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Analysis and selection of indicators for a sustainability assessment method for school buildings based on SBTool - PT

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ABSTRACT: Nowadays, the sustainability of buildings has an extreme importance. This concept goes towards the European aims of the Program Horizon 2020, which concerns about the reduction of the environmental impacts through such aspects as the energy efficiency and renewable technologies, among others. Sustainability is an extremely broad concept but, in this work, it is intended to include the concept of sustainability in buildings. Within the concept that aims the integration of environmental, social and economic levels towards the preservation of the planet and the integrity of the users, there are, currently, several types of tools of environmental certification that are applicable to the construction industry (LEED, BREEAM, DGNB, SBTool, among others). Within this context, it is highlighted the tool SBTool (Sustainable Building Tool) that is employed in several countries and can be subject to review in institutions of basic education, which are the base for the formation of the critical masses and for the development of a country. The main aim of this research is to select indicators that can be used in a methodology for sustainability assessment (SBTool) of school buildings in Portugal and in Brazil. In order to achieve it, it will also be analyzed other methodologies that already incorporate parameters directly related with the schools environment, such as BREEAM or LEED.

Keywords: SBTool, school buildings, sustainability assessment methodologies, iiSBE.

1. INTRODUCTION

The concept of sustainable development has achieved worldwide prominence in 1970 after the proclamation of the Year of the Environment by the United Nations, and appeared as a result of the awareness and concern of society with the shortage of natural resources (Castanheira, 2013). "Sustainable development is defined as being a development that meets the needs of the present generation without compromising the capability of future generations to meet their own needs" (WCDE, 1989).

Charles Kibert (1994) introduced for the first time the concept of sustainable construction as being the “creation and responsible management of a healthy built environment, taking in consideration the ecological principles and the efficient use of the resources". Sustainable construction ought to seek a balance between the environmental, social and economic levels in the construction sector.

Some advances have been made intended to boost the implementation of sustainable construction in the planet, specially the research and development of tools for sustainability assessment of buildings. As a result of the use of these tools, it has been made possible to improve the sustainability in building construction (Mateus & Bragança, 2011).

They also made easy to distinguish between sustainable and unsustainable practices, thus facilitating conscientious choices and the making of decisions, both in the project and in the construction phases. Therefore, in different countries were developed tools such as SBTool (Sustainable Building Tool) , LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method), CASBEE (Comprehensive Assessment System for Building Environmental Efficiency), HQE (High Environmental Quality), NABERS (National Australian Built Environment Rating System), among others, tools that allow the implementation of sustainability assessments of buildings (Mateus & Bragança, 2011).

The previously mentioned tools were created with the aim of being adapted to all types of constructions. However, it was gradually felt the necessity of creating tools for specific buildings such as residences, offices, shopping centers, hospitals and others.

The SBToolPT (Sustainable Building Tool – Portugal) had already categorized into specific methodologies, such as SBToolPT-H (Sustainable Building Tool – Portugal for residential building), that is considered as residential constructions (Mateus & Bragança 2009), as well as methodologies for Office and Tourism buildings and Construction Environment, that are at the moment waiting to be validated by the association iiSBE-PT (International Initiative for a Sustainable Built Environment –Portugal).

LEED and BREEAM methodologies have already created specific systems for schools. This is crucial because the environment of schools is extremely unique. Students and teachers spend many hours a day surrounded by the school environment and, as a consequence, this specific environment has a great influence on the students' and teachers' quality of life.

Bearing the mentioned advantages in mind, this paper aims to analyze the importance of the use of sustainability indicators to reach and develop strategies for the regeneration of school buildings, taking into account the sustainability assessment tool SBTool, which is based on the international methodology iiSBE.

These indicators will be applied in some Portuguese schools in order to be tested and validated. It is also intended to extend the application of these indicators to some schools in Juiz de Fora, Brazil.

The study is being developed for the Portuguese reality, as the base methodology being used, SBTool, has already been adapted to other building typologies, according to the Portuguese reality. Brazil is in strong construction development, thus increasingly demonstrating a concern for sustainability. Portugal has great experience in developing sustainability assessment methodologies, and therefore, can help Brazil to take its first steps.

Nevertheless, Brazil is quite heterogeneous, which implies a very extensive work to develop a methodology applicable to the whole country. Therefore, and given the deadline to complete this word, only a city – Juiz de Fora – will be chosen, to begin the development and implementation of a sustainability assessment tool in the country.

2. SUSTAINABLE CONSTRUCTION

2.1 Sustainability assessment methodologies

The environmental impact caused by the construction sector has increased these past few decades. The activities inherent to the construction industry are at the top of the main responsible for pollution and also responsible for the consumption of 25-40% of the energy and 50% of the raw materials extracted from earth in the member countries of OCDE (Organization for Economic Co-operation and Development) (Gervásio, 2010).

As a response to these problems, a few initiatives started to emerge and led to the first methodologies for the assessment of sustainability for constructions. Over the years, there was

a progress and several methodologies for environmental assessment of building were created (Gu et al., 2006).

Since the rating system has profound impact on the results of the evaluation, there has been a special attention on the evaluation studies and on the strategies utilized to allocate the credits and questions assessed. These methodologies are adapted according to the region and the country in question and aim to contribute to a reduction of the overall environmental impact. The most used methodologies are the following (Gu et al., 2006): BREEAM, LEED, AQUA(Alta Qualidade Ambiental meaning High Quality Environment), SBTool, CASBEE, HQE, Green Star, NABER, Eco profile, PromisE, DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen), BCA (Building and Construction Authority) Green Mark Scheme.

2.2 Examples of environmental methodologies used in schools

After the previously description about the most common sustainability assessment methodologies for buildings, it will be now mentioned some methodologies for the evaluation of sustainability applied exclusively in school construction, as LEED for schools 2009 and BREEAM Schools 2004, with the main purpose of select the aspects that may be more suitable to the methodology that will be developed in the frame of this work.

The LEED for Schools can be used in the design and construction of new schools, being also adaptable to existing schools, and its certification can be divided in two stages: design and construction (LEED for Schools, 2009). The LEED method evaluates a building through the analysis of seven prerequisites and credits.

The prerequisites and credits for LEED certification is concerned about: sustainable sites; efficient utilization of water; energy and atmosphere; material and resources used; indoor environmental quality; innovative design and prioritization of the region.

Another typical feature of LEED is that it does not specify weights for categories, so the building is rated by the result of points obtained by the sum of the criteria, and it also gives importance to the specific features of the site. The certification is given to the buildings that achieve a minimum number of points and fulfil the prerequisites of the system (LEED for School, 2009).

BREEAM Schools has been designed specifically for the assessment of the following educational establishments: schools (elementary and middle school, and academies), colleges (further and higher education/vocational colleges), pre-school (nursery schools and children's center), and Institutions such as the learning resource center, student union, teaching facility, laboratory/workshop/studio, student residential accommodation (Multi-Residential) or a mixture of these types.

In 2004 was review the requirements and objectives of BREEAM for schools. The BREEAM Schools is a methodology of environmental certification pointed towards new schools and existing buildings. It considers nine factors of environmental impact that should be assessed in accordance with the rules of the BRE (Building Research Establishment): health and life quality, ecological values, energy, management, materials, transport, water; land used and pollution (BREEAM Schools 2004).

These two methodologies for sustainability assessment applied specifically to school buildings intend to help in the choice of the most appropriate indicators for the methodology to be developed for schools in Portugal. It has been realized that these methodologies have different priorities according to their objectives, location, social and economic aspects and the reality of the region where the building is located but they are an excellent base for this paper.

2.3 Analysis and choice of methodology

There are already some methodologies specifically utilized in school, such as LEED and BREEAM. Although being the most widely recognized environmental methods, being currently applied in the construction industry worldwide, they are not suitable for the purpose of this work. The BREEAM methodology is complicated, very strict and with an extremely complex process of accuracy. LEED, despite of being a method that allows an easy calculation, has been adapted to suit the US market. BREEAM uses European and UK codes while LEED is more dominated by the ASHRAE standards (Rezaallah et. al, 2012).

The choice of the methodology SBTool (Sustainable Building Tool) has been made because it allows a higher possibility of adjustment of the parameters evaluated in each dimension, considering the typology, location and the function of the building, which demonstrates the greater flexibility of this methodology. It also reduces subjectivity, making it more adaptable to the local conditions in relation to other more rigid and extensive systems (Barbosa, 2013).

This work will also be based on the results of the project Portuguese SBToolPT STP- Portuguese Sustainable Building Tool Methodologies to Tourism Commercial and Urban Planning Projects (Barbosa, 2013), funded by the ADI (Agency Of Innovation), under the QREN program (Barbosa, 2013). This tool is at the moment waiting to be validated by SBTool and iiSBE association.

This methodology was chosen because it is the newest system based on SBTool, made to be applied in Portugal, and also because the categories that it uses are more suitable to school buildings than the SBToolPT for homes. Furthermore, being that methodology elaborated in Portugal, makes it the one that best suits the Portuguese reality, since it is easier to adapt to the Portuguese conditions, thus eliminating the necessity of using methodologies elaborated for other countries, as LEED and BREEAM.

The indicators for the evaluation of sustainability in schools will be based on the methodology mentioned above since it has the same structure, being divided into categories, indicators, and comparing the performance levels of the studied building with practices of reference. It will be adapted to the specific characteristics of the school buildings, which will lead to some differences in what to the practices of reference is concerned. It will also lead to the adding or to the removal of indicators from the methods of evaluation, as well as the change of weights related to these indicators.

2. CHARACTERIZATION OF BRAZILIAN AND PORTUGUESE SCHOOLS

In this part of the paper are reported sustainability assessment of school buildings and also some fundamental characteristics of the school buildings that are used in this work, in Portugal and in Juiz de Fora, Brazil. It is giving more information about the context where the indicators that can be used in a methodology for sustainability assessment of school buildings will be performed.

2.1 Methods of sustainability assessment in Brazil

Nowadays, several buildings that search for sustainable certification in Brazil are trying to obtain resources to acquire licenses from the government relying on the availability of a large number of enterprises or governmental institutions that invest and encourage green building. The sustainability certifications as LEED, AQUA and PROCEL already operate in Brazil for few years. The English BREEAM certifications and German DGNB just start to be offered for companies in Brazil (Portal Itambé, 2013).

The LEED was the first Certification of Sustainability for buildings that was used in Brazil, in 2007. Since then, this certifier registers 449 projects. From the research coordinated by UNICAMP, they began outlining the methodology in São Paulo, and soon it was implemented for validation in other regions of Brazil (Silva et al, 2000).

The AQUA System was created in 2007, was developed by Carlos Alberto Vanzolini Foundation with the Polytechnic School of USP by adapting the French system HQE with the norms of ABNT. There are about 65 projects in process or already certified in Brazil Today (Fundação Vanzolini 2013).

The PROCEL (Programa Nacional de Conservação de Energia Elétrica) Program was launched in 1985 by the Federal Government, and is currently being managed by an Executive Secretariat subordinated to Eletrobras. This program has the objective to mobilize society and strategies to reduce energy waste by investing in building new projects and environmental awareness, and thus contributing to the preservation of natural areas. Eletrobras elaborated PROCEL Build Program, which invests in professional and technological training, seeking to create solutions related to the Brazilian reality (ELETROBRÁS, 2013).

The Casa Azul, program of the Bank Caixa Econômica Federal, is specific to public housing, given the housing projects that are funded by the Brazilian Federal Bank (Caixa Econômica Federal), currently has 10 candidates under evaluation (Capello 2011).

The BREEAM only started to operate in the Brazilian market in 2012 and has only 2 buildings located in Rio de Janeiro with this certification. The reason that was just a few buildings with this certification is because it had no patterns that fit in Brazilian reality. The situation is changing and it is being prepared a new version of this methodology that adapts to all regions of Brazil.

2.2 Methods of sustainability assessment in Portugal

As a result of the Conference of Rio de Janeiro, the European Commission established the European Conference on Sustainable Cities in 1994, seeking to set foundations for the implementation of Agenda 21 adapted to European reality. That resulted in the Charter of European Cities, which established practices and policies for sustainable development (Commission of the European Communities, 1994).

In 1993 took place in Lisbon the Lisbon Summit, where the Commission sought to broaden the vision of sustainable development, making it a long-term perspective. The National Strategy for Sustainable Development of Portugal was published in 2002 and updated in 2005 with the objective of making Portugal one of the most competitive countries of the European Union on environmental quality and social responsibility until 2015 (Torgal & Jalali, 2007).

Portugal was the European country that has made new buildings, without worrying about concepts as reuse and rehabilitation. The number of residential buildings in Portuguese cities doubled between 1970 and 2000, even if there were no demographic growth to justify this attitude.

Currently, Portugal includes a total of 477 public schools, construction which began at the end of the nineteen century. Around 23 % were built before the end of the 60s and the other (77 %) correspond to the period of expansion of the school network and increased compulsory schooling, from six to nine years. 46 % of schools were built in the 80s.

These schools form a heterogeneous group, both in terms of conditions of architectural and construction quality as morphological type buildings. Although it is mainly composed of standardized solutions, arising from the use of serial construction and use of project type, comprises buildings with a recognized asset value and also has some projects with innovative solutions in construction and spatial terms (Portal Parque Escolar).

Portugal currently applies some International Systems of Sustainability Assessment, which were previously cited, LEED, BREEAM and the SBTool. Other systems have been developed and adapted according to the needs, requirements and reality of the country, such as Natura Domus, LiderA and SBtoolPT (Portal da Construção Sustentável).

• NATURA DOMUS system was developed by SGS (Societe Generale de Surveillance) in 2005 and it is available in Portugal since 2008. The Natura Domus system in conjunction with Domus Qual cares about quality and sustainability of a building, acting on 4 levels: design, construction, demolition or rehabilitation and resource management (Portal da Construção Sustentável).

• SBToolPT is a tool that allows the evaluation, recognition and certification of sustainability of buildings, based on the international SBTool. It was released in 2009, developed by the University of Minho and approved by iiSBE (Portal da Construção Sustentável).

• LiderA is an environmental certification system, developed in 2005 by the IST (Instituto Superior Técnico de Lisboa) and has been available since 2009 on version 2.0. This is a Portuguese volunteer system that seeks an efficient and integrated manner to support the evaluation and certification of sustainability of buildings from the design phase to use by customers, given at strategic levels and project management (LiderA, 2005).

3. SELECTION OF KEY INDICATORS

The methodology proposed in this work is similar to SBToolPT-S (Sustainable Building Tool – Portugal, Service building). The evaluation is in accordance with the calculation of the performance level of the building, using some parameters related to social, economic and environmental aspects and comparison with national practices references with the help of Diaz-Baltero equation (Díaz-Baltero, 2004).

Each indicator should be calculated on your specific weight to get the result according to the performance of the building. The value of the global performance of a building should not be used alone to report the sustainability of a building, since this always have to be together with the result of macro indicators (environment, society and economy). Therefore, to obtain a better solution to improve the sustainability of a building, there must always be a compromise between all macro indicators (Mateus, 2009).

The macro indicators are:
• Category - combination of indicators to demonstrate the performance of the building;
• Dimension of Sustainable Development - environment, society, economy and sustainability of the area;
• Global performance (Level of Sustainability) - summarizes the dimensions into a single value.

All categories used in the construction assessment SBToolPT-S will be used in SBToolPT for schools, adding a new social category - consciousness and education for sustainability, and their respective indicators.

This category, consciousness and education for sustainability, which was part of the first SBToolPT (Mateus, 2009), will return to construction assessment for schools, but in different format, with the social concern of the necessity awareness of sustainability. The school is used as a vehicle for disseminating the importance that the experience of sustainability has in people's lives, using students as tools, as these can spread this idea in the family and in the society in which they live, making this part of their daily life in a natural way.

The weight of each indicator reflects on the results. Even though some indicators have greater relevance than others, there is not yet a consensus related to a methodology that define the specific weight for each, these being used as the priorities and context factors that interfere in the life cycle of buildings (Mateus, 2009). The weight given to the indicators on the methodology to be developed will be given in accordance with the priorities that the school environment has.

As a result of the use of a new category, Consciousness and Education for Sustainability, and their respective indicators, and also for being this methodology adapted to a new environment, school building, there will be some modifications related to weights of indicators.

After the study and analysis of indicators and categories existent in other sustainability assessment methodologies, LEED for School and BREEAM Schools, and also in the system SBToolPT for other types of buildings, some conclusions were drawn related to indicators and categories more suitable to the methodology presented in this paper for the evaluation of schools. The following table shows the dimensions, categories and indicators in the methodology for schools, based in SBToolPT- S.

Table 1: Categories and Indicators in the methodology for school, based in SBToolPT - S

Dimension	Category	ID	Indicador
ENVIRONMENT	C1. Climate Change and out-door air quality	I1	Life cycle environmental impacts
		I2	Heat island effects
	C2. Biodiversity and land use	I3	Land use efficiency
		I4	Sustainable location
		I5	Local biodiversity protection during construction
		I6	Certificated wooded materials
	C3. Energy	I7	Energy consumption
		I8	Renewable Energy
		I9	Commissioning
	C4. Materials, solid residues and resources management	I10	Reuse of materials
		I11	Materials with recycled content
		I12	Construction and demolition wastes
		I13	Environmental management plan
		I14	Flexibility and adaptability
	C5. Water	I15	Water consumption
		I16	Water treatment and Recycling
		I17	Storm water management
SOCIETY	C6. User health and comfort	I18	Indoor air quality
		I19	Thermal Comfort
		I20	Visual Comfort
		I21	Acoustic Comfort
	C7. Accessibility	I22	Mobility plan
	C8. Security	I23	Occupants security
	C9.Consciousness and education for sustainability	I24	Consciousness of sustainability
		I25	Educational materials
ECONOMY	C10. Life cycle costs	I26	Life cycle costs
	C11: Sustainability of the area	I27	Accessibility to public transport
		I28	Accessibility to amenities

4. CONCLUSION

The analysis and choice of indicators specifically directed to school buildings is important to help the development of a methodology of assessment of school buildings for Portugal. This methodology will be applied in some Portuguese schools in order to be tested and validated. It will also be applied in Brazil with the intent of disseminating and implementing the practice of this methodology in the country.

The indicators that can be used in a methodology for sustainability assessment of school buildings is to be analyzed and chosen according to its specific characteristics and adapted to the Portuguese reality, allowing to be one of the most flexible methodologies compared with others. Therefore, it is the one that best suits the Brazilian reality, because it can be easily adapted to all regions in Brazil.

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