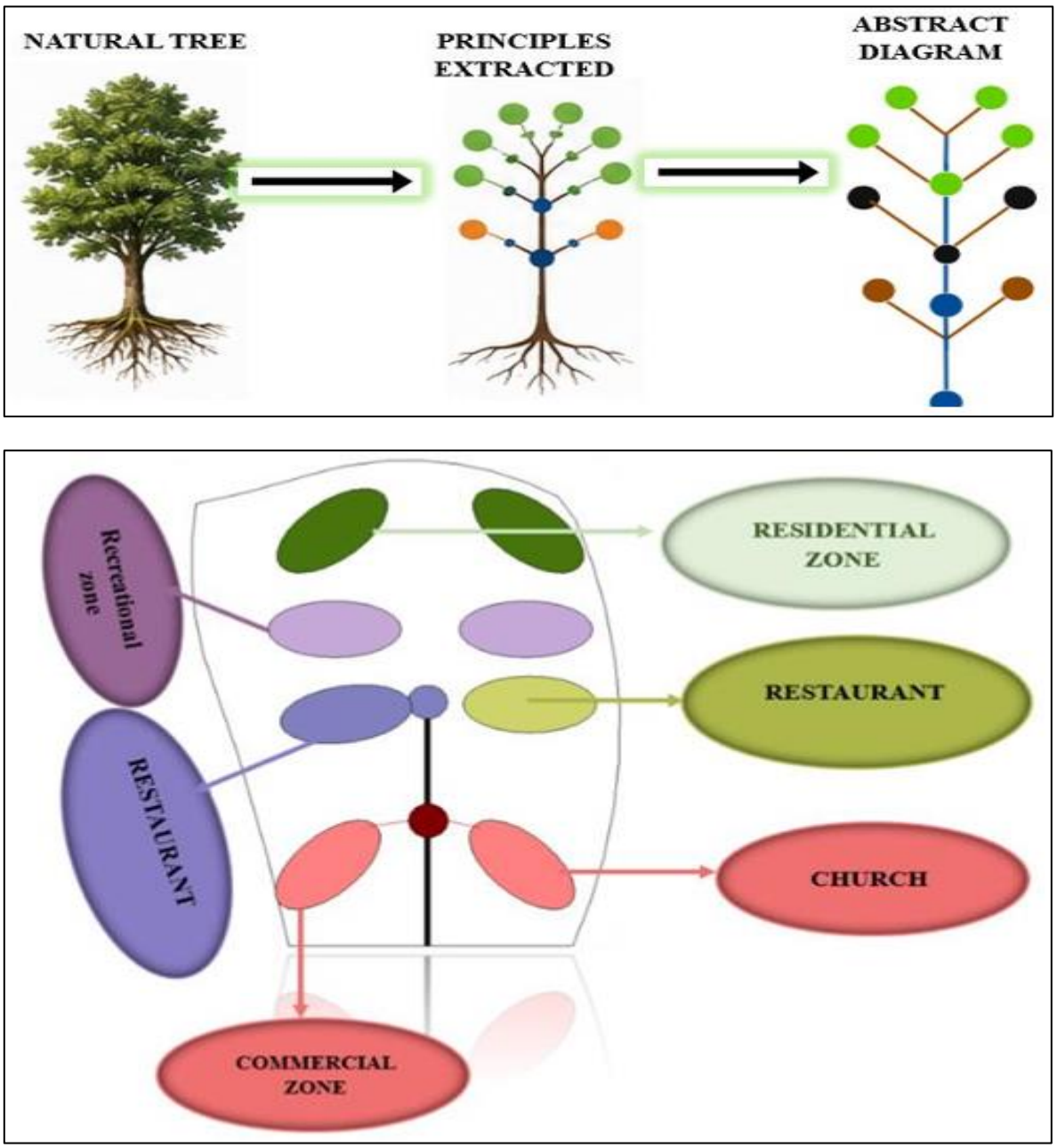

Fig 20 Concept Origin

Table 1 Translation of Tree Anatomy into Architecture

Tree component	Symbolic meaning	Architecture translation
Soil	Context and environment	**Bonas, the site, community, climate, and urban fabric**
Roots	Support and stability	Administration, utilities, security, healthcare
Trunk	Connection and strength	Main circulation spine
Branches	Distribution and diversity	Residential, academic, commercial and recreational wings
Nodes	Interaction and exchange	Courtyards and circulation intersections
Leaves	Growth and environmental exchange	Green facades
Canopy	Shelter and collective identity	Roofs, shading systems,
Fruits	Outcomes of growth	Knowledge, innovation, entrepreneurship and leadership
Seeds	Continuity and future growth	Ideas, future expansion and community transformation

- *Different Concepts Used in the Project*

Although the Tree of Life and Growth constitute the project's principal conceptual framework, the architectural proposal is not derived from this concept alone. Given the development's multifunctional nature and the diversity of student needs identified through the research, several complementary design concepts based on tree elements were incorporated to strengthen the proposal's functional, spatial, environmental, and experiential qualities.

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These supporting concepts do not compete with the primary concept. Rather, they serve as sub-concepts within the broader Tree of Life and Growth framework, each addressing a specific dimension of the project. Together, they help create an integrated living-learning ecosystem. They include:

✓ *Tree Crown*

The shell roof of the multipurpose hall represents the crown of a flourishing tree, a symbol of maturity, achievement, and protection, as shown in Figure 21. As the crown shelters life beneath it, the hall serves as a gathering space for students to engage in academic, cultural, and social activities. The flowing geometry conveys continuous growth, excellence, and the aspiration to reach greater heights.

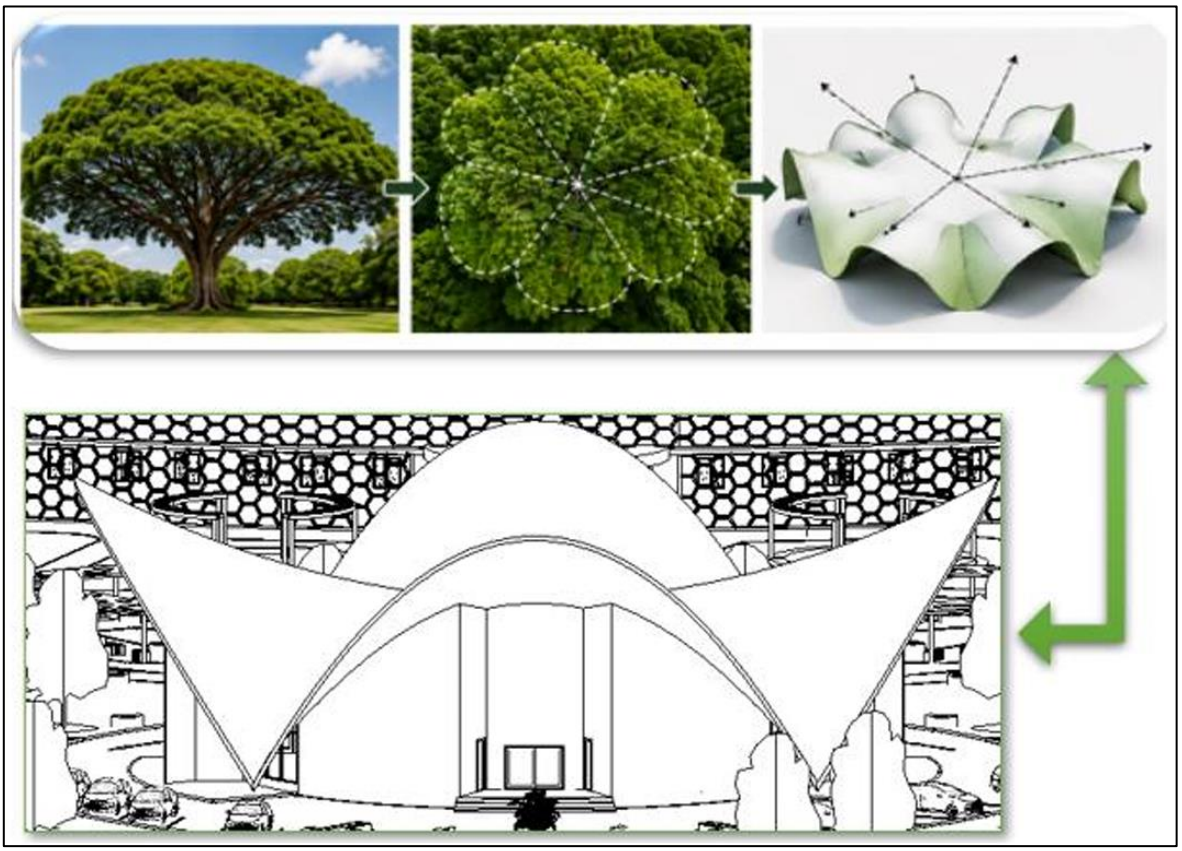

Fig 21 Rooftop Tree Crown Representation

✓ *Palm Leaf Roof*

The library's roof is inspired by the radial geometry of a tropical fan palm leaf, with leaves that extend outward to capture sunlight and provide shade. It visually represents students expanding their knowledge and the continuous pursuit of excellence, as shown in Figure 22.

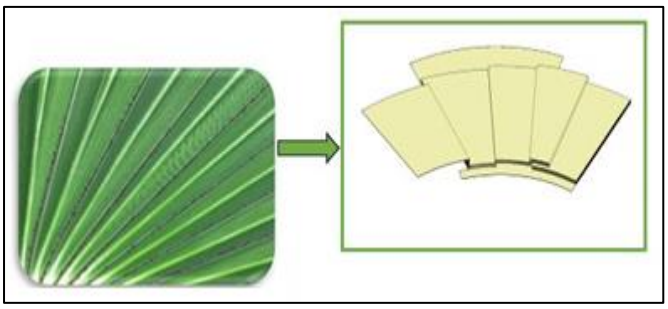

Fig 22 Palm Leaf Roof

✓ *Honeycomb Façade:*

Inspired by the efficiency and organization of a beehive, the hexagonal façade serves as a brise-soleil, providing solar protection while establishing a distinctive architectural identity. Its geometric rhythm creates a visually dynamic façade that reflects the values of unity, collaboration, and academic excellence, as seen in Figure 23.

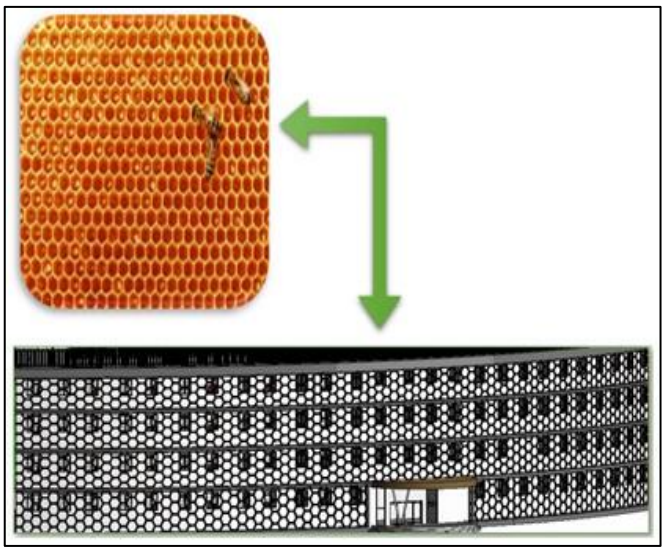

Fig 23 Honeycomb Inspired Façade

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✓ *Nature as Inspiration: Life that Thrives on a Tree*

Inspired by the nests of birds that live in trees, the façade embodies protection, community, and growth. The woven geometric screen, as shown in Figure 24, serves as a brise soleil, filtering sunlight and allowing ventilation while creating a warm, textured identity. It reflects the spirit of a supportive home where students can thrive.

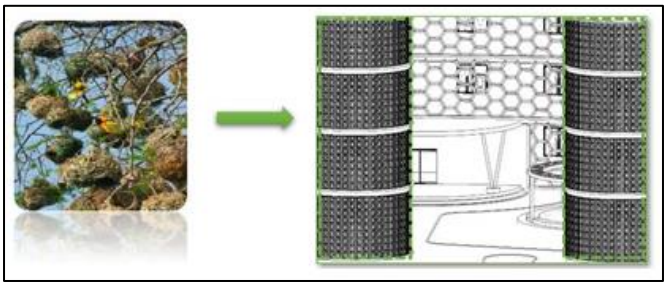

Fig 24 Woven Façade

✓ *Leaf-Inspired Pavilions*

The recreational pavilions, as shown in Figure 25, are inspired by the leaf, the life-giving element of a tree. They provide shade, comfort, and space for interaction, helping students relax, connect, and grow. Just as leaves sustain the tree, these spaces sustain the student community, promoting well-being, creativity, and togetherness.

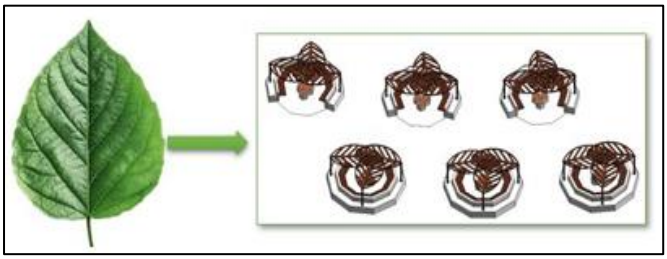

Fig 25 Recreational Pavilions

✓ *Leaf Venation*

The leaf's venation inspires the commercial building's façade. Just as leaf veins distribute water and nutrients to sustain life, the building serves as a hub for the flow of goods, services, information, and opportunities. It also acts as a living skin that filters sunlight while allowing diffused daylight. A façade that breathes like a leaf and connects like a network, as shown in Figure 26.

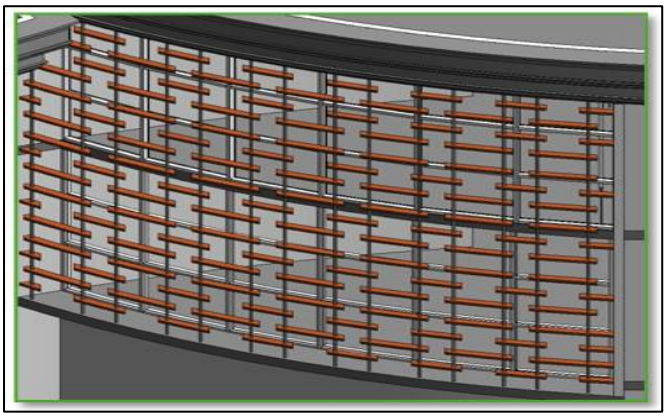

Fig 26 Leaf Venation Façade

✓ *The Bromeliad Sanctuary Canopy*

Inspired by the epiphytic bromeliad, the church roof translates the bromeliad's radial, overlapping leaf structure into a protective sanctuary canopy, as shown in Figure 27. As a life form that grows on the tree, the bromeliad symbolizes the church as the spiritual dimension of the wider Tree of Knowledge and Growth, nurturing unity, faith, fellowship, and spiritual growth.

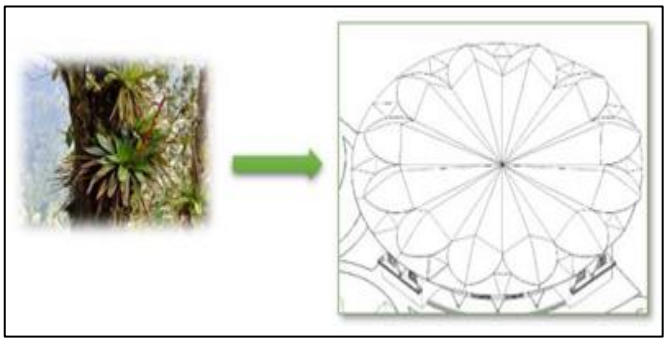

Fig 27 Bromeliad Canopy Roof

B. Analysis

The analysis phase forms the foundation of the architectural design process for the proposed multipurpose student housing complex. 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 defines how spaces relate to one another; adjacency analysis shows the desired functional relationships or degrees of connection among the different spaces in the complex; and dimensional analysis determines the appropriate sizes of spaces based on standards and site conditions, while structural considerations assess the technical feasibility, load-bearing systems, and material strategies necessary to ensure the building's stability and long-term performance. These analyses provide the basis for the design and ensure that the architecture is relevant to its surroundings and meets technical standards.

➢ *Functional Analysis: General and Specific Organigram*

The spatial organigram is a conceptual planning tool for defining and visualizing the relationships among the functional zones within the complex. It organizes the complex into clear zones, ensuring ease and comfort for students and visitors.

The spatial arrangement, illustrated in Figure 28, presents the overall organigram of the complex. This spatial arrangement ensures that the complex's functions are based on flow logic and operational efficiency.

- *General Organigram (Macro-Level Zoning)*

At a high level, the complex is divided into three main zones:

✓ Public zone: Located near the main entrance, it includes the Entrance, Parking, Commercial building, Library, Church, and the multipurpose hall. This zone serves as a

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controlled transition between the external environment and the complex.

- ✓ Residential zone: Comprising five distinct student housing blocks integrated with shared living facilities, the residential zone forms a major branch of the project's Tree of Life and Growth.
- ✓ Recreation Zone: Comprising landscaped green spaces, relaxation areas, shaded seating, and informal social spaces, the recreation zone is strategically positioned between the public and residential zones, serving as a transitional buffer between active public functions and the more private student living environment. The zone offers opportunities for relaxation, informal recreation, social interaction, and mental restoration.

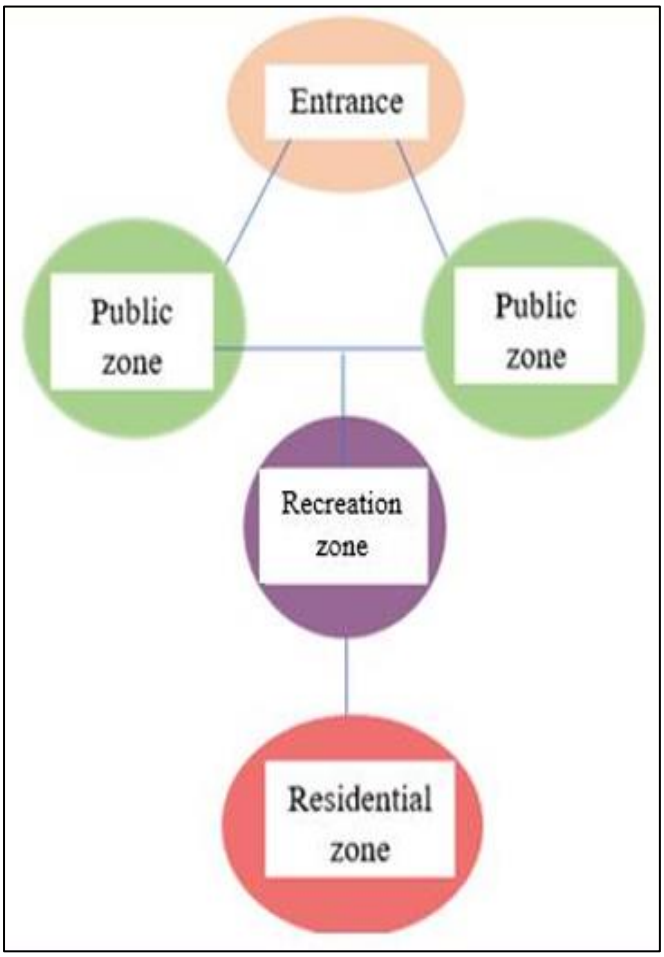

Fig 28 Macro-Level Bubble Diagram.

- *Specific Organigram (Detailed Functional Relationships)*

At the detailed level, the Main Entrance directs movement toward the principal public and mixed-use functions, including the Commercial Zone, Multipurpose Hall, Library, Church, Restaurant, and parking. As shown in Figure 29, these facilities are strategically connected to the main circulation network to ensure accessibility and minimize unnecessary movement through private residential areas. The recreational zone serves as a transitional and social node, linking active public functions to the more private student living environment. From this central network, circulation extends to the five residential blocks, ensuring clear access while maintaining security and privacy. The residential blocks are interconnected through landscaped pedestrian routes and shared open spaces, creating a gradual transition from public and commercial activities to recreation and, finally, private residential life, while promoting social interaction, environmental comfort, and efficient circulation throughout the complex.

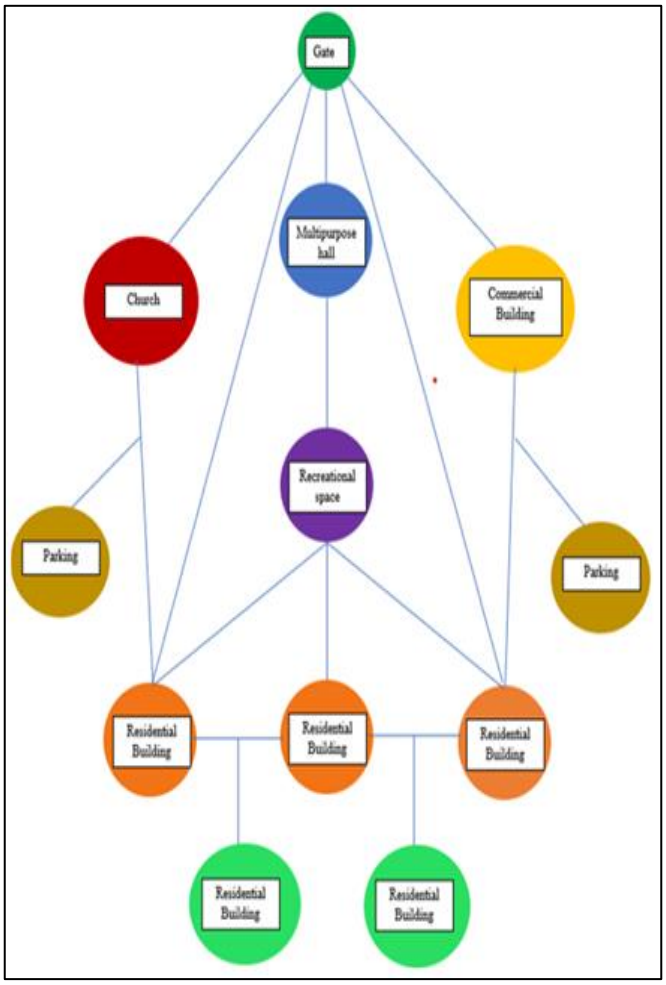

Fig 28 Detailed Relationships Bubble Diagram

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➢ *Adjacency Analysis*

Table 2 Relationship between the different functional zones

Space	Library	Restaurant	Multipurpose Hall	Church	Hostel	commercial
Library	●	○	●	○	●	○
Restaurant	○	●	●	○	●	●
Multipurpose Hall	●	●	●	●	●	●
Church	○	○	●	●	○	○
Hostel	●	●	●	○	●	○
Commercial	○	●	●	○	○	●

Legend:

● Direct relationship

○ Indirect relationship

The adjacency analysis ensured that functions with strong operational relationships were located close together, while conflicting uses, such as noisy commercial spaces and quiet study areas, were physically separated.

➢ *Dimensional Analysis*

This section outlines the key spatial dimensions considered in designing the proposed Multipurpose Student Housing Complex at Bonas. The dimensional requirements were established to ensure functionality, user comfort, safety, accessibility, and efficient spatial organization across the development's components. Consideration was given to the diverse functional requirements of the residential blocks, library, commercial facilities, multipurpose hall, church, restaurant, recreational spaces, and circulation areas. The dimensions were refined through digital modeling, space planning, and layout testing to optimize space utilization, movement, environmental comfort, and accessibility.

- *Estimated Student Capacity*

Room Typology	Single	Double	Studio
Number of rooms	244	129	117
Number of students per room type	244	258	117

Total number of rooms = **490**

Total number of students

= **619 students**

C. Conceptual Mass Evolution

The massing evolution of the proposed Multipurpose Student Housing Complex represents the progressive transformation of the conceptual principles established in the Tree of Life and Growth into a three-dimensional architectural composition. Rather than deriving the final form from a literal representation of a tree, the massing process extracts the tree's underlying organizational principles, including rooting, connectivity, branching, nodal interaction, growth, and protection, and adapts them to the site's functional, environmental, and spatial requirements.

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The evolution begins with the definition of the site and its principal movement structure and progresses through functional clustering, branching, curvature, vertical development, fragmentation, and climatic refinement. The resulting composition is therefore the product of a systematic design process rather than an arbitrary formal gesture.

D. Spatial Distribution of the Different Functional Zones

➢ *Residential Typologies.*

The residential component is the primary function of the proposed Multipurpose Student Housing Complex. However, the student population is not homogeneous. Students differ in financial capacity, privacy requirements, physical abilities, length of stay, study habits, and preferred levels of social interaction. Room typologies are designed to prioritize privacy, comfort, functionality, natural ventilation, daylight, storage efficiency, adaptability, and connection to the wider student community, as seen in Figure 30.

- *Type A: Single Room*

The single room is conceived as a compact yet complete personal environment that supports rest, study, storage, and privacy.

✓ Spatial component: single bed, study desks, wardrobe, private kitchen, and window
✓ Area: 23.675 m^2

- *Type B: Single Room*

The double room provides a more affordable accommodation option while maintaining adequate personal territory for each occupant. The room should therefore establish two recognizable personal territories:

✓ Area: 30.682 m^2
✓ Spatial components: Two beds, two separate desks, separate wardrobes, shared circulation space.

- *Type C: Studio*

The studio offers a higher level of residential independence and may be suitable for postgraduate students, senior students, visiting researchers, or other users requiring longer-term accommodation.

✓ Area: 31.752 m^2
✓ Spatial components: sleeping area, kitchenette, private bathroom, small sitting area, individual study.

Comparative Evaluation of Residential Typologies

Criterion	Single	Double	studio
Privacy	High	Moderate	Very high
Affordability	Moderate	Higher affordability	Lower affordability
Social interaction	Moderate	High	Lower internally
Independent facilities	Limited/moderate	Limited/moderate	High
Study provision	Individual	Individual for each user	Individual

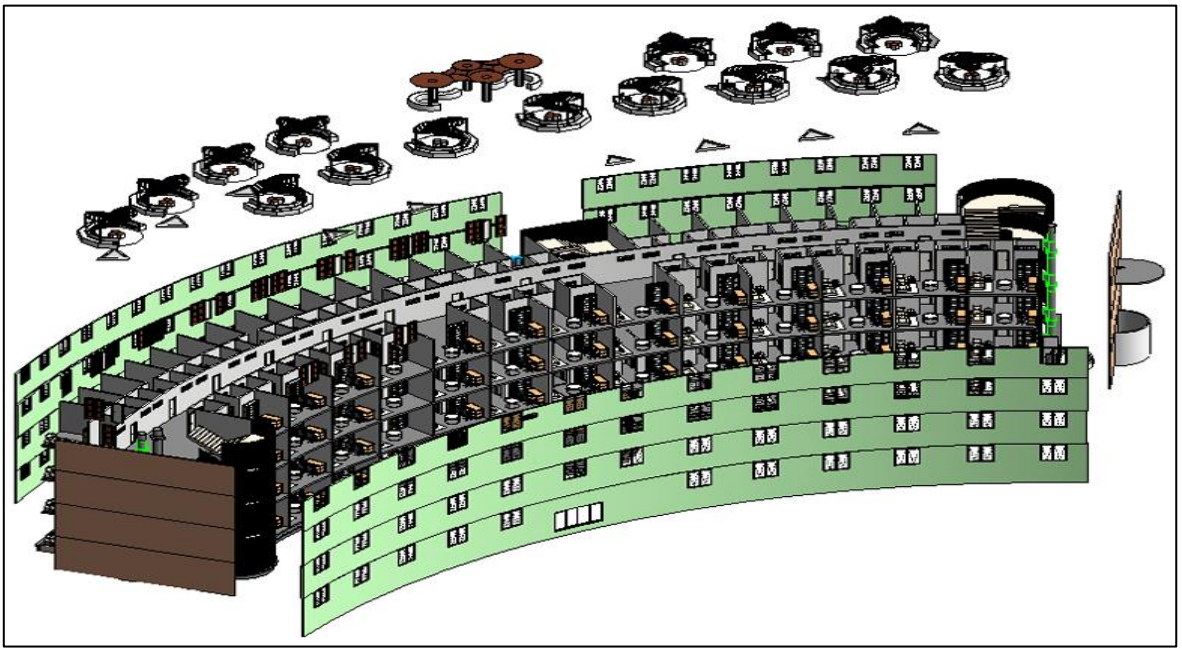

Fig 30 Exploded Axonometric View Showing the Different Room Typology

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➢ *Commercial Functions*

Commercial functions, as seen in Figure 31, are part of the project's mixed-use ecosystem and support daily convenience, student entrepreneurship, local employment, and interaction between the development and Bonas.

Functions include Printing, administrative offices, photocopying, retail shops, restaurants, a clinic, gym, and cafes.

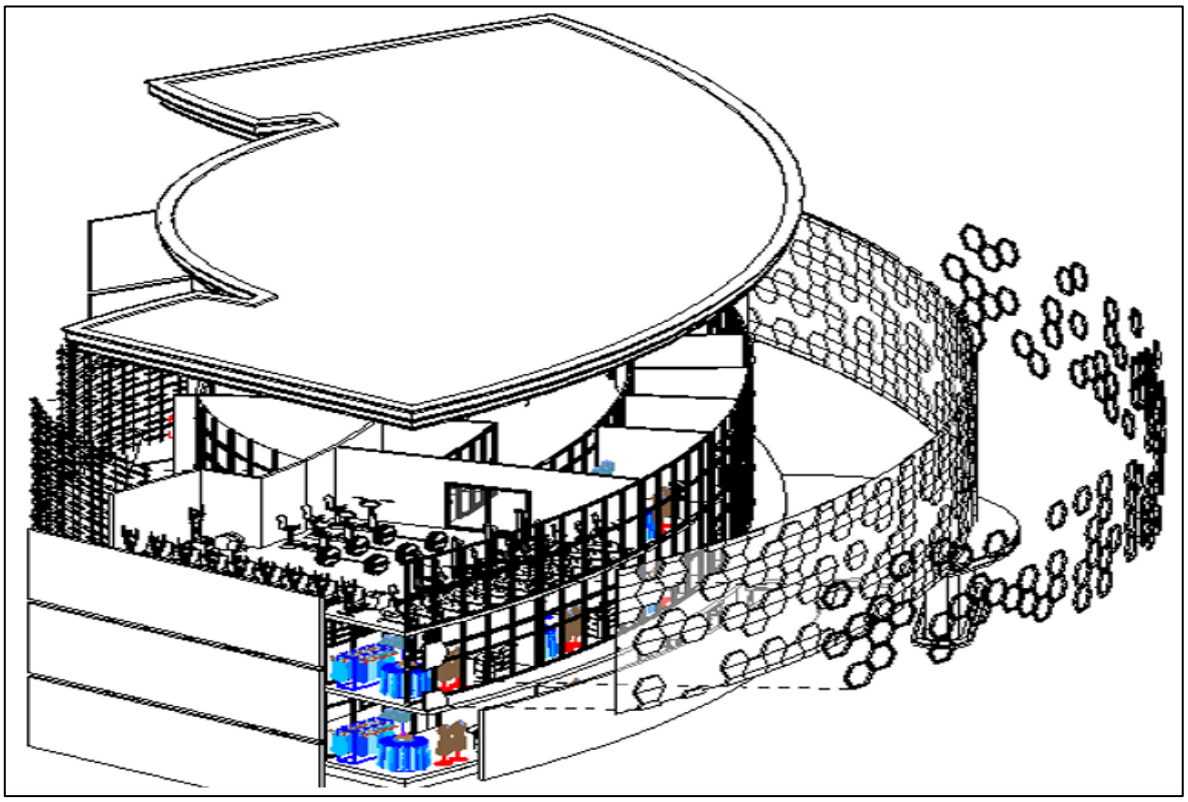

Fig 31 Exploded Axonometric View of the Commercial Building

➢ *Library*

The library, as seen in Figure 32, serves as a primary knowledge resource and a quiet academic environment. It includes reading areas, book collections, the director's office, and a computer room.

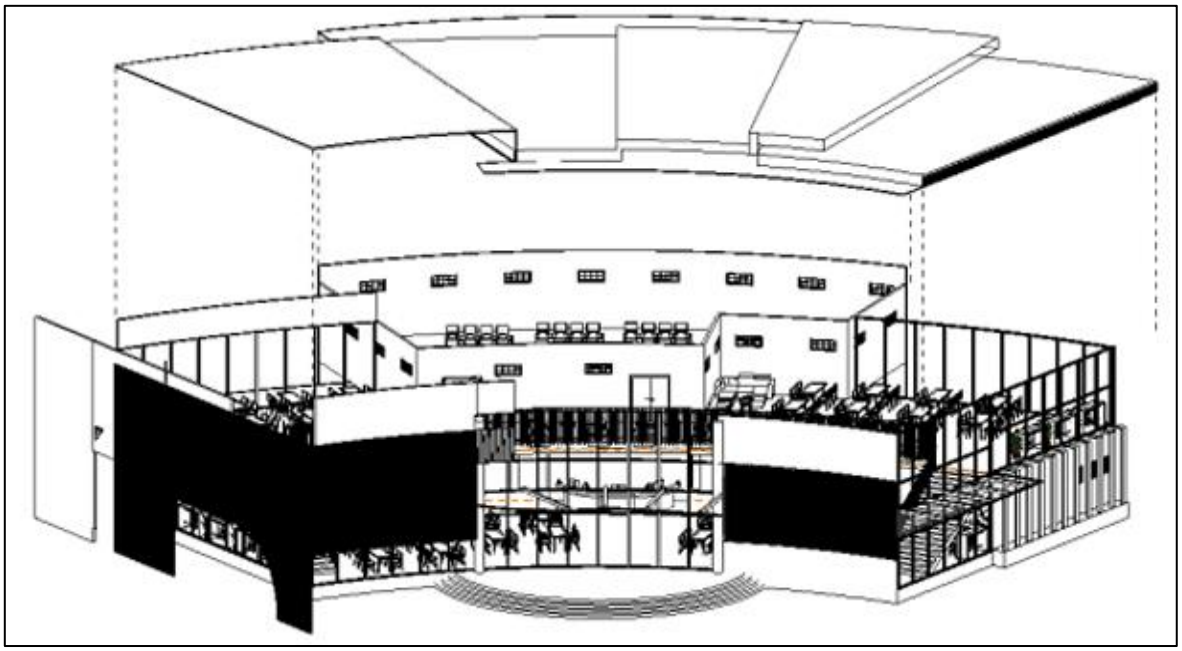

Fig 32 Exploded Axonometric View of the Library

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➢ *Multipurpose Hall*

The Multipurpose Hall is a principal communal facility in the student housing complex, as shown in Figure 33. It is designed as a flexible space for academic, social, cultural, and recreational activities, including seminars, workshops, conferences, exhibitions, student gatherings, and community events. Strategically located within the public zone, the hall promotes interaction, collaboration, and active student engagement, supporting the project's vision of an integrated living-learning environment.

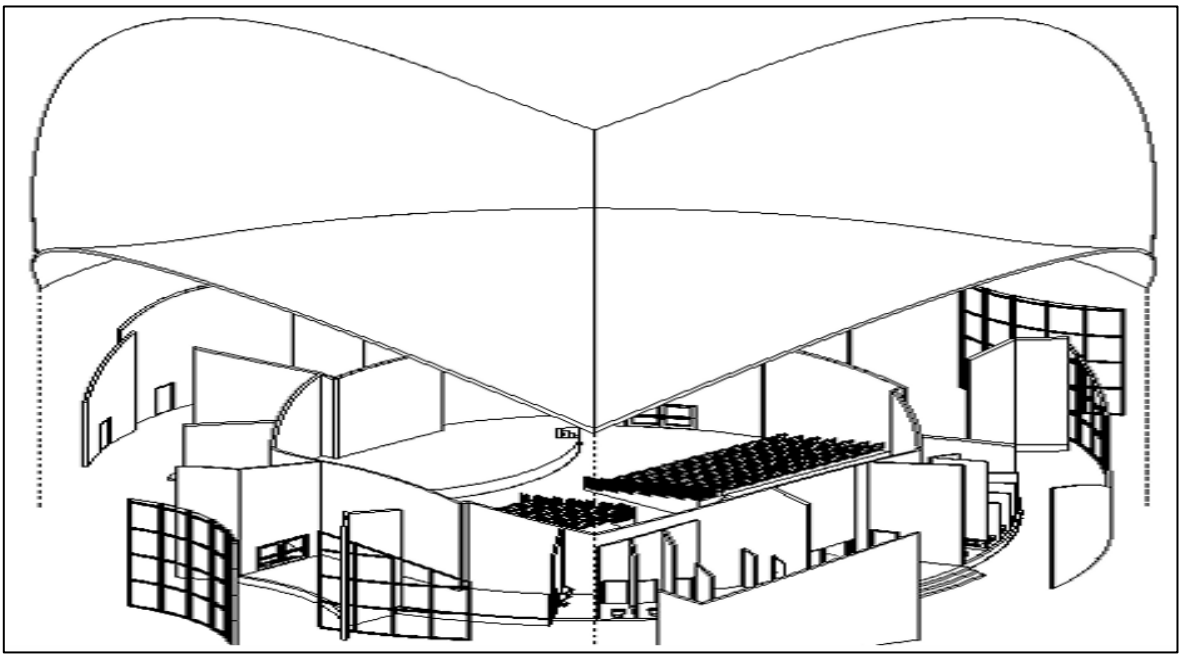

Fig 33 Exploded Axonometric View of the Multipurpose Hall

➢ *Church*

The Church Building provides a dedicated space for spiritual growth, worship, reflection, and fellowship within the student housing complex. Inspired by the Bromeliad Sanctuary Canopy in Figure 34, the roof symbolizes unity, protection, and spiritual nourishment as part of the broader Tree of Knowledge and Growth concept. Beyond religious services, the church serves as a quiet sanctuary that fosters moral development, emotional well-being, and a strong sense of community among students.

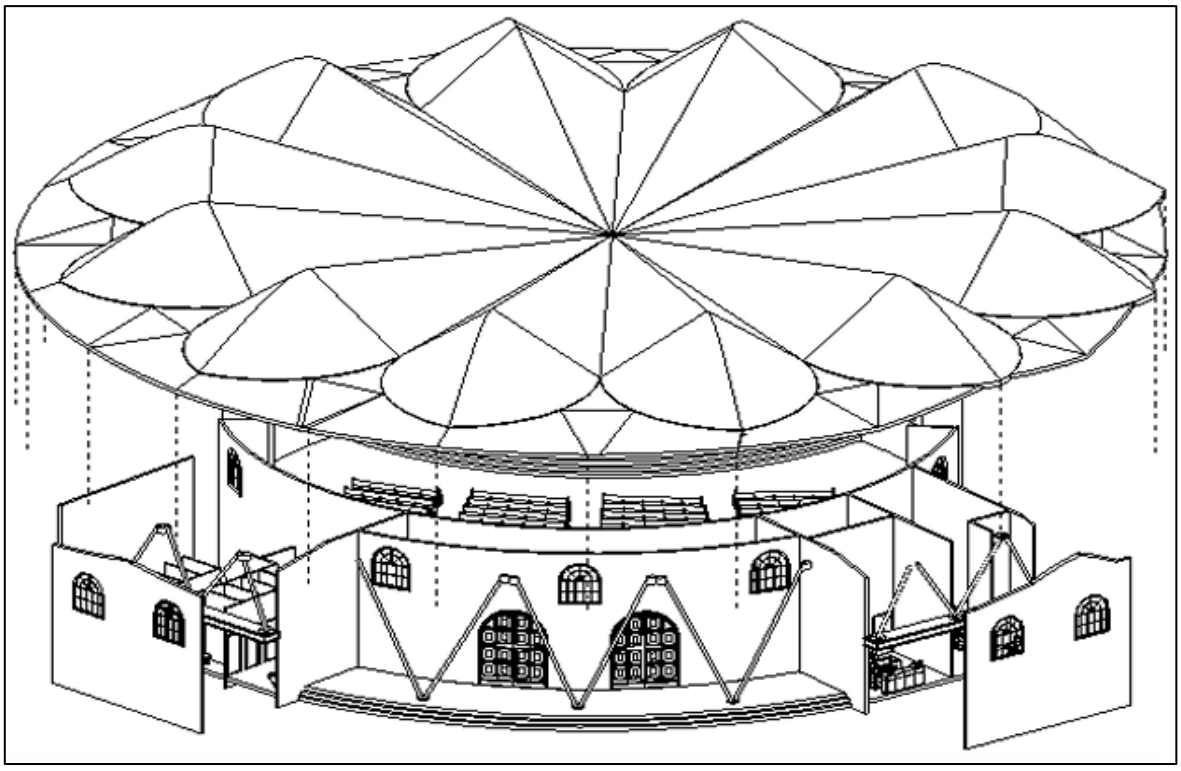

Fig 34 Exploded Axonometric View of the Multipurpose Hall

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E. Architectural and Sustainable Design Approach

The proposed Multipurpose Student Housing Complex's environmental strategy integrates passive design, resource efficiency, renewable energy, and green infrastructure. The aim is to create a climate-responsive development that reduces energy consumption, improves user comfort, and responds appropriately to Yaoundé's tropical conditions.

The multipurpose student housing complex in Bonas integrates seamlessly into the urban environment, addressing spatial and social dynamics. Located in an area with vibrant academic activity, dense student foot traffic, and proximity to university networks, the design aligns with existing pedestrian flows and access corridors, fostering a strong connection between the residence and the broader educational community.

➢ *Urban Integration*

The proposed complex is designed with a clear hierarchy of access and circulation to ensure safety, convenience, and efficient movement throughout the site. The development features separate vehicle and pedestrian access points, allowing for controlled circulation while minimizing conflicts between vehicles and pedestrians. Dedicated entry and exit points facilitate smooth traffic flow within the complex, while pedestrian pathways, 2m wide as seen in Figure 35, create safe and accessible connections between residential, recreational, academic, and commercial facilities.

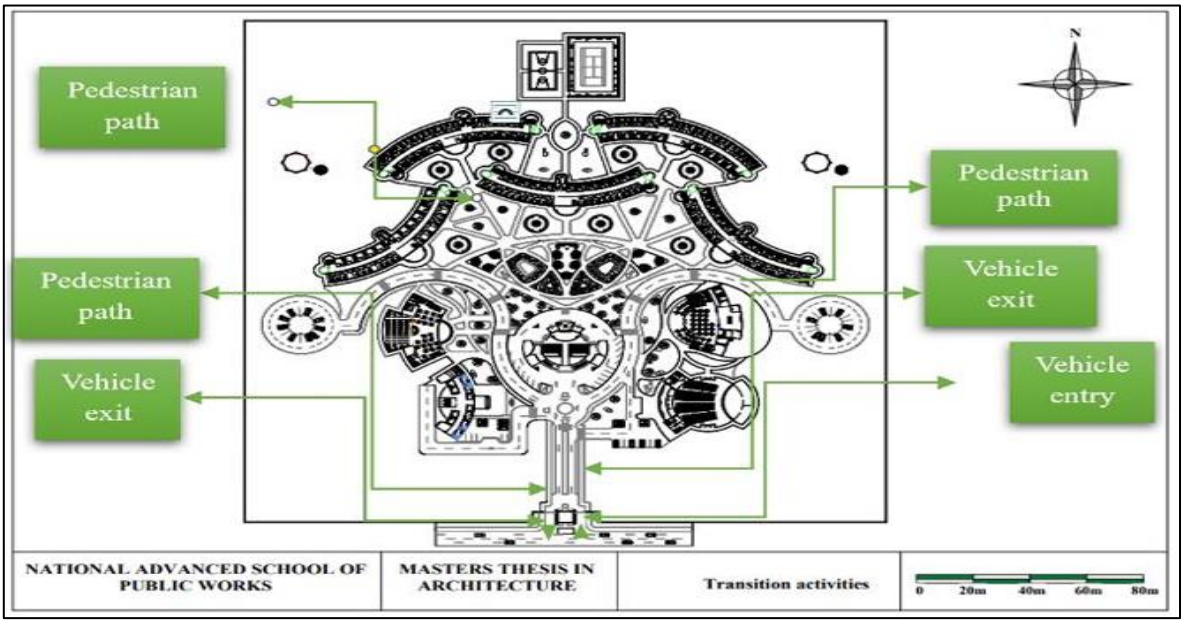

Fig 35 Master Plan Illustrating the Access Points

➢ *Building Orientation*

Residential blocks are positioned so that their longer façades face north and south, while the shorter façades face east and west as seen in Figure 36. This minimizes the building's exposure to intense morning and afternoon sun, significantly reducing solar heat gain and the need for mechanical cooling. Public and communal buildings are oriented toward major circulation routes and activity spaces, where façades experience greater solar exposure; honeycomb screens, brise-soleil, balconies, and vegetation

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Fig 36 Orientation of the Residential Buildings

➢ *Solar Protection and Passive Cooling*

Solar protection is achieved through a layered system comprising the honeycomb façade, brise-soleil, recessed windows, balconies, and trees, as shown in Figure 37. The honeycomb-and-leaf-venation façade serves as a secondary skin that filters sunlight, enhances privacy, reduces glare, and contributes to the project's architectural identity.

The project prioritizes passive cooling to reduce dependence on mechanical air-conditioning; strategically placed windows on opposing façades capture prevailing winds and draw them through the building. This promotes continuous airflow, improving indoor air quality and further reducing reliance on air conditioning.

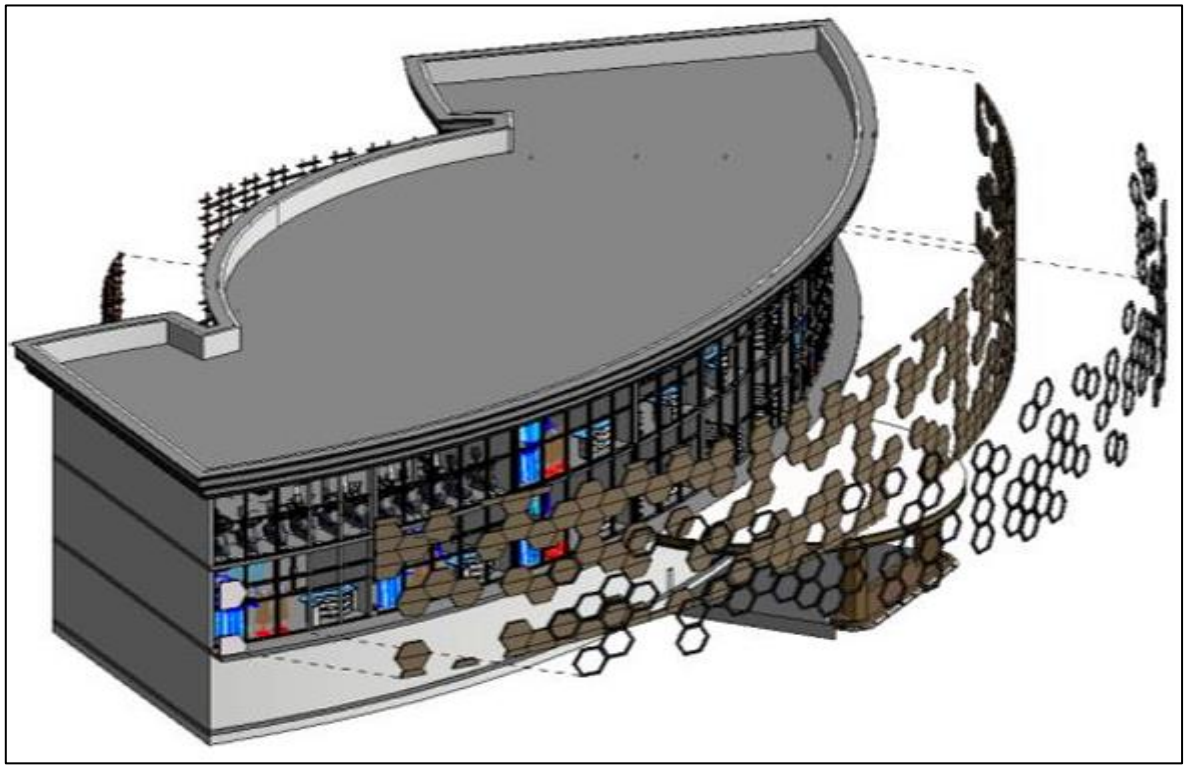

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Fig 37 Perspective View

➢ *Water Management and Distribution Strategy*

The proposed Complex incorporates a primary potable water supply sourced from the CAMWATER municipal network. To improve reliability during interruptions, water will be stored in appropriately sized tanks based on the calculated daily demand and the required reserve capacity, as shown in Figure 38. Pressure pumps will distribute water to the different buildings and upper floors where network pressure is insufficient. The system follows the principle:

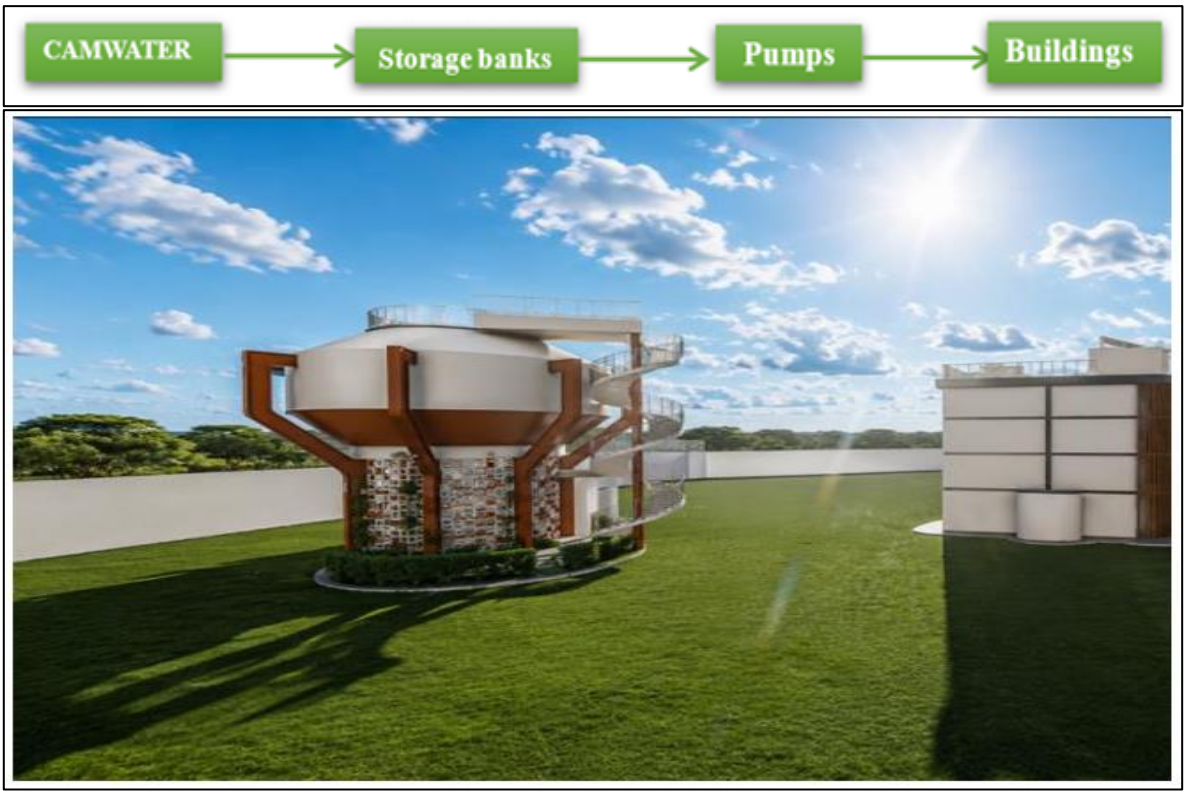

Fig 38 Water Storage Tank

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➢ *Waste Collection and Management*

Waste management is organized through a coordinated system beginning at the point of generation. Figure 39 shows a centralized waste collection strategy that is integrated into the building design by providing vertical trash chutes that serve the residential floors. The trash chute system consists of enclosed vertical shafts that allow residents to conveniently dispose of household waste from designated collection points located on each floor. Waste deposited into the chute is transported by gravity to a centralized collection room or container at ground level in the building. This approach eliminates the need for students to carry waste through stairways and corridors, thereby improving hygiene and reducing inconvenience. Waste can be sorted, stored temporarily, and collected at scheduled intervals for disposal by authorized waste management providers. The system follows the principle:

Fig 39 Waste Collection Chute

➢ *Security and Surveillance Systems*

Security is conceived as a layered system combining architectural planning, human supervision, lighting, and technology. The proposed Complex incorporates a comprehensive security and surveillance system to ensure the safety, security, and well-being of students, staff, and visitors. The complex is equipped with a Closed-Circuit Television (CCTV) system strategically installed at key locations, including building entrances and exits, circulation corridors, parking areas, recreational spaces, commercial zones, and other common areas. A centralized security control room is provided within the development, serving as the main monitoring and response center for the CCTV network and other security systems, as seen in Figure 40. Security personnel stationed at this control point can monitor live camera feeds, coordinate emergency responses, and maintain oversight of activities throughout the complex. In addition, we also have streetlights positioned along streets for security at night. The system follows the principle:

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Fig 40 View Showing Security and Surveillance Systems

➢ *Electrical Supply*

The primary electrical supply will be delivered via the SOCADEL electrical network and distributed through appropriately designed electrical panels to the various functional zones. Because reliable electricity is essential for student accommodation, learning facilities, security, and digital infrastructure, backup systems will be incorporated. These include backup generator systems for essential loads and photovoltaic solar panels, as seen in Figure 41. The system follows the principle:

Fig 41 View Showing Installed Solar Panels

➢ *Student Experience and Comfort*

The complex prioritizes student comfort through design features such as natural ventilation, adequate daylighting, shaded outdoor spaces, and passive cooling measures that maintain pleasant indoor conditions year-round, as shown in Figure 42. Spacious residential units, communal study areas, recreational facilities, and landscaped open spaces provide students with opportunities for learning, relaxation, and social engagement.

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Fig 42 View Showing Spaces Outdoor

➢ *Aesthetic*

The aesthetic approach balances functionality with visual appeal, as shown in Figure 43 Inspired by the concept of the tree of knowledge and growth, the design creates a visually distinctive and meaningful architectural identity. It combines organic forms, nature-inspired elements, and contemporary architectural principles to create a vibrant, welcoming environment that reflects the aspirations and dynamics of student life.

Fig 43 Bird's-Eye Aerial View

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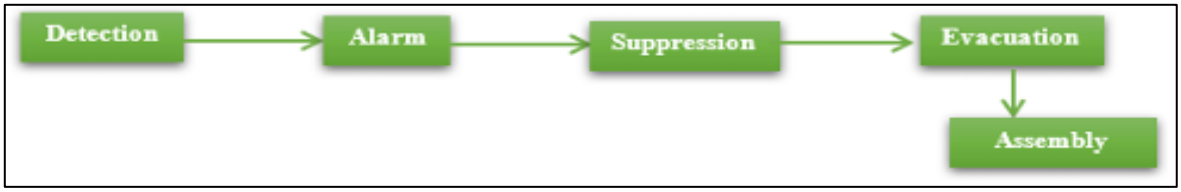
➢ *Durability*

The durability of the complex is ensured through a combination of resilient materials and smart design strategies. The honeycomb-inspired façade is constructed from aluminum finished to resemble wood, providing shading and screening protection for the building envelope while delivering the strength, corrosion resistance, and low maintenance of metal, all ideal for Yaoundé's climate. Beyond the façade, the structure employs reinforced concrete slabs and columns to ensure high load-bearing capacity. High-quality roofing is incorporated to enhance the complex's longevity and minimize deterioration, as shown in Figure 44.

Fig 44 Bird's-Eye Perspective View

➢ *Fire Safety*

Fire safety will be integrated into the architectural and building services design from the earliest stages. The strategy combines prevention, detection, suppression, evacuation, and emergency response. The proposed system includes smoke and heat detection, fire alarms, fire extinguishers, sprinklers where required, internal and external hydrants, protected escape stairs, and clearly marked emergency exits. The system follows the principle:



IV. COST ESTIMATION

The cost estimation of the Multipurpose Housing complex 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 the various elements, circulation systems, and sustainability features, it qualifies as Category 2 (Standard), estimated at 300,000 FCFA/m^2.

With a total built-up area of $40{,}588m^2$, the estimated construction cost is calculated as follows;

$$18{,}591\text{m}^2 \times 300{,}000 = 5{,}577{,}300{,}000$$

Thus, the total estimated construction cost for the facility is approximately 6 billion FCFA, exclusive of taxes, consultancy fees, and unforeseen contingencies. This estimation serves as a financial benchmark for project planning and budget allocation.

V. PROJECT EVALUATION AND PERFORMANCE ASSESSMENT

The performance of the proposed Multipurpose Student Housing Complex in Bonas, Yaoundé, is assessed by how effectively the final design addresses the problems and objectives established at the start of the project.

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Table 3 Functional Evaluation of the Proposed Multipurpose Student Housing Complex

User Group	Identified Needs	Design Response	Performance Assessment
Students	accommodation, study recreation, security interaction, food and essential services	Hostels, library, Multipurpose hall, green spaces, controlled circulation	High
Visitors	Clear access, waiting areas	Defined entrance, Legible pedestrian, Routes, accessible Commercial, and Community facilities	Good
Staff	functional workspaces, service circulation	Administrative and service integrated within the functional zoning system	Good
community	Commercial services, meeting facilities, recreation and social interaction	Commercial spaces, multipurpose hall church restaurant, accessible external, spaces	High

VI. IMPACT ASSESSMENT

This section outlines the anticipated impact of the proposed Multipurpose Student Housing Complex in Bonas, Yaoundé. The assessment evaluates the sociocultural and economic, architectural and environmental implications of the project, as well as its contribution to student welfare and sustainable urban development. The project is envisioned as more than a residential facility. It also includes a SWOT analysis to identify the complex's key strengths, weaknesses, opportunities, and threats.

- *Sociocultural Impact*

The proposed student housing complex is expected to have a significant positive sociocultural impact by providing a safe, inclusive, and supportive environment for students. The development fosters social interaction and community building through communal spaces, recreational facilities, study areas, cafés, and multipurpose gathering spaces. The Tree of Life and Growth concept promotes a sense of belonging, collaboration, and shared identity among residents from diverse cultural and academic backgrounds. Recreational spaces, landscaped courtyards, and communal facilities encourage social integration, cultural exchange, and personal development while supporting students' physical and mental well-being.

- *Economic Impact*

Economically, the proposed Multipurpose Student Housing Complex is expected to generate both short-term and long-term benefits. During the construction phase, the project will stimulate economic activity through the procurement of construction materials, the engagement of contractors, and the employment of skilled and unskilled labor.

Upon completion, the complex will generate steady revenue from the rental of student apartments, including studios, one-bedroom units, and other residential units. Additional income will come from commercial spaces within the complex, such as retail shops, cafés, restaurants, bakeries, laundromats, gym facilities, and other support services.

The project will also create direct and indirect employment opportunities in areas such as facility management, security, administration, maintenance, cleaning services, retail operations, healthcare services, and recreational facility management. By attracting students and supporting local businesses, the development will contribute

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positively to the local economy while strengthening the city's educational infrastructure. The commercial component will create opportunities for student entrepreneurship. Selected commercial units could accommodate student-led businesses and services, such as printing and photocopying, digital and ICT services, and food services.

- *Assumptions*

Cost of Rent Per Room

Room Type	Single	Double	Studio
Price per month/FCFA	35,000 FCFA	40000 FCFA	50000 FCFA

Cost of Rent Per Retail Shop

Shope Type	Small retail	Big retail
Price per month/FCFA	50,000 FCFA	60,000 FCFA
Photocopy and printing shop	30, 000 FCFA	

Gym membership per student: 10,000FCFA

Construction cost: 5,577,300,000 FCFA

Running costs: 10% of gross annual revenue

Annual Revenue Calculations

$$Single\ room = 35{,}000 \times 12 \times 244 = 102{,}480{,}000FCFA$$

$$Double\ room = 40{,}000 \times 12 \times 124 = 59{,}520{,}000FCFA$$

$$Studio = 50{,}000 \times 12 \times 117 = 70{,}200{,}000FCFA$$

$$Total\ 1 = 232{,}200{,}000FCFA$$

$$Mini\ retail\ shop = 7 \times 50{,}000 \times 12 = 4{,}200{,}000FCFA$$

$$Mini\ retail\ shop = 12 \times 60{,}000 \times 12 = 8{,}600{,}000FCFA$$

$$\text{Gym membership} = 10000 \times 100 \times 12 = 12{,}000{,}000FCFA$$

$$\text{Photocopy and printing shops} = 30{,}000 \times 10 \times 12 = 3{,}600{,}000\text{FCFA}$$

$$Total\ 2 = 28{,}400{,}000\ \text{FCFA}$$

$$Annual\ Gross\ Revenue = Total\ 1 + Total\ 2$$

$$= 232{,}200{,}000FCFA + 28{,}400{,}000\ FCFA = 260{,}600{,}000FCFA$$

Annual Net Revenue (After 10% running costs):

$$260{,}600{,}000 \times 90\% = 234{,}540{,}000\ FCFA$$

Return on investment (ROI)

Construction cost: 5,577,300,000 FCFA

Annual Net Revenue: 234,544,000 FCFA

Estimated ROI period: $5{,}577{,}300{,}000 \div 234{,}540{,}000 \approx 23.78 years$

- *Note:*

✓ These calculations were based on assumptions.
✓ The revenue generated by the restaurant, bakery, café, and clinic, as well as the rent for the multipurpose hall, was not included.

So, this greatly affects the return on investment.

➢ *Architectural Impact*

Architecturally, the project offers an innovative approach to student housing in Cameroon by integrating residential, commercial, recreational, and communal functions within a single development. The project demonstrates how nature-inspired design principles can be translated into contemporary architecture to create meaningful, sustainable, and contextually responsive built environments.

The development could serve as a model for future student housing projects in Cameroon by promoting mixed-use planning, sustainability, and community-centered design.

➢ *Environmental Impact*

The project's environmental performance was evaluated based on energy use, water management, carbon reduction, waste management, and the provision of green spaces.

Table 4 Environmental Performance Assessment

Environmental Aspect	Proposed Strategy	Expected impact
Energy	Natural lighting, natural ventilation Solar energy and efficient lighting	Reduction in conventional energy demand
Green space	Rooftop, trees and landscape spaces	Improved microclimate and user well-being
waste	Organized waste collection and trash chute strategy	Improved waste handling
Solar Control	Honeycomb-inspired façade and screening devices	Reduction of excessive solar exposure

VII. CONCLUSION

This article addressed the growing student housing challenges in Bonas, Yaoundé, by proposing a sustainable, multipurpose student housing complex that integrates residential accommodation with academic, commercial, recreational, and community facilities. The findings demonstrate that the housing deficit in Bonas extends beyond a shortage of accommodation to include inadequate infrastructure, poor environmental quality, limited communal

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1049

spaces, and fragmented urban development. These deficiencies negatively affect students' well-being, academic performance, and the overall quality of the urban environment.

The proposed architectural solution shows that student housing can be more than a residential facility. By adopting a mixed-use development approach, the project integrates housing, learning spaces, commercial services, recreational facilities, green infrastructure, and public open spaces within a cohesive architectural framework. Incorporating passive environmental strategies, including natural ventilation, daylight optimization, landscape integration, and energy-efficient design, further enhances the development's environmental performance and long-term sustainability. These strategies improve user comfort while reducing operational costs and environmental impacts.

Beyond meeting students' accommodation needs, the proposed development can significantly contribute to the regeneration of the Bonas neighborhood. Through improved pedestrian connectivity, organized mixed-use functions, high-quality public spaces, and a strong architectural identity rooted in the local context, the project promotes social interaction, strengthens the local economy, and enhances the overall urban experience. Integrating academic, social, and commercial activities within a single development reflects contemporary principles of sustainable urbanism and demonstrates how architecture can respond to both institutional and community needs.

The findings of this study support the view that well-planned student housing should be considered an essential component of urban infrastructure rather than merely a collection of residential buildings.

While this research presents a conceptual architectural proposal, future studies could extend the work through detailed post-occupancy simulations, building energy performance modeling, structural optimization, financial feasibility analysis, and stakeholder evaluation. Comparative studies of student housing developments in other university cities across Cameroon and Sub-Saharan Africa would also help validate and refine the proposed model. Overall, this study offers a practical, adaptable framework for planning and designing sustainable student housing that can inform future architectural practice, institutional investment, and urban development policies in rapidly urbanizing regions.

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