Low cost sustainable building solutions: A study in Angola

Joana Rosa Santos Aleixo

Instituto Superior Técnico, Lisboa, Portugal

Manuel Correia Guedes

Instituto Superior Técnico, Universidade Técnica de Lisboa, Lisboa, Portugal

ABSTRACT: Aiming a sustainable development through the vital area of energy efficiency in buildings, strategies of bioclimatic architecture will be set in order to provide housing accessible to people in need, giving attention to environmental and cultural aspects.

The work aims to study architectural and constructive solutions to housing at affordable rates in southern Angola (provinces of Kunene and Namibe), analyzing traditional models previously applied and proposing solutions within the existing socio-economic and environmental context. It seeks to contribute to the resolution of socio-economic and environmental problems in our days. Examples of these problems include the cultural uprooting as a result of migration from rural to urban places (mainly during the 30 years of armed conflict), poverty levels of the poorest people, poor living conditions (lack of quality in construction and basic support infrastructure), and the excessive use of energy in buildings as an alternative to the lack of bioclimatic architecture strategies correctly oriented. Aiming a sustainable development through the vital area of energy efficiency in buildings, strategies of bioclimatic architecture will be set in order to provide accessible housing to people in need, giving attention to environmental and cultural aspects.

1 STATE OF THE ART

Angola is a country with developing economies marked by armed conflict in the long term, like many African countries. Sustainable Construction and Urban Development become urgent in a context where demand for housing and basic support equipment is constantly increasing, where lack of resources and lack of construction and urban planning are frequent.

The absence of basic comfort performance criteria in the construction involves increasing use of air-conditioning, making it more expensive. Moreover, for much of the population, such a system is unaffordable, making the interior spaces conducive to unhealthy concentration of mosquitoes (malaria) and other insects. The lack of adequate ventilation, overheating, the appearance of fungi on the walls, are problems easily solved by the implementation of passive architecture strategies.

The buildings and construction sector is one of the key sectors for sustainable development, both in terms of the important benefits it contributes to society and the considerable negative impacts it may cause if appropriate considerations are not given to the entire life span of buildings" - UNEP-SBCI (Sustainable Buildings and Construction Initiative, United Nations Environment Programme).

The aim of this work is to find solutions for sustainable passive architecture and building with the inclusion of renewable technologies, through research on models of vernacular housing built to respond to the climate in which they operate, using local materials available. For example, the use of earth on walls gives them thermal inertia, making the house cooler during the day and warmer at night, an important condition in places with high temperature difference between night and day. The use of "stick-to-peak" structures with straw roofs allows ventilated

and shaded spaces, comfortable during the peak hours. These kinds of strategies should be analyzed in order to propose methods adjusted to the development of sustainable housing with controlled costs, responding to environmental and socioeconomic needs, and inserted in the Angolan context.

This issue was raised in Angola before independence, with no definitive solutions and without making studies about buildings environmental performance. There is, in spite of this, a great body of literature on Angola which gives to the attention, among cultural and socioeconomic issues, facts about the construction of vernacular housing, to be considered in this work, such as Carlos Estermann, 1961, Maria Lima, 1977, Ramiro Ladeiro Monteiro, 1994, Garcia da Orta, 1996, René Pelissier, 1986, José Redinha, 1973 e 1975.

Also good examples of solutions in other countries should be referenced, in response to the growing need to adapt the building to local contexts, reducing energy costs and minimizing the environmental impact, such as the work of Laurie Baker, 1986, Joo-Hwa Bay and Boon-Lay Ong, 2006, Samuel Cougey and Jean-Pierre Oliva, 2006, Peter Van Dresser, 1996, Wolfgang Lauber, 2005.

The development of this proposal is supported by the work done under the Sure-Africa Program (Sustainable Urban Renewal: Energy Efficient Building for Africa), of which I belong, and which is currently taking place in Portugal at the Instituto Superior Técnico, co - funded by the European Union. This program aims to develop a network of practical and intellectual knowledge between African and European universities, about energy-efficient building and urban design.

2 MAIN OBJECTIVES:

- 1. Gather information about the Vernacular Housing model, its evolution and current framework in the urban space, of two southern Angola regions;
- 2. Analyze the construction methods and environmental performance of these models and other models of existing housing within the urban space, comparing the results;
- 3. Propose solutions for passive architecture construction development, including renewable technologies, with a view to its future implementation in dwellings at affordable rates.

In order to achieve these objectives, it is necessary to:

- 4. Increase knowledge in the areas of spatial and constructive organization, assessing levels of comfort, by the analysis of thermal, acoustic and lighting performance of the building;
- 5. Understand the influence of two different cultures in defining their models of vernacular housing;
- 6. Understand the way traditional housing models developed over the years, identifying some characteristics of those same models in urban spaces or cities;
- 7. Combine the study of traditional housing with tools of environmental comfort analysis (monitoring and computer modeling) in order to rate the performance levels and compare them with contemporary housing models. This will allow having technical and measurable conclusions to be applied in future solutions;
- 8. Across all the information obtained, resulting in an organized data system, allowing the definition of constructive and project strategies for housing at affordable rates, with application in everyday practice.

The following proposal falls under the PhD in Architecture that I am developing at the Instituto Superior Técnico, about "Low cost Housing in southern Angola".

Angola has seen 30 years of armed conflict, resulting in great human and material damage. Today it is growing at a fast rhythm, with the creation of new urban centers, residential areas, business, shopping, etc.. However, not always is the city planning or building construction appropriate to the local climate and, often, to the social environment: glass towers are raised in a tropical climate; the buildings have large glazing areas without any shading or natural ventilation. The result is an uncomfortable interior, making the use of air-conditioning and involving unnecessary spending of energy. Angola is a country of contradictions - the lack of housing conditions and the unsustainable construction clashes strongly with the economic potential of the country.

It is urgent to have an answer, a contribution so that the urban growth can be conducted in a sustainable manner, helping to reduce poverty levels and assigning sufficient housing conditions to everyone.

The study of traditional contexts concerns the search for constructive answers for examining the behavior of vernacular housing models, given the geographic and climatic context in which they operate. It will be essential to understand how those housing models behave, evaluating their best abilities and their main weaknesses, to propose improved solutions.

In order to base the work in specific contexts, and given the great diversity of cultures and ethnic groups in Angola, the scope of this PhD is limited to two peoples of southern Angola. The case studies focus on two sub-ethnic groups, the Kuanhama belonging to the group Ambó [10], and Kuvale, belonging to the Herero [17], both of Bantu origin. The option comes from the particularity of both Kuanhama and Kuvale being two sub-major groups within each group above (in number or influence). It was also a fundamental criteria of choice that they are two peoples who only would later give in to the colonization by the Portuguese, keeping deeply, even today, typical qualities and characteristics of its cultural roots, which will certainly allow a more specific and targeted study.



Figure 1 –Illustration of the geographic location of the Kuanhama and Cuvale ethnic sub-groups belonging Provinces.



Figure 2 - Aspect of Kuanhama's traditional models of housing and cultural traits

3 METHODOLOGY

3.1 Collect literature in various libraries and institutions

The work have a basis for further research on the various issues surrounding it (traditional Construction, Architecture and Urbanism).

3.2 Local data survey

Starting from general to detail, it is vital to understand all the procedures in terms of legislation and its local applicability, at the current state of vernacular housing in both rural and urban areas and, finally, at the construction processes and economic implications. In this sense should be made on site:

- Survey about how applies or implements legislation and policies to promote housing and urban and territorial development in the study area;
- Survey of architectural typologies and design features;
- Monitoring and analysis of the environmental performance of buildings (involving the use of Data Loggers)
- Queries to the population (rural and urban), in order to understand the criteria and expectations.

Monitoring the environmental performance of buildings through the use of Data Loggers is essential since it allows the measurement of levels of comfort, namely, identifying and assessing existing environmental comfort problems. The results are then used in comparisons with analysis of computer simulation, also indispensable.

3.3 *Computer simulation of the environmental performance of the building:*

Both studied buildings (existing) and final project proposals computer models will be carried out, using Ecotect software for the environmental performance simulation (see figure 3).

Ecotect allows the integration of the 3D visual aspect with a wide range of environment analysis and simulation and has the feedback results of both calculation and design. These results will allow the evaluation of the buildings behavior, identifying key issues and pointing out some solutions to them.



Figure 3 - Aspect of the Ecotect Software' sketchpad



Figure4 - Output example - Chart Energy Consumption



Figure 5 – Output example – Solar projection on the building às 9h, 12h e 16h de Verão, for a building in Luanda



Figure 6 - Output example - Mean radiant temperature distribution on the building interior

The intersection of all obtained information during the study and research will result in a organized data system, allowing the development of strategies for constructive and project housing at affordable rates, with simple application in everyday practice.

Strategies as a result of the whole process of research and analysis will be presented, finally, showing in practice feasible solutions, which should not, however, represent limited and unique model applications in terms of housing.

REFERENCES

- [1] Baker, Laurie, 1986. *Houses, How to reduce building costs*, Centre of Science and Technology for Rural Development (COSTFORD).
- [2] Bay, Joo-Hwa; Ong, Boon-Lay, 2006. *Tropical Sustainable Architecture, Social and Environmental Dimensions*. Oxford, Architectural Press.
- [3] Cougey, Samuel; Oliva, Jean-Pierre, 2006. La conception bioclimatique : Des maisons économes et confortables en neuf et en rehabilitation. France, Terre vivante.
- [4] Dresser, Peter Van, 1996. Passive Solar House Basics. New Mexico, Ancient City Press.
- [5] Estermann, Carlos, 1961. Etnografia do Sudoeste de Angola, JIU. Vol. 1 e 2.
- [6] UN-Habitat, 2008. *Housing for all: the challenges of affordability, accessibility and sustainability the experiences and instruments from the developing and developed worlds.* Nairobi, UN-Habitat.
- [7] Lauber, Wolfgang, 2005. Tropical Architecture: Sustainable and Humane Building in Africa, Latin America and South-East Asia. New York, Prestel Publishing.
- [8] Lima, Maria H. F., 1977. Nação Ovambo. Lisboa, Aster.
- [9] Mendler, Sandra; Odell, William, Lazarus, Mary Ann, 2005. *The Guide book to sustainable design*. United Kingdom, John Wiley & Sons, inc.
- [10] Monteiro, Ramiro Ladeiro, 1994. Os Ambós de Angola antes da Independência. Lisboa, Instituto Superior de Ciências Sociais e Políticas da Universidade Técnica de Lisboa.
- [11] Orta, Garcia da, 1996. Em torno da casa Kuanhama no sul de Angola. Lisboa, Instituto de Investigação e Ciências tropicais, Sér. Geogr., 15, pp.45-79
- [12] Oliver, Paul Enciclopédia de Arquitectura Vernacular no Mundo
- [13] Oliver, Paul, 2003. Dwellings New York, Phaidon Press Limited
- [14] Pelissier, René, 1986. História das campanhas de Angola. Volume II, Editorial Estampa.
- [15] Rapoport, Amos, 1972. Pour une anthropologie de la maison. Paris, Dunod
- [16] Rakodi, Carol; Nkurunziza, Emmanuel, 2007. Globalization and Urban Centres in Africa, International Development Department, School of Public Policy, University of Birmigham, United Kingdom. Nairobi, UN-Habitat.
- [17] Redinha, José, (9^a ed), 1975. Distribuição Étnica de Angola. Luanda, Fundo de Turismo e Publicidade.
- [18] Redinha, José, 1973. A habitação tradicional Angolana, Aspectos da sua Evolução. Luanda, Fundo de Turismo e Publicidade de Angola.
- [19] Streemers, Koen; Streane, Mary Ann Environmental diversity in architecture, Spon Press.