

Shopping Mall Architecture in Tropical Environment of the Republic of Congo

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Abstract The lack of multifunctional shopping centers is a major issue that hinders tourism and leisure activities in the Republic of the Congo. This work proposes architectural techniques for the spatial organization of three-level commercial and leisure centers. This methodology addresses the scarcity of such infrastructure in Congolese urban centers. The approach involved collecting and analyzing data on key climatic and geographical conditions, as well as drawing on construction feedback from hot and humid environments. The three levels of architectural and urban organization obtained include: (a) the urban planning level, which encompasses streetscape design and green spaces; (b) the building design level, which focuses on integrating the structure into the environment and creating protective elements against climatic factors; and (c) the spatial level, which involves the treatment of marshy areas and the creation of drainage channels for runoff water. The ultimate goal of this work is to establish conditions for comfort, urban hygiene, and safety within multifunctional shopping centers serving as public hubs.

Keywords: *hopping and entertainment center, retail trade (retail), climatic influence, architectural and spatial organization*

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1. Introduction

This article examines the influence of climate on shopping and leisure centers, taking into account the specific characteristics of their construction in the Republic of the Congo. Key architectural techniques for organizing seasonal (summer) trade within these complexes are identified. The article also analyzes the possibilities for functional distribution within shopping centers, in accordance with the conditions of different climatic regions and the flood risks present in various areas of the country.

Climatic conditions in the Republic of the Congo are extremely diverse. The country spans three climatic zones simultaneously: equatorial, subequatorial, and tropical. Furthermore, a significant portion of the northern regions experiences constant flooding due to the Congo River

(Figure 1), while the weather conditions in the southern regions are influenced by the ocean.

Overall, the country's climate is hot and humid, being equatorial in the north and subequatorial in the south.

Average monthly temperatures in the capital region are approximately +26°C in April and +22°C in July; however, daytime temperatures often exceed +25°C every month, while nighttime temperatures can drop to +17°C. Almost everywhere, except for a narrow strip north of the equator, the year is divided into a dry season (May – September) and a rainy season (October – April). In certain areas, an alternation of two dry seasons and two rainy seasons is observed. The heaviest rainfall occurs in March-April and October-December. January and February mark the "short dry season," when rain is less frequent. However, air humidity remains very high throughout the year. Typical annual rainfall varies between 1400 and 2000 mm, with slightly lower precipitation along the coast [1,2].

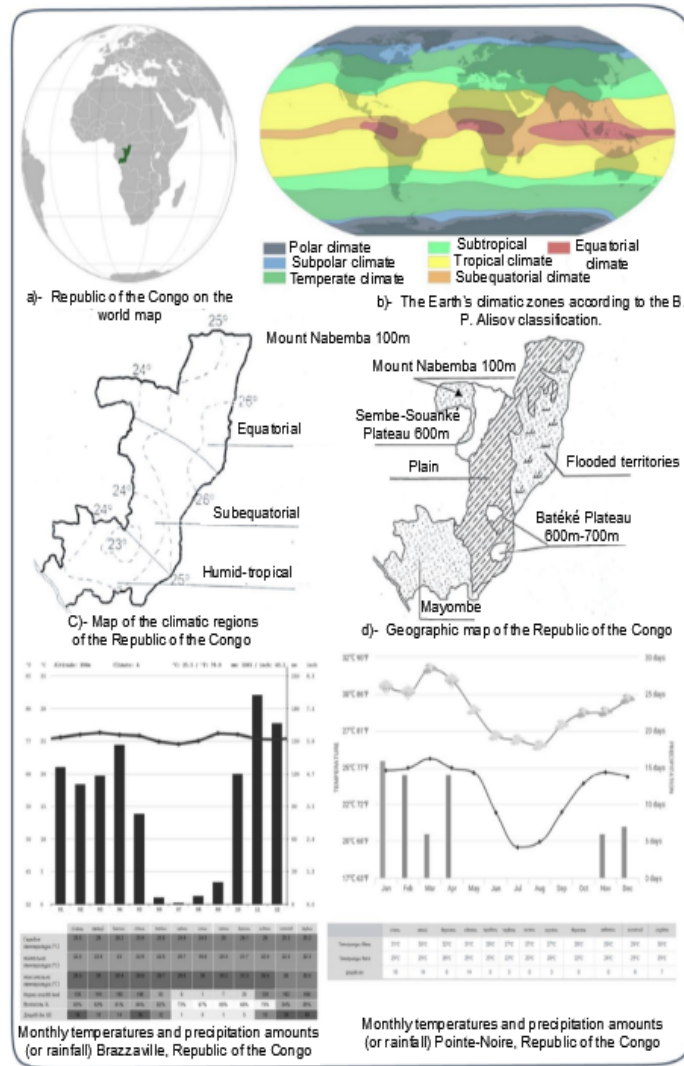


Figure 1. Geographical and climatic conditions of the Republic of Congo's location

2. Materials and Methods

In previous studies on the organization of commercial and entertainment establishments [3-15], the influence of significant amounts of precipitation on architectural and urban planning was not taken into account; however, there have been works reflecting the influence of local conditions on architectural and spatial organization [14], as well as works dedicated to design in tropical climate conditions [16].

All of these weather conditions have a significant impact on the lives of the local population and a corresponding impact on the organization of public places, particularly shopping and entertainment centers. Creating comfortable living and working conditions for both visitors and employees will contribute to the development of this type of building and, consequently, to the increase in the overall development level of the country. Architectural and planning methods are determined for the design and construction of shopping and entertainment centers in humid tropical zones. This makes it possible to protect visitors, staff, and products from the effects of humidity and rain.

3. Results

The greater part of the territory of the Republic of the Congo is prone to heavy rainfall and also suffers from flooding due to the overflowing of the Congo River. The results obtained from this study are presented at three specific levels:

3.1. Urban Planning Level

Spatial planning and designing in humid climatic conditions necessitate the resolution of several tasks: creating a hygienic microclimate within urban areas and draining spaces to ensure their usability. There are numerous methods for developing public spaces within flood-prone territories. The most successful among them are implemented in Northern European cities. The concept developed for Copenhagen [17], based on the installation of wide green streets capable of absorbing excess surface moisture, warrants particular attention.

Generally, in a hot and humid climate, an open-space system can function very effectively to create the

necessary microclimatic conditions, though it possesses distinct characteristics. The increase in air humidity at high daily temperatures necessitates a targeted opening of interior spaces to ensure cross-ventilation. Simultaneously, protecting buildings against overheating is a prerequisite: this involves a specific orientation of the overall urban development, the organization of the landscaping system, and the use of solar protection devices.

The composition of architectural space under these conditions also exhibits characteristic features [18]: (i) a unique system of interdependent spaces is created (residential sites, the city center, public squares); (ii) green belts traverse the city in directions coinciding with the prevailing winds; (iii) residential neighborhoods have a streamlined shape, which increases breeze circulation; (iv) the space within residential buildings opens up to cool breezes; and (v) the composition of the buildings is open and spatial (Figure 2, Figure 3).



Figure 2. Use of terrain elevation changes and green spaces for water absorption in the vicinity of the shopping center [19,20]

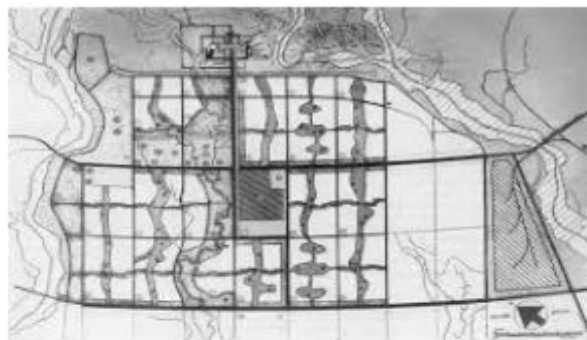


Figure 3. Creation of fluid spaces and street profiles [19,21]

It was on this basis that the city of Chandigarh was designed [18]. This illustration represents one of the best-known examples in the world of constructing new cities within the limits of a tropical climate. Solar radiation and winds were considered the primary climatic factors for the city. The open spatial composition of Chandigarh is dictated by the need for ventilation of neighborhoods and buildings, which is extremely characteristic of a hot and humid tropical climate.

3.2. Building Design Level

The forced openness of shopping and entertainment center spaces must be balanced by the presence of canopies. The spatial structure of an interior courtyard covered by a canopy can be used to organize outdoor trade within the shopping center, as well as dining facilities, terrace areas for restaurants and cafes, and entertainment spaces such as dance floors or roller-skating rinks [13], as shown in Figures 4 and 5. It can also serve as a shelter for technical processes, such as unloading goods and the organized storage of waste. Another specific method for protecting the environment from the impact of precipitation involves shaping the building to collect rainwater. In this case, the rainwater can be purified and used for domestic purposes, utilized in decorative ponds on the shopping center grounds, or simply diverted into the storm sewer system.

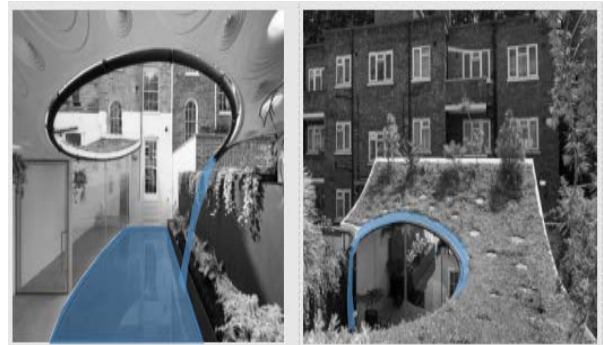


Figure 4. Morphogenesis for rainwater harvesting [22]



Figure 5. Canopies for rain protection [23]

3.3. Spatial Level

Within the grounds of the shopping center, it is possible to develop public spaces designed for pleasant outdoor leisure. These areas can feature specific landscaping elements that, during rainfall, function as rainwater receptors, draining the water into storage tanks or storm sewers Figure.6. To drain marshy areas allocated for the development and construction of shopping centers, drainage canals can be utilized—a common practice in global experience for reclaiming marshy and flooded lands Figure.7. These canals can be transformed into landscape features, such as a park adjacent to the shopping center. This acts as an attractor for the local population, stimulating an increase in visitor footfall and commercial revenue.

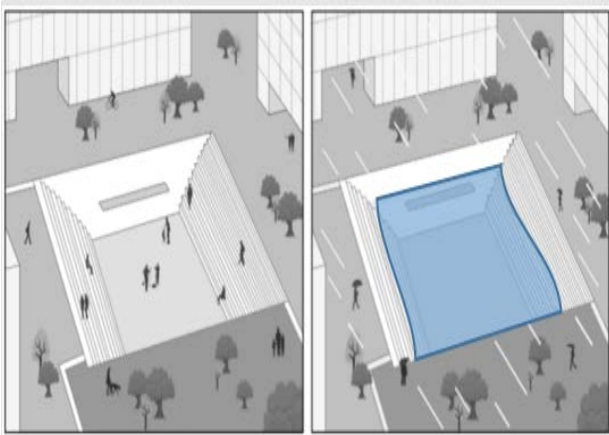


Figure 6. Protection of open surfaces within the shopping center grounds against runoff water [24]

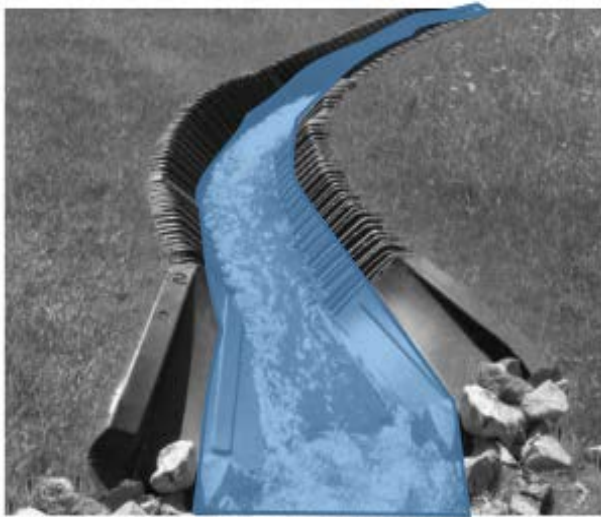


Figure 7. Drainage canals in the landscaping within the grounds of the shopping and entertainment center

4. Conclusions

This research on shopping center architecture in the Republic of the Congo highlights the fact that the Western "closed-box" architectural model is ill-suited to humid tropical climates. Consequently, this work adopts a bioclimatic approach as a design model specifically

adapted to such environments. The findings demonstrate the research's implications across three main pillars:

- **Design based on natural ventilation:** This involves creating cooler microclimates without systematic reliance on mechanical ventilation. The study concludes that the most successful centers are those that integrate transitional spaces (indoor-outdoor), reflecting the Congolese lifestyle where the street and commerce are intimately linked.
- **Fragmented spatial-volume design:** Recommending fragmented volumes allows for better penetration of prevailing winds. This promotes passive cooling throughout the structure, in contrast to existing monolithic blocks. Furthermore, the integration of vegetation (indoor gardens and green walls) serves as a humidity regulator and thermal filter, enhancing both the visual and thermal comfort of visitors.
- **Socio-economic implications and sustainability:** Prioritizing local construction resources (wood, raw earth, thatch, etc.) ensures the sustainability of the premises, while reducing construction costs and operational constraints for shopping centers.

The authors' future research will build upon these findings. They will deepen studies on comfortable urban hygiene conditions within public centers destined to become shopping hubs. The fundamental challenge is to propose an architectural model that contributes to the resilience of shopping centers in the context of climate change.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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