Brazilian building evaluation through reverse analysis based on environmental rating systems: a case study

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ABSTRACT: Brazilian's architecture offices are initiating their search for methods that could give some orientation about the design process for sustainable buildings. The North American method LEED™ and the French initiative HQE® have made their way to Brazil. The French methodology has been adapted, resulting in the AQUA Brazilian certification. However, history has revealed many professionals who expressed their concern about the environment through interesting architecture solutions, years before the launch of the first environmental rating system. In this sense, the Environmental Protection Center of the Hydroelectric Plant Balbina should be stressed. Authored by Severiano Mario Porto architect, the Center integrates nature, environmental comfort and beauty. Recognizing the importance of this award-winning project and also considering the interest in discussing about the efficiency of environmental rating system methods for the production of green buildings, the aim of this research was to test the rating systems adopted in Brazil through the evaluation of characteristics presented on this building. Results indicate that even in a state of neglect and already degraded parts, the building presents the potential to meet satisfactorily most part of environmental performance requirements proposed by the rating systems studied. The lesson left by the architect highlights the importance of using the techniques of design and implementation, which, harmonized through the project, will lead naturally to solutions with high environmental performance. So, it is necessary to rethink the exaggerated importance that has been given to environmental rating systems.

Keywords *sustainability, environmental rating systems, BIM, green buildings.*

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1. INTRODUCTION

Environmental rating systems lead the discussion around the environmental quality of buildings and sustainability. Cole (2005) affirmed that the need to develop decision methods that actively involve the stakeholder interests will become increasingly important to infuse the considerations of sustainability as an integral part to conduct architects day-by-day activities. Nevertheless, it is important to discuss the whole of sustainable rating systems as proper tools to validate the environmental quality of buildings.

Currently, Brazilian's architecture offices are initiating their search for methods that could give some orientation about the design process for sustainable construction**.** LEED™ and HQE® rating systems have made their way to Brazil, where the French methodology has been adapted, resulting in AQUA Brazilian certification. It is assumed that Brazilian architecture offices must organize their management system in order to accomplish the sustainable requirements along the design management process. (SALGADO, 2011)

However, history has revealed many professionals who expressed their concern about the environment through interesting architecture solutions, years before the launch of the first environmental rating system. The legacy of Severiano Mario Porto, an important Brazilian's architect which stands for solutions that seek to integrate the building with the environment, should be highlighted.

Among the projects authored by him, the Environmental Protection Center of the Hydroelectric Plant Balbina should be stressed. Built by initiative of ELETRONORTE, as one of the compensatory measures for the environmental impacts caused by the construction of hydroelectric power, the Center has been design to integrate nature, environmental comfort and beauty simultaneously. Unfortunately, despite the relevance of this project, the Center is currently abandoned and deteriorating rapidly.

Hopefully, on 2016 Balbina's has been incorporated to the list of projects protected by the Amazon Government. The Law 312 (18th February, 2016) legislate for the preservation of the architect's works built in the Amazon State, given its architectural, historical and cultural interest. (DIÁRIO, 2016)

Recognizing the significance of Environmental Protection Center of the Hydroelectric Plant Balbina, and also considering the interest to discuss the exaggerated importance that has been given to environmental rating system, this research discusses the validity of those certifications, confronting the characteristics of the Center with the requisites defined by the two certifications currently adopted in Brazil.

2. ENVIRONMENTAL RATING SYSTEMS FOR BUILDINGS IN BRAZIL

The discussion about sustainable building has been intensified since the launch of Agenda 21 for sustainable construction (CIB, 1999) and Agenda 21 for sustainable construction in developing countries (CIB, 2002). Those documents described a row of tasks to be held in order to guarantee adequate environmental decisions in civil construction industry – particularly in buildings construction.

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It is generally accepted the current era of rating tools commenced in 1990 with the introduction of the BREEAM (UK) rating tool. This method was followed by the French system HQE® and by the U.S. LEED™ in 2000. Further analysis confirms that the evolution of rating systems into different countries is largely based on those initial rating systems (REED et al, 2009)

Although the great number of environmental rating systems proposed, two methodologies were the first to be considered by Brazilians' architects:

- North American *LEED™* (*The Leadership in Energy and Environmental Design Green Building RatingSystem)*;
- French method HQE® (*Haute Qualité Environmentale – High Environmental Quality)* adapted in Brazil as AQUA-HQE method.

LEED and AQUA-HQE certifications were adopted by Brazilian entrepreneurs, according to the type of enterprise and the intended scope for the environment certification.

2.1 LEED™ Certification

LEED™ certification erased from the proposal elaborated by *The Leadership in Energy and Environmental Design.* The initiative began in 1993, and has been spearheaded by Natural Resources Defense Council (NRDC) which led a broad-based consensus process, including non-profit organizations, government agencies, architects, engineers, developers, builders, product manufacturers and other industry leaders.

LEED was created to accomplish the following: define "green building" by establishing a common standard of measurements; promote integrated, whole-building design practices; recognize environmental leadership in the building industry; stimulate green competition; raise consumer awareness of green building benefits; and transform the building market. . (ENVIRONMENTAL..., 2015)

Currently, LEED consists of a suite rating systems for the design, construction and operation of buildings. LEED for Building Design and Construction is divided into six different scopes: LEED-NC New Constructions and Major Renovations; LEED ND - Neighborhood Development (ND)**;** LEED CS Core and Shell; LEED for Retail; LEED HC Healthcare; LEED EB-OM Existing Buildings **–** Operations and Maintenance; LEED Schools and LEED CI Commercial Interiors.

To earn LEED™ certification, the applicant project must satisfy all the prerequisites and qualify for a minimum number of points to attain the established project ratings as listed. Having satisfied the basic prerequisites of the program, applicant projects are then rated according to their degree of compliance within the rating system. All prerequisites must be achieved in order to qualify for certification. Points add up to a final score that relates to one of four possible levels of certification. (SALGADO and LEMOS, 2005)

The method analyses the performance of buildings considering eight dimensions: Sustainable sites; Water efficiency; Energy & atmosphere; Materials & resources; Indoor environmental quality; Innovation in design or innovation in operations; and Regional priority credits. For each dimension there is a group of requisites (quantitative) that must be considering during the process.

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The weight of each requisite depends on the scope of certification. For this reason, it is not possible to compare, for example, the environmental performance of a building certified LEED-NC level Platinum with a building that has been certified as LEED CS level Platinum. That why it is imperative to identify the scope of the certification to understand the scope of the assessment.

2.2 AQUA-HQE Process – High Quality Environmental

The HQE® **–** *Haute Qualité Environmental* (High Environmental Quality) association **–** was created in 1996 in order to develop environmental quality management in the building construction industry. This association produced a report containing recommendations in the form of environmental targets to be pursued by architects and engineers. Among the targets, it is important to highlight: Eco-Construction; Eco-Management: Including energy management, water and waste management and building maintenance; Comfort (thermal, acoustic, visual); and Health (air and water quality, among others). This report led to the methodology for support of the high environmental quality design, where each target should be divided into several requirements and recommendations which should be reviewed for each building, since it is not possible to establish a single formula for all types of construction. (Association HQE, 2015)

Architecture design process that considers the principles of High Environmental Quality (HQE®) method may be divided into two phases: the first phase can be entitled "*setting parameters*" and the second *"the design conception*." The first phase can be divided into (CASTELLS, 2010):

- The study of the environmental potential of the location - specifically related to the parameters set by the HQE® method;
- The Pre-programming HQE® - with the ranking of the 14 targets set by the methodology.

There are no bad grades in AQUA-HQE method, which defines only three levels of evaluation: good, superior or excellent. Good level corresponds to the minimum acceptable performance for a High Quality Environmental enterprise. This may meet regulations if it is sufficiently strict about the performance of the venture, or, in the absence thereof, current practice. The Superior is attributed to best practice level and the Excellent evaluation corresponds to the maximum performance observed in High Quality Environmental enterprises, ensuring that these may be achievable. (LANDWOIG M et al., 2013)

The French method HQE® has been adapted and originated the Brazilian process AQUA-HQE - acronym in Portuguese for High Environmental Quality - which is defined as a project management process to obtain the environmental quality of an enterprise

3. CASE STUDY: ENVIRONMENTAL PROTECTION CENTER OF THE HYDROELECTRIC PLANT BALBINA

Severiano Mario Porto has graduated on 1954 at Faculty of Architecture and Urbanism at Federal University of Rio de Janeiro (prior University of Brazil). In 1963 the architect took

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a trip to Manaus on vacation, and decided to move with his family to this region in 1966. (CAMPOS, 2003) The architect is recognized for its brand in the Amazon architecture.

On February 2015, Severiano has completed 85 years old and his architecture to this day surprised by daring shapes and solutions, always seeking harmonious relationship with the environment. However, it is observed, unfortunately, the lack of respect for his work. Several projects were scrapped or modified, and some projects are condemned to oblivion by neglect and abandonment of those responsible for its preservation as in the Environmental Protection Centre Balbina (photos 3/4).

Photo 3 – Balbina's Center – main entrance (2015) (Source: author)

Photo 4 – Balbina's Center – general view (2015) (Source: author)

The Environmental Protection Center of the Hydroelectric Plant Balbina received the award granted by the IAB-RJ in 1987, highlighting the recognition of the architect who also received the Honorable Mention for the whole of his work. (CAMPOS, 2003).

In order to analyze the environmental performance of the building, the research team has visited The Environmental Protection Center on August, 20th 2015. Manaus is located at 3°S of the Equator, in the maximum solar radiation zone. There are no fluctuations in the length of day and night throughout the year and the seasons, except for the presence of a rainy season ("winter") a dry season ("summer"). The Center is located at Presidente Figueiredo City, approximately 200km from Manaus.

Aiming to discuss the environmental rating systems, this research involves the evaluation of the potentialities of Balbina's Center considering requisites defined by the two main rating systems adopted in Brazil: AQUA-HQE and LEED

For this analysis it has been considered the principles of reverse analysis, starting from the identification of the building's characteristics and then, evaluating the potentialities of the building to respond to the environment requirements defined by LEED and AQUA-HQE rating systems.

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As explained before, there are no bad grades in AQUA-HQE method, which defines only three levels of evaluation considering three phases: program, project and construction. Considering that the building that has been chosen for this research already exists, it was necessary to apply the principles of reverse analysis. So, for this analysis it has been considered as minimum level (Good) the requisites whit potential to accomplish the requirements, but that cannot be evaluated yet. Environmental categories with great potential to achieve the environmental targets established by the rating systems has been considered with intermediate classification (SUPERIOR) The highest rating (EXCELLENT) was assigned only to the categories that have exceptional potential to be been fully achieved by the building features.

It is known that the environmental assessment methods require a series of measurements and informations that are not available and/or were impossible to obtain, considering the abandon of the building. In this sense, it is important to emphasize that this research has no intent to validate Balbina's project through any environmental rating system, but to intensify the discussion around the exaggerated importance that has been given to those methods in detriment of discussing architecture solutions with high quality environmental.

4. CONFRONTING CHARACTERISTICS OF THE ENVIRONMENTAL PROTECTION CENTER OF BALBINA WITH THE ENVIRONNMENTAL RATING SYSTEM CATEGORIES

The visit occurred in a typical summer day. Using a Digital Hygro-Termometer, it was possible to measure the internal and external temperature. At mid-day the external temperature was around 37°C and 39°C while internally, the thermometer indicates 32°C and 34°C, demonstrating a significant attenuation of heat.

4.1 Environmental categories with potential for "excellent performance"

The concern of the architect to harmonize the project with the characteristics of the region can be noticed through Photo 5. The large space between the roofs and the coverage allows for thermal protection through air circulation, due the height that reaches 8 meters favoring the internal thermal conditions (photo 6).

Another aspect that can be highlighted about Balbina's construction is the fact that the architect was free to use the wood from the area that would be flooded due to the construction of the hydropower (Neves, 2006). Thus, the project can be evaluated positively regarding the use of local materials and building systems.

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Photo 5 – Harmonious relationship with the environment

Photo 6 - the roof reaches a height up to 8 meters creating an air protection

The analysis of Balbina's project indicates that in laboratories were identified technical solutions that could allow the removal of toxic gases, and also ample ventilation. Furthermore, the air renewal occurs through the various openings along the main roof (photos 7 and 8)

Photos 7 and 8 - Zenith openings in the main cover

4.2 Environmental categories with potential for "superior performance"

With regard to energy management, it has been noted that the large coverage of the facility, plus the zenith ventilation designed for each part individually, indicates potential for energy saving as the use of air conditioning could be reduced. (Photos 9, 10).

Photo 9 – Double protection and zenith ventilation

Photo 10 – Double protection

Wide windows and visual interface with the outside illuminating the set, indicates that, artificial lighting will be only used in a complementary situation. (Photos 11, 12).

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Photo 11 – Wide windows

Photo 12 – Natural lightening

In this sense, it can be inferred that there would be large reduction in energy consumption as a result of the magnificent architecture solutions. However, it was not possible to evaluate the performance of artificial lighting considering that the building is not being used.

In relation to water management, although it was not possible to find any indication regarding the optimal use of water or rainwater, channels were detected in the floor that could function as capture and utilization systems, indicating potential to meet this requirement satisfactorily.

With regard to acoustic comfort, during the visit it was revealed the concern of the architect in keeping work areas protected of the main sources of external noise – particularly vehicles. Measurements, with Portable digital sound level meter, allowed identify an attenuation of 10dB within the building. It should be noted the distance between the set and the main route, favouring the acoustic performance of the facility. In reference of material specification, the use of waterproof and washable liners in the canopy, restrooms and laboratories, indicates concern about the hygiene on site.

4.3 Environmental categories with potential for "basic performance"

Considering the missing information about the low impact during building construction, it was not possible to corroborate the full performance in relation to waste management, pollution and resource consumption. However, the architect option for construction material - basically wood seized extracted from the area that was flooded to build the hydropower – leads to a positive evaluation on this requirement.

Similarly, it was not possible to assess the project in relation to the management of waste from use-operation of the building, the quality of the use-operation waste management system, maintenance of the building and resilience of the performance of heating systems, ventilation, lighting and water management, considering that the building is abandoned. Thus, their performance was considered within the minimum standards required by the regulations. With regard to sanitary water quality, unfortunately we have not obtained the information or document analysis. Anyway, it was noticed the abundance of water supply due to the large number of rivers in the region.

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5. SYNTHESIS OF POTENTIALITIES CONSIDERING AQUA-HQE AND LEED

The results of the qualitative evaluation, considering the environmental potentialitiesof Balbina's Center is summarized on Table 1, based on the correlation according to France GBC (2015) comparison.

The research demonstrates that Balbina Environmental Protection Center has great potential to meet satisfactorily the demands of environmental quality as established by the requirements of AQUA-HQE and LEED methods.

The analysis showed that the set could receive review "excellent" at least for five environmental targets, and demonstrates potential for maximum rating also in other categories. Therefore, despite the absence of international standards on the subject at the time of that project, the Centre designed by Severiano Mario Porto architect exceeded expectations in relation to environmental quality.

Table 1 – Correlation between Brazilian's AQUA-HQE, LEED, and Balbina's performance

AQUA-HQE (Brazil)		*LEED*	*BALBINA's Performance evaluation*
Requisites		*Dimensions*	
ECO-CONSTRUCTION	Category 1: Building relationship with the immediate surroundings	Location and Transportation (LT) + Sustainable sites (SS)	Excelent
	Category 2 - Integrated choice for processes and construction systems	Materials and Resources (MR)	Excelent
	Category 3 - Construction site with low impact	Location and Transportation (LT) + Sustainable sites (SS)	Good
MANAGEMENT	Category 4 – Energy management	Energy and Atmosphere (EA)	Superior
	Category 5 – Water management	Water Efficiency (WE)	Superior
	Category 6 - Management of waste from use-operation of the building	Materials and Resources (MR) + Sustainable sites (SS)	Good
	Category 7 - Maintenance	Materials and Resources (MR)	Good
COMFORT	Category 8 - Comfort Hygrothermal	Indoor Environmental Quality (EQ)	Excelent
	Category 9 - Comfort Acoustic		Superior
	Category 10 - Comfort Visual		Superior
	Category 11 - Comfort Olfactory		Excelent
HEALTH	Category 12 - Quality of spaces	x	Superior
	Category 13 - Air quality	Indoor Environmental Quality	Excelent
	Category 14 - Health quality of water		Good

Source: Comparison adapted from France GBC 2015 and completed with Balbina's research results

6. CONCLUSION

This paper has no intention to demonize the environmental certifications, nor to validate Balbina's Center through any environmental rating system. The main purpose was to discuss the exaggerated importance given to environmental certifications, through the reverse analysis of one recognized building, considered an icon of Severiano Porto legacy.

It has been presented that with basic architecture design principles, appropriate choice of construction systems and technical solutions, the environmental performance of the building can be enhanced, regardless of exclusive concern with any certification method.

The results obtained with this analysis indicates the urgency to discuss the importance given to environmental rating systems. It is necessary to encourage professionals to

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search for the best solutions for design concept, and not the persecution of "*points for the assessment*" as defined by those certifications.

The case study highlights, therefore, the importance of professional training based on the domain of the best techniques of design and construction, which - harmonized through the project - will lead consequently to architectural solutions with high environmental performance.

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