Critical overview of urban sustainability assessment tools

Erika Guimarães

University of Minho, School of Engineering, Department of Civil Engineering, Guimarães, Portugal
erikaguimaraes@poli.ufrj.br

José Amarilio Barbosa

University of Minho, School of Engineering, Department of Civil Engineering, Guimarães, Portugal
jabarbosa@civil.uminho.pt

Luís Bragança

University of Minho, School of Engineering, Department of Civil Engineering, Guimarães, Portugal
braganca@civil.uminho.pt

ABSTRACT: Sustainability assessment has been promoted by several institutions and organizations in order to encourage sustainable practices in the building sector. The scope of the first assessment tools was on buildings and building solutions. Research within this field of knowledge is already well established. But very recently, there has been a progressive development of tools aiming at broader scales such as neighborhoods, urban districts and larger urban areas. These assessment tools borrowed strategies that were used in their predecessors (aiming at the building scale) that bring some problems when assessing sustainability in urban areas. In this article, several sustainability assessment tools for urban areas were analyzed in several criteria. The analysis showed that all existing assessment tools share some issues regardless of having different approaches. It is argued that sustainability assessment tools need to evolve in the sense of becoming more similar regarding their assessment framework and scoring methods.

Keywords *Sustainability, Assessment tools, Urban Planning, Top-down approach*

ISBN: 978-85-92631-00-0

1 INTRODUCTION

The current accelerated growth of urban populations, together with the paradigm of the consumerism lifestyle is pushing the environment to its limits and harming the planet (Ameen et al., 2015). Urban inhabitants stand for over 50% of the global population, and the figure tends to evolve to 70% until 2060 (Mele, 2014) (United Nations, 2014). Urban areas are nowadays the main responsible for local consumption of natural resources and land, contributing in about 70% of global pollutant emissions (United Nations, 2014) (Shen et al., 2011) and are responsible for numerous other environmental problems (Barbosa et al., 2014a) (Barbosa et al., 2014b).

In an attempt to push the construction sector towards a sustainable development, it is very important to guide urban planning projects towards sustainability principles (Ameen et al., 2015) (Barbosa et al., 2014b). In this way, the development of sustainability assessment tools in the late 1990's had attracted the attention of stakeholders by making possible to assess and certify the performance of construction projects. The assessment is normally based on an assessment framework composed of several indicators/criteria that are grouped in categories. Nowadays, there are many sustainability assessment tools all around the world aimed at buildings of several types and, more recently, aiming at urban planning operations (Berardi, 2015).

Nevertheless, there are many problems identified in these tools that are borrowed from tools that were aimed for buildings. Luetzkendorf et al. identifies problems related to a bottom-up approach such as: indicators often do not cover the full range of sustainability issues; Indicators may be overlapping; Indicators may be of different value in terms of significance (Lützkendorf et al., 2012). Additionally, most existing tools present extensive lists of indicators that can cause redundancies and, in some cases, inconsistencies in the assessment of different parameters (Ameen et al., 2015). Moreover, it is common to observe the use of indicators previously developed for building in the assessment of urban areas, which adaptation is inadequate. On the other hand, the scope of the tools have huge variations, from the scale of a couple of buildings to the scale of a full urban block or district. Consequently, there are many difficulties in comparing different sustainability assessment tools (Ameen et al., 2015) (Barbosa et al., 2014a), (Lützkendorf et al., 2012), (Srinivasan et al., 2014) (Whitehead et al., 2015) (Haapio and Viitaniemi, 2008). Considering these issues and the ongoing tendency for normalization and standardization in this field with new norms being launched by ISO (ISO, 2008, ISO, 2010, ISO, 2011) and CEN (CEN, 2010, CEN, 2011, CEN, 2012a, CEN, 2012b), there is a necessity to further develop and update existing tools.

Aiming to make a positive contribution on the matter, the objective of this work is to analyse several sustainability assessments tools developed for urban communities to conclude about several issues previously identified and to identify new ones. Afterwards, instead of promoting the development of a new assessment system, the objective is to develop guidelines and recommendations for future development of existing tools. For this reason, the study will focus on the development of a new assessment framework to be used as a reference for the development of existing sustainability assessment tools.

ISBN: 978-85-92631-00-0

To fulfil the purposes of this study, several sustainability assessment tools were analysed. Table 1 lists and summarizes information about the selected tools. The analysis of the different tools was based on several criteria in order to conclude about the existence of the issues identified in bottom-up approaches, namely: assessment framework and methods, weighting systems, definition of sustainability, neutrality and redundancy of indicators. Taking into account the results and conclusions of the analysis of existing tools, a new structure is developed and proposed implementing solutions to solve some of the identified problems.

Table 1: Summary of Selected Sustainability Assessment Tools

Sustainability Assessment Tool	Acronym	Developer	Country	Latest Version
LEED Neighbourhood Development	LEED -ND	USGBC - United States Green Building Council	U.S.A.	2014
BREEAM Communities	BREEAM Co	BRE - Building Research Establishment	U.K.	2012
CASBEE Urban Development	CASBEE-UD	IBEC - Institute for Building Environment and Energy Conservation	Japan	2014
SBTool PT UP	SBTool PT-UP	iiSBE Portugal	Portugal	2013
Earth Craft Communities	ECC	Earth Craft	U.S.A.	2014
Green Star Communities	GSC	Green Building Council Australia	Australia	2015
GSAS District and Infrastructures	GSAS-DI	GORD - Gulf Organisation for Research and Development	Qatar	2015

2 RESULTS AND DISCUSSION

2.1 Description of Tools

LEED was developed by the United States Green Building Council - USGB, which stands for Leadership in Energy and Environmental Design. The first version was designed in the United States in 1993 and consisted on a single tool conceived specifically towards the green buildings market. Over the past decades, the methodology's scope has expanded, so that nowadays five different tools can be identified in the fields of building external and interior designs, building's operations, single-family houses and recently, urban areas. The version directed to sustainability assessment of urban areas, LEED-Neighbourhood Development (ND), had its pilot version launched in 2010, having been annually updated since then. The analysis done in this work was based on edition LEED-ND V4, of 2014. According to USGB, LEED ND can be applied to both new development and rehabilitation projects, at any stage of the process, as its scope goes from conceptual planning to construction activities (LEED, 2014).

BREEAM was developed in the United Kingdom in 1990 by Building Research Establishment (BRE) and was applied in the certification of over 400.000 buildings ever since. The methodology initially concerned the evaluation of best practices of building design, becoming a reference method to describe environmental performance of buildings. The BREEAM methodology is claimed to properly assess any type of building worldwide. Likewise, the urban planning version, released in 2009, embraces both mixed-use and single-use international developments (BRE, 2012). BRE also states that this urban planning

ISBN: 978-85-92631-00-0

tool is able to identify the different impacts of an urban project on the surroundings, and, therefore, size boundaries are not recommended neither established. In fact, its appliance is recommended whenever it is intended to promote significant impacts on a community and adequate provision of new services (BRE, 2012). The latest version of BREEAM Communities (Co) features a process guide, which allows an international application of the tool (BRE, 2012).

Comprehensive Assessment System for Built Environment Efficiency – CASBEE was born from the association between Japan Green Building Council (JaGBC) and Japanese Sustainable Building Consortium (JSBC) as a tool to assess and rate the environmental performance of buildings and built environment. Released in 2001, CASBEE was initially directed to office buildings. However, since 2008 the assessment scope expanded with the release of new tools, designed for different areas (JSBC and IBEC, 2014). Nowadays the CASBEE family integrates four basic components related to New Constructions, Existing Buildings, Renovations, and Pre-design (still under development).

The basic CASBEE tools were designed for individual buildings, not building groups. In this sense, CASBEE for urban development, CASBEE-UD, was released in 2006 to make broader assessments, covering urban development projects in the scale of blocks or zones (JSBC and JaGBC, 2014). The tool is strictly related to urban clusters and ancillary external spaces, excluding any kind of indoor environment. In 2012, JaGBC and JSBC launched CASBEE for Cities, a more generic and extensive tool to evaluate environmental performance of larger municipalities. Considering this, the 2014 edition inherits the basic principles of CASBEE-UD, while featuring a revised and more specific evaluation for enhanced and diversified demands in neighbourhood-scale arrangements.

SBTool PT for Urban Planning (UP) was developed as an adaptation of SBTool (Sustainable Building Tool) to the Portuguese context. SBTool was originally developed by International Initiative towards a Sustainable Built Environment and was specifically planned to help local organizations develop their own assessment and certification systems (iiSBE, 2015). SBTool assessments embrace projects from single building to urban scale and have been adapted to several countries, as the system is designed to be easily inserted in local criteria and language (iiSBE, 2015). SBTool PT-UP was developed by the Portuguese iiSBE Association, in partnership with University of Minho and company Ecochoice (Mateus and Bragança, 2011). The scope of the tool is restricted to urban planning operations which are subject to two legal frameworks that are used in municipal plans: detailed plans and plans of national interest. The pilot edition of SBtool PT-UP, which is subject of this study, was released in 2013 and is the most recent version.

The Earth Craft program was established in 1999 by the Greater Atlanta Home Builders Association and the Southface Energy Institute (Southface, 2016). It offers different kinds of green building certification specifically designed for the built environment of United States' Southeast region. The first product, from 2001, was directed to new constructions of single-family houses. Since then, the program has evolved towards the fields of renovations, multifamily buildings, urban communities, commercial buildings and lately, preservation of historic heritage (Southface, 2016). Launched in 2005, Earth Craft Communities (ECC), has its guidelines continuously updated. According to Southface, the program came from the American market's necessity of a holistic approach in the development of community

ISBN: 978-85-92631-00-0

projects. In this sense, city centres and suburbs, as well as rural areas, are eligible without alleged dimension restrictions (Southface, 2016).

Created in 2003 by the Green Building Council of Australia, Green Star is a rating system developed to evaluate sustainable features of Australian buildings and urban precincts. Unique in the country, the system is designed for the specific needs and characteristics of that context, and its certification is internationally recognized (GBCA, 2016).

Later, the founding entity expanded the methodology beyond the single-edifice scope through the creation of an additional main tool, directed to urban communities. Green Star Communities, GSC, emerged in 2012 and had three pilot editions. In August 2015 the tool's first version, here described, has been officially released. To evaluate a project, Green Star Communities impose the minimum dimension of four buildings groupings. Also, the project must define a clear study area, subject of a "plan of development", which has to be managed by a governmental or private entity (GBCA, 2016).

Released in 2009, Qatar Sustainability Assessment System (QSAS), the methodology was developed by the Gulf Organization for Research & Development (GORD) in collaboration with the Pennsylvania University and the Georgia Institute of Technology. The tool was afterwards renamed as Global Sustainability Assessment System (GSAS).

The neighbourhood-scale scheme is based on the individual assessment of existing building, proposing the most suitable available scheme to the main use. As an integrated analysis of the area is not featured, the study of such tool is not consistent with the objectives of this article. Instead, attention is directed to the District and Infrastructure appliance (GSAS-DI). The referred scheme is currently on its second edition (V 2.1, from October 2015) and aims a guide design assessments for both new and existing districts (GORD, 2016).

2.2 Comparison of Tools

2.2.1 Scope of Assessments

None of the analysed methodologies allegedly restrict the size of eligible projects, however, some variations are observed on the scale of assessed urban areas. BREEAM Communities may assess projects from 2 to 179 hectares (0,02 to 1,79 km^2) and is mainly aimed at mixed-use urban communities containing up to 6000 built units, although there are bespoke cases superior to this figure (Berardi, 2015) (BRE, 2013).

In LEED-ND there is mention that the ideal urban community is restricted to 1,3 square kilometres and it is recommended the division in smaller lots if this size is exceeded (BRE, 2012). The size of pilot projects evaluated with LEED-ND was very variable: the smallest evaluated project had 687 m^2 and the largest, 51,8 km^2, with an average size of 1,2 square kilometres (BRE, 2012).

CASBEE-UD's technical manual pleads the evaluation of limited groups of buildings connected through urban spaces, reserving larger areas to the CASBEE Cities tool (Berardi, 2015) (JSBC and IBEC, 2014). It is mentioned the possibility of evaluating larger-scaled areas as long as suitable information is provided. However, no further information regarding the dimensions of urban communities is disclosed.

ISBN: 978-85-92631-00-0

SBTool PT-UP was the only tool analysed that attempts to frame the applicability of the assessment subjects on existing legislation, being applied on Detailed Plans (PP – “Planos de Pormenor”) and National Interest Projects (PIN – “Projectos de Interesse Nacional”). These plans, defined in Portuguese Spatial Planning Standards, are instruments that help local municipalities approve urban rehabilitation and development programmes (Portugal, 2007, Portugal, 2011). However, the mentioned documents do not indicate clearly the applicable dimension for such interventions, which may vary from a single street to larger neighbourhoods and respective networks. Regarding Earth Craft, Green Star and GSAS, it was not found any information regarding the assessment scope.

The analysis of the scope of the several tools indicates that existing sustainability assessment tools for urban areas are not homogeneous regarding the size of the assessed projects, varying from a small group of buildings to a medium-sized city. This shows that there is not a consensus or clear definition for the scope and scale of the assessment, making it hard to establish a comparison between them. The main issue with this vagueness concerns the difficulty in defining a concept of sustainable urban planning, since varied scales of assessment involve different measures and stakeholders. As an example, if the object of assessment is a group of streets or an urban district, the layout or the connectivity of the infrastructures is an important aspect to be considered. However, when the scale of assessment is reduced to a single block, this aspect cannot be considered. Consequently, the framework of tools, the calculation methods and the benchmarks must be adaptable to each type of situation. Thereby, it can be argued that tools with broad spectrums of application cannot provide objective assessments.

2.2.2 Assessment framework

In terms of the assessment framework, all the tools analysed demonstrated to be based on bottom-up approaches. However, the number of indicators and the way in which they are organized in categories is quite variable. LEED-ND presents five impact categories and distinguishes two main groups of indicators, pre-requisites and optional indicators. Pre-requisites comprehend the characteristics that projects must comply to be certified. Optional indicators provide bonus points if certain characteristics are verified. A total of twelve mandatory indicators is disposed, in contrast with the forty-four elements of the optional set.

In BREEAM Communities there are also five categories, but the 40 indicators are disposed according to 3 steps of implementation (BRE, 2012). Step 1 concerns to the impacts of the proposed development on a wider community scale, having only mandatory indicators. Step 2 focuses on layout aspects, following the site’s specific needs and highlighting community engagement with lesser mandatory standards. Step 3 regards to design details, and does not dictates any mandatory indicator.

CASBEE-UD presents an alternative approach, defining two main assessment categories. Quality (Q) category relates to the improvements provided on a daily basis for the buildings’ users. Load (L), on the other hand, concerns the evaluation of negative environmental impacts beyond the enclosed space boundary. The ratio Q/L gives the Built Environment Efficiency (BEE) of the project, which is the index evaluated parameter and the core-concept of the CASBEE method (JSBC and IBEC, 2014). The tool provides a list of 31 indicators, grouped in three main impact categories, comprising exclusively qualitative parameters.

ISBN: 978-85-92631-00-0

The Portuguese method presents 13 impact categories and 41 indicators. Like CASBEE-UD, in this tool the categories are divided according to the 3 dimensions of sustainability, but allocation does not follow a top-down approach. GSAS-DI divides 76 indicators in 8 groups. Green Star Communities is the most concise having 33 indicators organised in five classes. Earth Craft tool stands out for distinguishing separate lists of mandatory and optional indicators, where the obligatoriness depends on the location of the project (coastal or piedmont). This tool from has a total of 24 (piedmont) or 26 (coastal) mandatory indicators and 74 (coastal) or 76 (piedmont) optional indicators, distributed in 7 impact categories.

It is verified that urban planning assessment methodologies have very divergent approaches. This may demonstrate an unclear and imprecise definition of an urban sustainability. For this reason, no distinction can be made regarding a correct model of assessment. In the pursuit of an evolutionary approximation that would allow proper ways of comparison in the future, methodologies should be developed according to top-down approaches. Furthermore, given the similarity between indicators and categories of assessment, local conditions must not justify different approaches.

2.2.3 Neutrality

This analysis was performed at indicator level and consisted of evaluating the emphasis given to specific aspects that are beyond the urban planner reach in spite of actual sustainable issues. For this purpose, any evidenced impositions of products or procedures related to brands and/or products, such as certification, labels and partial criterion attendance where examined. Considerations also included the statement of licensed project elements and the presence of professionals and team members accredited according to the same company or partner entities.

In Earth Craft Communities over half of available optional credits and 12 out of 27 mandatory indicators are submitted to either ECC accredited professional inspections, Earth Craft certified builder contracts or certifications from agencies under the EarthCraft Renovation program. This can be seen as a partial assessment methodology, once there might be other equally qualified professionals to fulfil the purposes of the described evaluation.

Although in a more moderate form, the other appraised methodologies also have significant indications of products and procedures. BREEAM addresses an ecological strategy developed by ecologist qualified according to determined institutions and indicates an accredited assessor to work with the design team throughout the development of steps 2 and 3. SBtool-UP destines half of its spare credits to sustainability certification according to specifically recognized methods. GSAS reserves one mandatory indicator to the recognition of a Green Star Accredited Professional engagement under the justification of supporting the Green Star certification process. From the analysed tools, CASBEE-UD's structure is the closest to impartiality of assessments, as CASBEE certification schemes are suggested to evaluation of buildings but the adoption of another proper tools is equally recognized. Anyways, the level of proactive utilization of CASBEE tools is directly referred as an evaluation issue, therefore revealing a slight yet perceptible partiality. LEED and GSC were found to be the least impositive methods, having roughly 1% of their assessments' weight associated to accreditations or certifications by their brand.

ISBN: 978-85-92631-00-0

The practice of indicating accredited certifications or professionals within the assessment of sustainable issues can be understood as an underlying marketing strategy. According to some of the technical manuals (JSBC and IBEC, 2014) (LEED, 2014) (Southface, 2016, GBCA, 2016) the purpose of such parameters might be more concerned with selling the brand and providing outputs to respective professional trainings. With that in mind, it may be considered that these methods may not promote an evaluation strictly attached to sustainable principles.

2.2.4 Redundancy

The result of this analysis demonstrates that all methodologies have a considerable degree of redundancy, being ECC the holder of the higher redundancy degree among them (figure 2). This is not a surprising revelation, as it has already been acknowledged as the tool with greater amount of indicators (100).

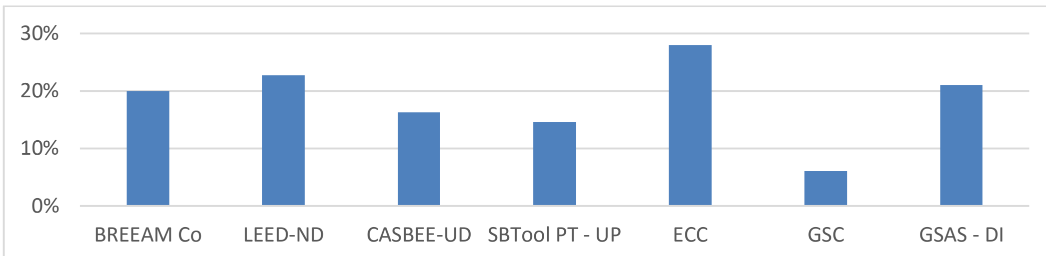

Figure 2. Percentage of redundant indicators

Despite the coincidence of size and redundancy verified for ECC, further analysis did not concluded a relation between these characteristics, nor revealed defined trends or patterns. However, the existence of such levels of redundancy confirms the adoption of top-down approaches in the development of the methods. Also, it confirms the need for a better definition on urban sustainability assessment concept.

2.2.5 Positioning through Sustainability's Dimensions

Through the former evaluations of structures and weighting systems, it is clear that each methodology emphasises different subjects within Sustainability's scope. A detailed appraisal of indicators was followed to identify assessment tendencies regarding social, economic and environmental dimensions.

Figure 3 shows the overall distribution among the studied methods. The studied methods destine equal averages of 44,4% of their assessments to both Environment and Social areas. GSAS-DI is the most concerned with the environment dimension, reserving over 62% to the subject, and GSC is the least, with only 32% of indicators. The percentages of BRREAM Co, LEED-ND, GSC and CASBEE-UD in the social area are very similar, where the former holds the highest value (53%). GSAS-Di is the least socially involved, with a little more than 30%. Economy is clearly the dimension with least focus regarding sustainability assessment, having average percentage of 11%. Once more, GSC stands out for having the greater number of indicators but it makes sense regarding the tool's absence in the environment dimension. In this area, BREEAM Co provides the lesser evaluation (8,9%), what demonstrates a significant imbalance in comparison with the environment and social dimensions.

ISBN: 978-85-92631-00-0

Although the weight distribution seems quite different at first sight and disregarding the fact that each methodology follows distinct strategies, a trend on the focus directed at each dimension may be noticed. Although a tendency to social issues may be noted, international scope tools in general (BREEAM Co, LEED_ND and CASBEE-UD) present more homogeneous weight systems. This is comprehensible due to proposed wider ranges of application; however the use of fixed weight systems in different contexts may result misleading conclusions. Local tools, on the other hand, appear to be more homogeneous in the distribution of indicators. A remarkable exception is ECC, which reserves roughly 2% of its weight to economic issues.

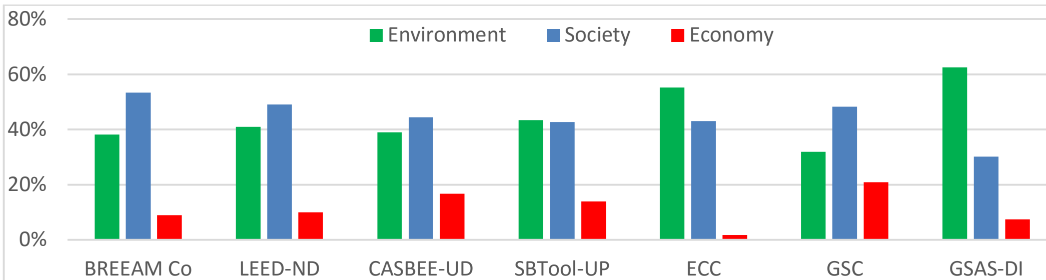

Figure 3. Sum of weightings of Indicators related to the dimensions of sustainability

3 CONCLUSIONS

A comparative and critical analysis of several sustainability assessment tools for urban planning allowed to conclude that these tools share the same issues that are found in the literature regarding sustainability assessment tools for buildings, mainly those associated to a bottom-up approach. This study identified in all the Urban Sustainability Assessment tools analysed issues such as difficulties in the definition of assessment scope, problems in the assessment framework and disconformity between different tools, making them hard to compare, lack of neutrality in the assessment of sustainability, redundancy and difficulties in the definition of sustainability regarding the weighting of sustainability dimensions environment, society and economy.

ACKNOWLEDGMENTS

This work was done within the context of the research activities developed in the network URBENERE, supported by CYTED "Programa Iberoamericano de Ciencia y Tecnologia para el Desarrollo".

REFERENCES

AMEEN, R. F. M., MOURSHED, M. & LI, H. 2015. A critical review of environmental assessment tools for sustainable urban design. *Environmental Impact Assessment Review*, 55, 110-125.
BARBOSA, J., BRAGANCA, L. & MATEUS, R. 2014a. New approach addressing sustainability in urban areas using sustainable city models. *International Journal of Sustainable Building Technology and Urban Development*, 5, 299-307.
BARBOSA, J., BRAGANÇA, L. & MATEUS, R. 2014b. Assessment of Land Use Efficiency Using BSA Tools: Development of a New Index. *Journal of Urban Planning and Development*, 0, 04014020.

BERARDI, U. 2015. Chapter 15 - Sustainability assessments of buildings, communities, and cities A2 - Klemeš, Jiří Jaromír. *Assessing and Measuring Environmental Impact and Sustainability*. Oxford: Butterworth-Heinemann.
BRE 2012. *BREEAM Communities Technical Manual*.
BRE. 2013. *BREEAM The worl's leading design and assessment method for sustainable buildings [Online]*. Available: http://www.breeam.org/ 2013].
CEN, E. C. F. S. 2010. Sustainability of construction works - Sustainability assessment of buildings - Part 1: General framework. CEN/TC 350 - *Sustainability of construction works*.
CEN, E. C. F. S. 2011. Sustainability of construction works - Assessment of buildings - Part 2: Framework for the assessment of environmental performance. CEN/TC 350 - *Sustainability of construction works*.
CEN, E. C. F. S. 2012a. Sustainability of construction works - Assessment of buildings - Part 3: Framework for the assessment of social performance. CEN/TC 350 - *Sustainability of construction works*.
CEN, E. C. F. S. 2012b. Sustainability of construction works - Assessment of buildings - Part 4: Framework for the assessment of economic performance. CEN/TC 350 - *Sustainability of construction works*.
GBCA, G. B. C. A. 2016. *GreenStar [Online]*. Available: http://www.gbca.org.au/green-star/ 2016].
GORD, G. O. F. R. A. D. 2016. *GSAS Overview [Online]*. Available: http://www.gord.qa/trust-gsas-resource-center-overview 2016].
HAAPIO, A. & VIITANIEMI, P. 2008. A critical review of building environmental assessment tools. *Environmental Impact Assessment Review*, 28, 469-482.
IISBE, I. I. F. A. S. B. E. 2015. *SB Method and SBTool [Online]*. Available: http://iisbe.org/sbmethod 2016].
ISO, I. O. F. S. 2008. *Sustainability in building construction* -- General principles.
ISO, I. O. F. S. 2010. *Sustainability in building construction* -- Framework for methods of assessment of the environmental performance of construction works -- Part 1: Buildings.
ISO, I. O. F. S. 2011. *Sustainability in building construction* -- Sustainability indicators -- Part 1: Framework for the development of indicators and a core set of indicators for buildings.
JSBC & IBEC 2014. *CASBEE for Urban Development Technical Manual (2014 Edition)*. In: IBEC, J. A. (ed.).
JSBC & JAGBC. 2014. *CASBEE: Comprehensive Assessment System for Built Environment Efficiency [Online]*. Available: http://www.ibec.or.jp/CASBEE/english/overviewE.htm [Accessed 2013.
LEED. 2014. *Getting to know LEED: Neighborhood Development [Online]*. Available: http://www.usgbc.org/articles/getting-know-leed-neighborhood-development [Accessed 2014.
LÜTZKENDORF, T., HÁJEK, P., LUPÍŠEK, A., IMMENDÖRFER, A., NIBEL, S. & HÄKKINEN, T. 2012. New trends in sustainability assessment systems – based on top-down approach and stakeholders needs. *International Journal of Sustainable Building Technology and Urban Development*, 3, 256-269.
MATEUS, R. & BRAGANÇA, L. 2011. Sustainability assessment and rating of buildings: Developing the methodology SBTool PT-H. *Building and Environment*, 46, 1962-1971.
MELE, C. 2014. *Urban Issues and Sustainability*. E3S Web of Conferences, 2.
PORTUGAL 2007. Decreto-Lei n.o 316/2007 - *Regime Jurídico dos Instrumentos de Gestão Territorial*.
PORTUGAL 2011. Decreto-Lei n.o 76/2011 - *Projectos de Potencial Interesse Nacional*.
SHEN, L.-Y., JORGE OCHOA, J., SHAH, M. N. & ZHANG, X. 2011. The application of urban sustainability indicators – A comparison between various practices. *Habitat International*, 35, 17-29.
SOUTHFACE. 2016. *EarthCraft Green Building Certification [Online]*. Available: http://www.southface.org/green-building-services/programs/earthcraft-building-certification 2016].
SRINIVASAN, R. S., INGWERSEN, W., TRUCCO, C., RIES, R. & CAMPBELL, D. 2014. Comparison of energy-based indicators used in life cycle assessment tools for buildings. *Building and Environment*, 79, 138-151.
UNITED NATIONS. 2014. *World Urbanization Prospects: 10 The 2014 Revision, Highlights [Online]*. Department of Economic and Social Affairs, Population Division. Available: http://esa.un.org/unpd/wup/ [Accessed 2014.
WHITEHEAD, B., ANDREWS, D., SHAH, A. & MAIDMENT, G. 2015. Assessing the environmental impact of data centres part 2: Building environmental assessment methods and life cycle assessment. *Building and Environment*, 93, Part 2, 395-405.