The importance of sustainable architecture in tropical climate countries

Case-Studies in Luanda city

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Extended Abstract

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Introduction and framework

Human activities, that building is an example, have accompanied the population growth and development, including through the increase of living standards of individual populations, the increased capacity to mobilize resources and the consequent environmental impact (Pinheiro, 2006).

Buildings and the built environment are the defining elements of the urban environment. These determine the character and the most important landmarks of a city that create a sense of familiarity and identity that can make cities pleasant places and pleasant, where people like to work and live. Therefore, the quality of the built environment has a strong influence on the quality of urban environment, but this is much deeper and more comprehensive, well ahead of purely aesthetic considerations (Pinheiro, 2006).

Man savoir-faire allowed him to challenge the environmental rigors using fire to keep warm, and skins to cover themselves. When the weakest among the animals replaced the Promethean device similar to the physical adaptations of other species, the shelter has become the most elaborate defense against hostile climates. As it evolved under the accumulated experience that, with ingenuity, diversified to meet the challenges and the great variety of climates. The interpretation of climate as the main factor is justifiable only if the climate has a direct influence on the surrounding architectural expression (Olgyay, 1962).

The ancients recognized that adaptation was an essential principle of architecture. Vitruvius (cited by Olgyay, 1962) said in De Architecture: "The style of buildings should manifest itself differently in Egypt for Spain, in Pontus and Rome, and in countries and regions of different characteristics. [...]."

Dr. Walter B. Cannon (cited by Olgyay, 1962) states that: "The development of a stable thermal balance in our building it should be noted as one of the most valuable advances in the evolution of the building." This statement can be confirmed by observing the various forms of villa developed by ethnic groups of similar ethnic origin established in various climatic regions. For architects, the "homoclima", ie, human needs, are the determining factor (Olgyay, 1962).

Jean Dolfus (cited by Olgyay, 1962), with its showcase of homes features from around the world, confirms that the main purpose of the builders was always looking for the optimal conditions for thermal comfort. According to the results of its analysis, concluded that the type of construction is defined more by climatic zones than by territorial boundaries.

In the approach to thermal comfort issues arise relating to the consumption of resources, which leads us to the issue of sustainability that came from other fields to architecture: "It was not in architecture that the term sustainability was introduced for the first time. Already by the end of the 1980's, the term "sustainability" was used extensively in the economics field in reference to development for criticizing Earlier models of economic growth for nations or regions that had favored fast returns and accelerated growth, while disregarding that in the long-run they were depleting
irreplaceable resources - the very resources upon Their growth is largely dependent upon." (Baweja, 2008).

There is evidence that sustainability is a fundamental consideration: "The question of the long-term, unanticipated negative impact of an Economic Policy on its performance was further extended to cover the effect of new products - chemical, agricultural, and mechanical - on environmental quality in the long run. It was in relation to this latter problem that the criterion of sustainability entered into architecture and urban design, providing a conceptual framework to handle the long-term negative impact of the application of techniques and materials of construction on material resource consumption and environmental physical quality (Baweja, 2008).

Integrated in the reflection on sustainable development, it emerges in developed countries, an international movement in 1993 (Kibert, 2003, cited by Pinheiro, 2006) that seeks to define and implement the concept of sustainable construction. Charles Kibert (1994) (cited by Pinheiro, 2006) defines sustainable construction as the "creation and responsible management of a healthy built environment, taking into account ecological principles (to avoid environmental damage) and efficient use of resources."

Inevitably, in association with the concept of sustainable construction, emerges the concept of sustainable architecture, because, as stated by Corbella (2003, 8) (cited by Vieira and Barros Filho, 2009), "the architect, without neglecting the beautiful and plasticity forms, [had to] necessarily rediscover the environment, the balance is of fundamental importance to human survival on Earth. "Another concept of sustainable architecture is provided by Corbella (2003, 17) which defines it as being conception and development of buildings that aim at "improving the quality of human life in the built environment and its immediate environment, integrated with the characteristics of life and local environment, and reducing the use of natural resources."

However, according to Steele (1997, 11) (cited by Vieira and Barros Filho), sustainable architecture "is the production of a building that suits the climate, lighting, ventilation and topography, taking advantage of the natural conditions of the place by reducing wasting energy.

But Baweja (2008) argues that sustainable architecture is already implicit in the relationship with the tropical architecture: "Green Architecture, Which is considered arecent discourse, Therefore can not be fully grasped unless it is historicized inrelationship to Tropical Architecture".

Regarding tropical architecture Baweja (2008), states that: “Existing histories locate Tropical Architecture as a neo-colonial project that emerged in the 1950s along the networks of the diminishing British Empire.”

Based on the writings of Koenigsberger, Baweja (2008) defines this architecture with a strong involvement with the energy dimension, regardless of resources and climate: Tropical Architecture paradigmatically the climate-responsive design and energy-conservative that makes the best use of locally available resources.

In this sense, the same author (Baweja, 2008) asserts the existence of a set of authors with reflection in practice and approach: "From its inception in the 1930s through the 1950s, Tropical Architecture also developed and circulated through a network of global conferences. In the UK,
Tropical Architects such as Otto Koenigsberger, Jane Drew, Maxwell Fry, Leo De Syllas, Fello Atkinson, and George Atkinson were engaged in the production of knowledge on energy-conservative climatic design.

**Goals**

The main goal of this work, is to study and analyze the importance of sustainable architecture, and its principles, the definition of strategies for constructive options in tropical countries, that Angola is an example, and its contribution in reducing the environmental impacts arising from the use of inefficient and non-rational of non-renewable resources.

For this purpose we defined the following objectives:

- To present the likely causes and factors that contribute to thermal discomfort in the city of Luanda; To analyze, critically, the extent to which existing buildings in Luanda include sustainable architecture principles;

- Propose measures for improvement and guidance, which suit to the reality studied, based on research carried out, and in that sense to make this work a reference in support of architects, construction industry professionals, and key social actors, tools for the performance of their duties to make decisions consistent with the preservation of the natural environment through mitigating the impacts caused by existing and latent construction throughout the process;

- Study cases of buildings with residential use - an apartment and a house - in the city of Luanda, and evaluate its environmental performance using as a tool to support the LiderA Africa v.2.00 - Assessment System for Building Sustainable adapted to PALOP;

**Approach and Methodology**

According to the proposed objectives, it was considered appropriate to establish a descriptive approach, with technical procedures based on literature review and case studies. For this purpose, the methodology was the research and analysis of documents on the subject of study, including articles, thesis, websites, publications, national and international organizations on the subject, which served to
support the understanding and exposition of ideas. These documents were useful in the study of building typologies proposed for the case study (an apartment and a house).

Process

For a relevant discussion on these aspects is important to understand the climate, their characteristics and how they manifest in different regions of the world and in this context relates it with the comfort conditions of man, so with the built environment.

This is possible through a system of classification. The most commonly used classification system is the Köppen, which distinguishes 25 types of weather. For building design, a simple system (after Atkinson, 1954), which only distinguishes four basic types, is appropriate. This is based on the nature of the problem of human thermal comfort in a particular location (Szokolay, 2004). From these types of climate which the most important is the tropical for the purpose of this work, with particular emphasis on the hot and humid as it characterizes the object of study.

Note that for the study of human comfort under certain weather conditions it is necessary to set of climatic variables, namely: "The main elements that affect human comfort are: air temperature, solar radiation, air movement and humidity '(Olgyay, 1962).

The house is the main instrument that allows us to meet the appropriate requirements of comfort. Modifies the natural surroundings and near-optimal conditions in the housing. Must filter, absorb or repel the elements of the environment according to their beneficial or negative influence in the comfort of human beings. The ideal criterion for the design of a shelter in balance, in relation to its environment would be satisfactorily covering all human physiological needs. The problem of the architect is to create an environment that does not produce negative voltages on the compensation mechanism of body heat. The goal should be reinterpreted in terms of comfort, the graphical representation should be and to be easily applicable, data derived from empirical studies should be expressed so that they can be used in architectural practice (Olgyay, 1962).

Among others the comfort associated with indoor air quality is of great importance because: In energy-efficient buildings, the choice of materials affects the indoor air quality, more so than in conventional buildings.

However, this selection of materials should not be done just to keep the indoor air quality but also so that there is no environmental impacts caused by construction, particularly in energy consumption concerns. This energy consumption is often associated with the of "urban heat island phenomenon."

The effects of urban heat island in hot climates exacerbate the energy consumption for refreshing in the summer. The effects of urban heat island are caused by meteorological factors and urbanization which increase the temperature and the corresponding urban electricity demand in an urban area.
The urban heat islands develop in areas containing a high percentage of non-reflective surfaces, and water resistant and a low percentage of vegetation and surfaces that retain moisture. In particular, materials such as stone, concrete and asphalt tend to retain heat to the surface (Landsberg 1981, Oke, 1982; Quattrochi et al., 2000) and lack of vegetation reduces the heat loss due to evapotranspiration (Lougeay et al., 1996). The addition of anthropogenic heat and pollutants in urban atmosphere adds to the intensity of the effect of urban heat island (Taha, 1997). Urban centers tend to have higher demand than the surrounding areas as a result of its high population density. Oke (1982) correlated the intensity of urban heat island with city size.

It is important to note that many impacts occur at different stages of a project, including planning and conception phase, construction phase and operation phase.

These impacts result from costs associated with the lifecycle of the building that is important safeguard.

You will need a cost analysis of the life cycle, so the client can make an assessment of the financial return on initial investment in energy saving measures or conservation of resources over the lifetime of a building.

The goal is to optimize the value of a construction project throughout its lifetime, taking into account all project costs, both direct and indirect.

The design and sustainable construction, or "Green Building" is an opportunity to use our resources more efficiently, while creating homes more energy efficient and healthy. The architecture professionals have to accept the fact that as the economic status of a society improves, its demand for architectural resources - land, buildings or building materials, energy and other resources - will increase. This in turn will increase the combined impact of architecture on global ecosystems, which is composed of inorganic elements, living organisms, and humans. The goal of sustainable design is to find architectural solutions that ensure the well-being and coexistence of these three constituencies.

To educate the architects to achieve these goals of coexistence, Kim and Rigdon (1998) developed a conceptual framework. The three levels of the frame (Principles, Strategies, and Methods) correspond to the three objectives of architectural education environment: creating environmental alert, explaining the ecosystem of the building, and teaching sustainable building design. In this sense propose three principles of sustainable architecture: Resource Economics, Life Cycle Design, and Human Design.

They can more easily achievable with the aid of instruments to support environmental project: solar diagrams and psychrometric chart.

Even as an instrument of support and assistance we have sustainability indicators. The sustainability indicators describing the environmental, economic and social buildings to owners, users of buildings and other stakeholders in the construction industry.

In addition to these there are rating systems for sustainable construction which are design to make the overall assessment of the demand and position sustainability performance of the built environment. Among the existing systems and developed in the Portuguese-speaking countries stands out LiderA system that is chose to be applied.
The LiderA System and the Case-Study

LiderA System

For this work we chose to use the LiderA - sustainability assessment of sustainable construction system, which is a registered trademark of Portugal, which can be (1) used immediately to support the demand for solutions in the design phase and plan, (2) the evaluation of positioning of sustainability, (3) if you have a proven level of performance can be given the recognition (for plans and projects) or certification (under construction and operation) by this brand. The first version V1.02 (released in 2005) was designed and built especially focus at environmental aspects (in strictus sensus) to the respective surroundings. However, given the investments made, we developed a version 2.0 that extends the possibility of application of the system, not just buildings, but also the built environment, including the demand for buildings, outdoor blocks, districts, zones and their users in a perspective of sustainable communities.

The system is based on the concept of LiderA reposition the environment in construction, sustainability perspective, taking as a leading system for the environment and is organized into sections that include areas, which are operationalized through the criteria to make the guidance and the levels of demand for sustainability.

LiderA's mission is to help create, support management and ensure sustainable built environments, thus supporting sustainable construction the demand for sustainable communities.

LiderA demand for sustainability in the built environment from the outset based on six principles to be adopted, which cover six aspects considered in the system.

The suggested principles for the pursuit of sustainability are:

Principle 1 – Valuing the local dynamics and promote the appropriate integration;
Principle 2 – Promote the efficient use of resources;
Principle 3 – Reduce the impact of charges (either in value or in toxicity);
Principle 4 – Ensuring the service, namely at building the quality of the environment, focused on environmental comfort;
Principle 5 – Promote the sustainable socio-economic experiences;
Principle 6 – To ensure the best sustainable use of the built environment, through environmental management and innovation.
The six strands are subdivided into twenty-two areas:

- Local integration, with respect to Ground, Ecosystem and Landscape and natural heritage;
- Resources, including Energy, Water, Materials and Food Resources;
- Environmental loads, involving the effluents, air emissions, waste, noise and Exterior Lights Thermal Pollution;
- Environmental Comfort in the areas of air quality, thermal comfort and lighting and acoustics;
- Experience socio-economic, which integrates access to all the life-cycle costs, economic diversity, the Amenities and Social Interaction and Participation and Control;
- Conditions that integrates sustainable use of Environmental Management and Innovation.

In the system, to guide and evaluate the performance, there is a set of criteria that operationalize the aspects to consider in each area. These criteria have different performance levels (1 to 10 or higher) evolve with technology, thus having more environmentally efficient solutions. However, the criteria and guidelines presented are intended to help select, not the best existing solution, but the solution that enhances, rather significantly, the existing performance, also in an economic perspective. For each type of use and defined for each criterion are considered performance levels (or thresholds), which will indicate whether the solution is sustainable or not.

The parameters for each of them below, or improvement of existing practices, or reference to the values of good practices, as is usual in international systems. The performance levels are numerical point of view of communication are transformed into classes (G to A +++). The thresholds are derived from three reference points. The first performance is based on the most widely used technology, so the existing building practice is regarded as the usual level (Class E). At the second level the best performance results from the best practice constructive feasible to date (Class C, B and even A), the third based on the definition of the level of sustainability high (search for neutral or regenerative (Classes A + +). Arising from this analysis are set for each use performance levels to be achieved.

For LiderA system the degree of sustainability can be measured by area in classes of increasing performance: from practice (E) Class C (over 25% of practice), B (37.5%) and A (50% or factor 2). In the best performance class exists beyond Class A, Class A +, associated with an improvement factor of 4 and class A + + associated with an improvement factor of 10 compared to the initial situation considered, or even A + + + that categorizes a situation regenerative.
The Case-Study

Currently there is an adapted version of the PALOP (LiderA Africa v.2.00) was used for the case study carried out in two housing types built in Luanda - an apartment and a detached, single family.

The evaluation of these two units intended to understand to what extent the principles of the leads are safeguarded in order to obtain a performance class (global) units of study and assess the need to allow optimization of the conditions existing today.

The human settlements in Angola developed mostly spontaneously, i.e., without projects or development plans previously prepared. Projects and studies of urbanization in major cities emerged after its founding. After independence in 1975, to the fullest extent of the territory, but especially in coastal cities - offering greater security and ease of access to imported goods - there was a pressure of urban growth, accelerated by the movement of displaced people in territory, that not only did not follow the urban development plans drawn up before independence, but did not receive proper response from the authorities responsible for spatial planning and territorial development, overloading the capacity of infrastructure and basic services. The existing housing framework, without proper maintenance, underwent a process of deterioration and decay, while settlements were mushrooming substandard housing - the slums - in suburban areas. Cities experienced the adverse effects of rapid urban growth and change, congestion, unemployment, inadequate sanitation facilities, pollution, lack of social services [...].

The apartment evaluated, with 3 bedrooms, is deployed in a building that is part of an urbanization called Project New Life, located in peri-urban Luanda.

Although this project there are some measures of sustainability for its operation it was found that after the allocation of credits to each of the criteria LiderA Africa, the overall performance is class C. This is because the criteria that weighed more negatively to this assessment were waste management, the contribution to accessibility, the Question of Economic Dynamics, and with regard to Sustainable Strand, the criteria for promoting the use and management, and innovation, among other. In our opinion these are the criteria that imply the need for improvements to the scope of a class above the overall performance of C.

For the single family house, located in suburban middle and is of type T2. Is located on a lot with urban potential, and has an area of about 1.5 ha. It is a building run by the owner but is not part of any program of urbanization of the area where it belongs :Kilamba Kiaxi, District of Sapu. Note that the area is characterized by the use housing to low-income homes. However, housing has some evaluated gains in relation to those. The interest in evaluating this type housing due to the fact that it is interesting to note the performance of a house with these features, set in medium without urbanization plan.
After the credits awarded for performance evaluation criteria, the overall performance was class B. Might infer from this result that is a good class performance to the extent that, despite the location of housing in suburban environment, where there is an estate plan, or sewage system and water distribution, which indicates that the measures promoted by the owner options to address the deficiencies observed locally. Still, it is important to note that some criteria need to be improved if you wish to obtain a class above the current performance in particular Water Management, Energy Management, Contribution to Economic Dynamics, Contribution to the amenities, among others.

The results reveal the possibility and interest of LiderA application of these two cases and their chances of identifying the aspects to consider in the search for more sustainable architecture. The measures that allow that improvement should include not only the building, but also environment and planning of nearby space.

In terms of limitations and issues to develop is important to mention the importance of having increasingly more methods and approaches designed to support not only in sustainable architecture bioclimatic component, there is already a manual (Guedes et al, 2010) as in the other like energy, materials and waste, water management.

**Conclusion**

This dissertation allowed to answer questions posed as targets to achieve, highlighted by the theme. As it is a pertinent topic and secular, it has also realized the importance of sustainable architecture principles in design and construction of buildings and built environments.

Research regarding sustainable architecture origins and its relation with sustainable development was a precondition, which allowed to understand its relationship to another concept – tropical architecture – and therefore was relevant to understand the relationship between subject of study and Luanda city.

Under these concepts, another has been emerged such as of natural resources, climate – with all its components -, environment, and non-renewable resources, the latter with paramount importance to sustainable architecture principles.

We found that, before design process, the architect must understand the climate, a fundamental premise to make constructive choices consistent with local climate conditions as well as with local resources to allocate, and to whom the construction is conceived for (the future users), and future construction usage.

This will enable to suit taken decisions to local existing conditions, in order to create and keep construction as sustainable as possible, so as to have built environment with minimal adverse environmental impacts and so for human kind comfort.

In this context, it has found that construction sustainable indicators and sustainability assessment of constructions and built environment plays an important role in the measurement –
quantitative and qualitative – of elements which allows to establish and achieve goals proposed, regarding sustainable construction.

It has also came to conclusion that problems relating adverse environmental impacts regarding humankind action are linked to poor natural resources management, urban management, lack of natural amenities essential to healthy living of city dwellers, a situation that often reaches the most vulnerable socioeconomic groups that settle in places also environmentally vulnerable (streams, water flood beds, slopes susceptible to landslides, among other places).

Although not directly demonstrated, in present study, the relationship between population and urban densities of Luanda city, with the hot climate felt locally there are, however, evidence in the made research regarding that relationship as proven from resulting phenomena (urban heat island, greenhouse gases, air-conditioning excessive usage in buildings, air pollution, among others), due to urban services demand inherent in the overcrowded urban population in that city.

Architecture is a multidisciplinary activity, in which several knowledge converge - sociology, construction technology, environmental studies, economy, anthropology, geography, human geography, among others – that have to be taken into account in architecture design, since an unweighted choice or decision can lead to deep impacts in the four sustainability vectors – social, economic, environmental and cultural – with severe consequences for a particular territory.

Angola is a country that is growing, as well as its capital Luanda and in that sense, we believe that, development needs should focus on management strategies, allowing avoiding, correcting and mitigating existing and latent impacts in which construction is of great importance. It is necessary to involve all social actors and it needs to be highlighted that even though there is urgency to build cities and places, it must be well performed today otherwise we would be compromising too much material and financial resources necessary for next generations.

Rebuilding a country like Angola, with its natural wealth and the effort to reborn, has naturally attracted a huge foreign investment, comprising the arrival of new people of all professional subjects, from civil construction to oil industry, from small business to multinational and coming from the four corners of the world (new) Portuguese, Brazilians, thousands of Chinese, some French, some American highlighting Luanda natural character – its cosmopolitanism. The question is how this cosmopolitan and global presence will transform the city and its architecture and how it will relate, in the future, with the heritage asset (also cosmopolitan and global) as expressive of Modern Architecture in Luanda (Magalhães, 2009).

It is in these new buildings and “historic city” that citizens’ life unfolds everyday but if these buildings do not respond favorably to the environment, to society, to local culture, and economic issues, we believe one cannot live in Luanda in the future, due to numerous constraints inherent in its urban density and overcrowding which are certainly the most committed to sustainability solutions for the city.
Bibliography


