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Review

Developing the methodology for determining the relative weight of dimensions employed in sustainable building assessment tools for Brazil

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ABSTRACT

The fundamental differences between the dimensions of sustainable development have been identified by researchers and many assessment tools have been developed in several countries. This paper introduces the development of a methodology for determining the weight of each dimension employed in sustainable construction assessment through the use of assessment tools that use the Brazilian indicators of sustainable development in accordance with the Commission on Sustainable Development, and also through the utilization of a database provided by the Brazilian Geography and Statistics Institute (IBGE). Firstly, the Sustainability Panel tool was employed to reveal separately the status of dimensions in sustainable development (environmental, social and economic) and then it was made a statistical analysis of the results for each region in Brazil (north, northeast, midwest, southeast and south). The solution presented in this paper aims to reduce the inconsistencies found in the adjustments of the assessment tools considering regional differences based on political actions included in governmental agencies.

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1. Introduction

The most frequently cited definition of sustainable development is attributed to the Brundtland Report of 1987 – "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" that may cover all three dimensions of sustainable development (social, environmental, and economic) or may be skewed to one of them; it may or may not address future generations; and it may address technology, resources, waste, pollution, energy consumption or other issues. In this context, many governmental organizations have offered, and periodically updated, the sustainable development indicators according to the Commission on Sustainable Development. In Brazil, the Brazilian Geography and Statistics

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Institute has been undertaking this research since 2002, focusing on four aspects, summarized below (IBGE, 2015):

i.) The environmental dimension is related to conservation objectives and environmental preservation, considered essential for the quality of life of present and future generations. These issues appear organized in 20 (twenty) indicators arranged according to aspects such as atmosphere, earth, water, oceans and seas, biodiversity and sanitation;
ii.) The social dimension pertains to objectives related to the satisfaction of human needs. The 21 (twenty one) indicators are arranged by population, labor and income, health, education, home and security, aiming to depict the education level, income distribution and living conditions;
iii.) The economic dimension is concerned with the efficiency of the production processes and changes in consumption patterns, being organized in 12 (twelve) indicators;
iv.) The institutional dimension concerns to the ability and effort spent by governments and societies to implement changes required for an effective implementation of sustainable development and is presented in 9 (nine) indicators.

In this context, different sectors, including building sector, began to recognize the impact of their activities on sustainable development in the 1990s and some of the organizations and research groups (Cox et al., 2015; Chang and Tsai, 2016; Rigamonti et al., 2016) involved in the building process have been incorporating the regulations regarding the "green building" concept. Furthermore, many assessment tools have been developed in several countries – such as BREEAM in UK, LEED in USA, SBTool in Canada, HQE in France, among others – that involve the assessment of alternative scenarios based on different criteria (Diakaki et al., 2010; Biesbroek et al., 2010).

There are many assessment tools and the comparison between their results is very difficult because they were developed for different types of buildings or different phases of the construction process, considering different perspectives of the building life cycle, or using different databases or guidelines (Mateus and Bragança, 2011; Wilde de and Coley, 2012; Ferreira and Pinheiro, 2014).

Further, uncertainties and errors may occur in the different phases of the assessment process of the building, which resulted in strong criticisms about the accuracy and reliability of these tools. These errors can distort the interpretation of the results, mainly the ones that are related with the definition of the weight of the dimensions, which can lead to misinterpretations of the results (Haapio and Viitaniemi, 2008; Ferreira and Pinheiro, 2014). It is possible that in the future a building that is qualified today as being of high quality may be considered a low-quality construction.

The significance of this paper lies in the development of a methodology for the determination of the relative weights of the three dimensions (environmental, social and economic) employed in the assessment tools, considering the five Brazilian regions (north, northeast, southeast, south and midwest), allowing a constant updating of the assessment tools as soon as new issues are published by governmental agencies. Finally, the authors expect that this research may provide the basis for future studies in countries with many regional differences, as is the case of Brazil.

2. Sustainable construction in Brazil

2.1. Regions of Brazil

Brazil is the fifth largest country in the world with 8,515.767 km^2, 5570 cities, and 27 states in five regions (North, Northeast, Southeast, South and Midwest – see illustration in Fig. 1). This division in regions and states enables the planning of political actions for regions with similar characteristics.

There are four different time zones as well as diverse climate regions in Brazil (equatorial climate, tropical climate, subtropical climate and quasi arid climate), which must be taken into account in the different construction practices and building types. In this context, the global interest in sustainable development in Brazil's building industry is promising.

2.2. Analysis of brazilian issues

For the analyses of Brazilian issues, using the data provided by the IBGE, i.e., indicators of sustainable development, it is possible to use the Dashboard of Sustainability Tool (http://sustainability-dashboard.software.informer.com/2.0).

The Dashboard of Sustainability Tool is an electronic tool that displays separately the status concerning the environmental, social, economic and institutional dimensions of sustainable development indexes in Brazil, and its main purpose is to measure the "supply" and the "fluidity" of each dimension allowing a counterweight of the dimensions in favor of the sustainability. Briefly, the procedure consists in:

a Customize each dimension of sustainable development through the parameters provided by the indicators of sustainable development (in this case provided by the IBGE), which should contain information such as the field to which it belongs (environmental, social, economic and institutional), variables and sources used in its construction, the result of the evaluation of the country and other minor information. The construction of the database takes place with the use of input information inserted in an Excel spreadsheet, following a pre-established format;
b Determine the reference value for each parameter seeking a levelling between them, since the panel evaluates the indicators through the data comparison. Most critics regard as being a good standard an equal distribution of the weights between the dimensions because it is uniform (Bakkes et al., 1994; Alves et al., 2014).

The results obtained with the Dashboard of Sustainability tool using the data provided in the years between 2008 and 2015, can be seen in Fig. 2, for a reference equal to 100% per year for the four dimensions of the sustainable development in the five regions of Brazil. It was verified that the environmental and social dimensions are unified throughout all regions. However, the economic and institutional dimensions are not uniformed, mainly in the North and Northeast of the country.

2.3. The state-of-the-art on "green building" in Brazil

In Brazil, regarding the implementation of the "green building" concept, there is still the need to strengthen the following:

i) *Financial issues*: larger databases related with the life cycle of buildings and materials are needed as well as more and better correlations between construction costs and operational costs;
ii) *Technical issues*: In the construction sector, there is still low industrialization and, occasionally, the use of traditional and outdated processes leading to the use of multiple construction processes and to a large heterogeneity of products.
iii) *Training*: qualification of more professionals on assessment tools is needed;

However, presently, the assessment tools always determine the criteria that guide the professionals to meet the standards and to follow the developments related to the update of the performance