Integration of local resources in the Guinea-Bissau single-family house architecture design

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Abstract. This paper presents an architectural project design for housing for a middle-high class family in the Biombo region, Guinea-Bissau (Gulf of Guinea region, West Africa). Climatic conditions, natural and labour resources, social characteristics and local architecture all have to be reconciled from an integrative perspective and a challenge for architect designers. To implement the architectural project design, a methodology tested in rural Angola has been adapted, which simultaneously benefits and harnesses resources from global industrial technology. Passive cooling and sun protection strategies are applied and the articulation between local and global technologies is promoted, guaranteeing a dwelling house with dignified comfort conditions that are appropriate to the region.

1. Introduction

Most West African countries, and in particular the case of Guinea-Bissau, face extreme weather conditions, scarcity of industrial activity and skilled labor, ethnographic diversity, etc. which are incompatible with the constructive activity that is commonly practiced in the western world. In this context, one should seek to value and take advantage of local specificities, harmonizing them with the benefits of global industry, promoting the progress of construction activity with comfort requirements that allow inhabitants to enjoy a dignified life.

The architectural design that is described in this paper aims to demonstrate that the aspects that constitute adversities to the architecture of the western world are not an obstacle and can play in favor of the communities residing in those countries. Moreover, local architecture has specificities that cannot be overlooked. The architectural design of any building, and in particular of a dwelling, should be a tool for enhancing local characteristics.

According to [1] the main bioclimatic concerns in architecture design in regions with hot and humid climate are:

- sun protection to reduce solar gains;
- passive cooling, through ventilation, avoiding overheating of the interior.

At the same time; in the case of developing countries and with the objective of optimizing an architecture design methodology that is appropriate for the native social conditions; the enhancement
of local materials and labor is encouraged, with the context of reverse engineering approach and the application of appropriate technologies; in order to enhance the integration of local resources.

The articulated combination of these features and objectives is exciting and challenging for architects of a single family house in the Biombo region, Guinea-Bissau (figure 1).

![Figure 1 - Location of the Biombo region, Guinea-Bissau (adapted from [2]).](image)

**2. Methodology**

For an architecture project design of this nature, a methodology created by [3] and developed in detail by [4] and [5] for rural areas of Angola, was applied. The first part is based on CIM - Construction Information Map [6] for Guinea-Bissau. Using a Geographic Information System and the climatology, geology, pedology, phytogeography and ethnography maps overlapping, a CIM is obtained with the main available local resources and the main geophysical characteristics of each territorial area. The second part consists of integrating local resources (human and material) with the global modus operandi of industrial technology and some additional features (scientific studies, interviews and experience) in order to obtain an architectural design suitable to the study area. Figure 2 shows schematically the methodology used.

![Figure 2 - Schematic methodology (adapted from [6]).](image)

**3. Architectural design**

The single family house architecture design is for a middle-high class family that advocates a sustainable lifestyle and values the adoption of passive climate strategies, in line with the Sustainable Development Goals of Affordable and Clean Energy (SDG7).

Thus, the most important element in the passive air conditioning of this dwelling house is the axis of spatial distribution occupied by the hall. Due to its positioning and ceiling height (maximum 6.8 m),
it takes advantage of the convection “chimney effect” in the expulsion of warm air from the interior of the house, which is expelled by horizontal windows arranged along the ridge. The roof design allows the lighting of this central distribution hall to the bedrooms, thus creating an inner core of intimate living with diffused zenith lighting. The house is also protected from direct sunlight and rain by the swinging roof (figure 3).

Complementary passive air conditioning strategies were also implemented:

- High ceiling height (3.5 m) in order to reduce hot air in the lower convivial atmosphere. Ventilation grilles for convection hot air will be installed at the top towards the highest central core that takes advantage of the “chimney effect”. The ceiling of the living room follows the slope of the roof with heights between 3.8 m and 6.8 m, which are coincident with the central distribution hall ventilation chimney to the bedrooms.
- Windows in corners of every room (figure 4) to take advantage of cross ventilation inside the rooms, resulting from both exterior breezes on the facade and the air temperature differences between opposite sides. The frames of all spans will have wooden shutters in horizontal blades to allow ventilation.
- A peripheral covered porch that protects the house from direct sunlight, avoiding excessive heat gain, and also protects from the rain on the exterior walls, preventing interior moisture and erosion of the facade built on raw soil. It also allows the internal distribution (living rooms, kitchen and bedrooms) by external access, being this connection to the garden and living the house abroad which is important in the daily life of an African family.
- Wooden blades placed at strategic points on the outside porch that act as light filters reducing the excess of direct light inside the rooms, making it diffuse, also avoiding the thermal overload of the infrared radiation emitted by the soil on the interior of the house. In addition, the use of these elements allows for greater privacy in the outside living areas of the porch in connection with the bedrooms (figure 4).

![Figure 3 - Single family house cross section and sun position on solstices and equinoxes.](image3)

![Figure 4 - Schematic plan of single family house and main wind direction.](image4)

Regarding to local technologies integrated into the Industry, Innovation & Infrastructure (SDG9) measures, the encouragement of the creation of workshops for steel and woodworking, as well as small and medium industries for the manufacture of cement bricks, ceramic roof tiles and plaster boards. It is essential that this work is carried out by trained local labor, promoting employment in the region. Local material resources such as soil, natural fibers and palm wood will also be used.

Global technologies will contribute mainly to the supply of industrial materials such as cement, steel, iron, wood, glass, paints, ceramics, pipes, wiring, etc.
More specifically each of these technologies will have the following participation in the construction of dwelling house:

- **Local technologies and resources:** manufacture of cement bricks for exterior walls (figure 5) and raw soil for exterior (figure 5) and interior walls; natural fibers for the consolidation of raw soil; manufacture of plasterboard for ceilings; manufacture of mechanical joints and steel fittings; manufacture of ceramic tiles for roofing.

- **Global technologies and materials:** reinforced concrete for foundations, pillars and beams; wood (imported from Senegal) with autoclave treatment for the roof structure and window frames; steel for mechanical connections and hardware; glass and plastic mosquito nets for windows; paints for exterior and interior wall finishing; ceramic tiles for floors and baseboards; wiring and piping for electric, water and sewerage networks.

![Figure 5 - Exterior wall under construction.](image)

4. **Conclusion**

It is demonstrated that the proposed architectural design crosses global modernity with the issues raised by local (geographical and cultural) constraints in the rural context of a developing country. Housing under construction in the Biombo region, Guinea-Bissau has been designed to suit the local climate while valuing local materials and labor and is integrated on the Sustainable Cities and Communities (SDG11) measures.

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