CERTIFICATION MODELS OF BUILDINGS' SUSTAINABILITY

COMPARATIVE ANALYSIS OF THE CERTIFICATION PROCESSES

André Rosa Pires

Instituto Superior Técnico, Universidade de Lisboa

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Abstract

Buildings' sustainability certification systems appeared in 1990 with the birth of BREEAM in England. Ever since and worldwide, several organizations created a number of tools designed to evaluate and certify buildings' sustainability adjusted to their local perspective. This thesis aims to study the buildings' sustainability certification models and compare them with the ISO 17000 specifications related to conformity assessment. This analysis is fulfilled through the consultation of studies made by the scientific community, certification systems' publications and conformity assessment standards. After introducing the systems and describing their certification processes, a comparison is established between the activities taken place during those processes and the functional approach of the conformity assessment. A SWOT analysis is also made to each of the studied systems. Based on the analysis, it is possible to verify that the conformity assessment's functional approach is followed on every system's certification model, although existing some differences with the entities involved in the certification process and in some activities. It is intended that this thesis, analysis and conclusions, can contribute to improvements on the Portuguese certification systems, namely LiderA and SBTool^{PT}.

Keywords: building certification system, certification scheme, certification process, conformity assessment, sustainability certification.

Extended Abstract

1. Introduction

It has become an imperative for construction industry to adopt a set of practices that lead to a more efficient use of the resources available, in order to reduce the inherent environmental impact. With that goal in mind, the assessment and certification systems of buildings' sustainability began to appear. Buildings' sustainability certification adds a mark of quality to the assessed construction which is highly considered by the construction sector stakeholders. So, it is important to define processes of certification of buildings' sustainability based on a set of activities defined through international standards or guides, which grant the certification a consensual robustness for all the stakeholders.

This thesis focuses on the comparison of the certification models used by the systems that certify building's sustainability. Several systems are studied, including Portuguese and international systems, as well as the certification processes used in specific schemes for different types of projects. The analysis of the processes is based on the functional approach of the conformity assessment as it presented in the international standards of ISO 17000.

2. Information Review

With the purpose of achieving a critical analysis of the theme, and also to understand how this topic is approached in the scientific community, a scientific publications' bibliography review has been done. It was also relevant to analyse the technical guides towards certification developed by the

several bodies responsible for the buildings' certification, as well as the international standards on conformity assessment and certification systems.

In the scientific community, the study of buildings' sustainability certification systems is directed towards the environmental, economic and social perspectives and how these areas weigh in the calculation process. Some examples of these studies are made by Ferreira, Pinheiro, & de Brito (2014) or Suzer (2015). However, this is not the intended approach for this thesis.

Relatively to the comparative study of the systems where both the weight of the criteria for the sustainability assessment and the certification process are taken into consideration, the following studies are highlighted: Fowler & Rauch (2006), Saunders (2008), Lee (2013), Villegas Ruiz (2013), Kudryashova, Genkov, & Mo (2015) and Politi & Antonini (2017). Despite not being the main focus of these studies, which is the comparison between the general characteristics of some systems, the certification process is considered relevant in that comparison.

The buildings' sustainability certification systems are developed by organizations whose aim is to promote sustainability in the construction sector. These organizations acknowledge and distinguish buildings' sustainability through assessment processes in several stages of a construction development and subsequent certification. In order to harmonize the way the assessments occur, these organizations create manuals or technical guides to, for example, establish the requirements the project needs to meet, to define the process of certification, or to identify the enveloped entities. In this thesis, some of these relevant elements such as manuals, technical guides, presentations, brochures or magazines, published by the organizations responsible for the studied buildings' sustainability certification systems, were used.

To assure that materials, products, processes and services are adequate to their purpose, it is useful to base their planning, conception and utilization in documents that harmonize all that characteristics. In that field, ISO, the International Organization for Standardization, and IEC, the International Electrotechnical Commission, have been playing a leading role in the development of standards directed to all activity sectors. Together, they form the worldwide specialized system towards Standardization. In the field of conformity assessment, the ISO committee on conformity assessment (CASCO) is responsible for the development of international standards and guides. In this thesis, three international standards have been considered relevant: ISO/IEC 17030 (2003) entitled "Conformity assessment - General requirements for third-party marks of conformity", ISO/IEC 17000 (2004) entitled "Conformity assessment – Vocabulary and general principles" and ISO/IEC 17067 (2013) entitled "Conformity assessment - Fundamentals of product certification and guidelines for product certification schemes".

Product certification schemes should apply the functional approach as described in ISO 17000:

I – **Selection** – include planning and preparation activities in order to collect or produce all the information and input needed for the subsequent determination function;

II – **Determination** – may include conformity assessment activities such as testing, measuring, inspection, design appraisal, assessment of services and processes and auditing to provide information regarding the product requirements as input to the review and attestation functions;

III – **Review** – verification of the suitability, adequacy and effectiveness of selection and determination activities, and the results of these activities, with regard to fulfilment of specified requirements;

IV – **Decision** on certification;

V – **Attestation** – issue of a statement of conformity, based on a decision following review, that fulfilment of specified requirements has been demonstrated;

VI – **Surveillance** (where needed) – systematic iteration of conformity assessment activities as a basis for maintaining the validity of the statement of conformity.

The development of certification schemes presuppose the definition of specific activities for each one of the functions described above. A certification scheme includes, at least, selection, determination, review and decision activities, ending with issuing a certificate of conformity or other statement of conformity (attestation).

A product certification scheme uses specific rules and procedures which may be unique to the scheme or can be defined in a product certification system applicable to a number of schemes. If the same rules and procedures apply to more than one scheme, it is possible to define a certification system. ISO 17067 defines these two terms as:

- Certification system: rules, procedures and management for carrying out certification;
- Certification scheme: certification system related to specified products, to which the same specified requirements, specific rules and procedures apply.

3. Buildings' Sustainability Certification Systems

In this chapter, the chosen systems are introduced and studied on their certification processes. These systems were selected according to two main criteria: worldwide geographical representability and experience. In Table 1, the eight selected systems are represented.

The choice of BREEAM, LEED and HQE was natural because they were the first systems to appear and the most widespread worldwide. The inclusion of Asian and Oceanic based systems was something wanted for this study. So, the CASBEE system, due to its experience and notoriety, and Green Star, the Australian system, were included. For being one of the objectives in this study, the LiderA system would be obviously studied. In a perspective of national comparison, the SBTool^{PT} was also selected. As an emerging European buildings' sustainability certification system, the DGNB system was also included.

As Table 1 shows, BREEAM was the first system to appear. Since 1990, BRE has developed different assessment and certification schemes to address several types of projects: directed to new construction operations there is BREEAM New Construction scheme; BREEAM Refurbishment & Fit-Out for refurbishment projects; BREEAM In USE for non-domestic buildings' management; and BREEAM Communities for large scale development plans, such as new communities and regeneration projects. The projects evaluated according to these schemes are classified as Outstanding, Excellent, Very Good, Good or Pass. The certification process differs from scheme to scheme, but they follow the same sequence of generic activities: decide which scheme the project fits in; contact a BREAM assessor or BREEAM Accredited Professional; perform evaluation; certification is awarded.

Table 1 – Analysed certification systems

System name	Country	Continent	Birth year	Parent organization	Number of certifications
BREEAM	UK	Europe	1990	BRE	561.500 (20 in Portugal)
LEED	USA	North America	2000	USGBC	159.200 (16 in Portugal)
HQE	France	Europe	1996	HQE Association	380.000
CASBEE	Japan	Asia	2001	JSBC	450
Green Star	Australia	Oceania	2003	GBCA	1.460
LiderA	Portugal	Europe	2005	LiderA	60
DGNB	Germany	Europe	2008	DGNB	1.300
SBTool^{PT}	Portugal	Europe	2009	iiSBE PT	2

LEED has also a set of schemes developed to address different types of projects: Building Design and Construction for new constructions or major renovations; Interior Design and Construction for interior renovations, Building Operations and Maintenance for buildings with at least one year of operation, Neighborhood Development for new zoning developments or local renovation projects; and LEED for Homes. The projects can be classified with Certified, Silver, Gold or Platinum according to the sum of the point attributed during the assessment. The certification process is different for every scheme, but it follows a generic sequence of activities: project registration, application preparation, review of the application by the Green Business Certification Inc., and issue of the certificate.
The HQE certification mark is applied to several types of projects, such as dwelling units, collective residential buildings, construction or renovation of non-residential buildings, non-residential buildings in operation, new or in operation sporting facilities, or territorial development projects. HQE differs from the other certification systems because there are four different certification bodies responsible for different schemes: Cerway is responsible for delivering HQE certification for international projects; Céquami for dwelling units; CERQUAL for collective residential buildings; and Certivéa for the other projects. Project classification can be *Pass*, *Bon*, *Trés Bon*, *Excelent* or *Exceptionnel*. The certification process includes the pre-project phase, audits and certification.
CASBEE system can be applied to all kinds of projects on every development stage. The certification levels can be Poor (C), Slightly Poor (B-), Good (B+), Very Good (A) and Superior (S). The certification process includes the collection of results from the introduction of the project information in the CASBEE software by a CASBEE Accredited Professional. Institute for Building Environment and Energy Conservation (IBEC) validates the results and issues the certification.
Australian system, Green Star, certifies neighbourhood developments with Green Star Communities scheme, construction or renovation of buildings with Green Star Design & As Built scheme, interiors renovation with Green Star Interiors and buildings' operation performance with Green Star Performance. Projects classification goes from one star to six stars, representing respectively, a minimum practice and world leading performance. The certification process includes the following steps: project registration, documentation study, submitting the necessary information, assessor's evaluation and certification issue.
LiderA is an assessment and certification system that has no specialized certification schemes like several of the previous systems. This system adapts itself to the project and it is able to certify residential, commercial and touristic projects on every development stage. The project classification goes from G (poor performance) upwards to A^{+++} (best performance). The certification process begins with the contact with the LiderA and the systems' assessor, compilation of evidence, independent verification, reconnaissance (on design stage) or certification (after construction stage) and monitoring of the project.
DGNB has developed a set of schemes called CORE 14 representing the types of project this system can certify. Project classification goes from Bronze to Platinum, with increasing quality of the project's sustainability performance. The certification process includes four generic steps: preparation and registration; documentation submittal; compatibility tests; results and certification issue.
$SBTOOL^{PT}$ assesses existing buildings, new buildings' construction operations or refurbishment operations. Project classification varies from E to A^{+}, representing respectively a poor performance and the best practice. There is one system's specific developed scheme directed to the residential projects, $SBTOOL^{PT}$ – H (Homes). The certification process includes five main steps:

registration, pre-assessment, verification, validation and certification.

4. Conformity Assessment in the Systems

In this chapter, the connection between conformity assessment and buildings' sustainability certification processes is established. This connection begins with the application of the standards related to the conformity assessment, more specifically, the functional approach described in ISO 17000 and ISO 17067, to the buildings' sustainability certification. The goal is to define, firstly, a set of activities that take part of the certification process that fit into the description of each of the conformity assessment functions. Then, for every studied system and their respective schemes, structure the certification processes in simple activities and label them according to the function of conformity assessment they belong to.

According to the definition of "Selection" given by ISO 17067, activities such as selection of the certification scheme, selection of which criteria to assess in the subsequent function, outline the evidence collection method and the planning of activities, are included in "Selection". Resuming, this function intends to establish what, how and when to assess.

The "Determination" function materializes the previously planned activities by qualifying or quantifying individually the selected criteria, gathering all the relevant information.

The "Review" function intends to verify if the activities performed previously were well performed, to check if the information necessary to the criteria assessment is complete and to assess result of each criterion and the whole criteria.

The "Decision on certification" assesses the fulfillment of the specified requirements, by analyzing if the criteria appraisal leads to the meeting of the pre-established objectives (certification).

After the decision is taken, the "Attestation" leads to issuing a statement of conformity by the certification body. According to the assessment made during the certification process, the statement of conformity, usually a certificate refers the extent of the building's sustainability.

The "Surveillance" exists for those cases where a continuous demonstration of fulfillment of the specified requirements is needed. The activities are usually scheduled by assessment cycles and may include some activities described above in the determination, review, decision and attestation functions.

5. SWOT Analysis

The SWOT analysis of the certification systems intends to assess their positive and negative aspects from an inside or outside perspective. The inside perspective is reflected in the Strengths and Weaknesses, while the outside perspective is reflected in the Opportunities and Threats. In the Strengths are listed system's characteristics that may be seen as an advantage. In the Weaknesses are listed system's characteristics that may be seen as flaws, imperfections or something that can be improved. The opportunities and threats highlight, respectively, the external aspects that can be beneficial or unfavourable. This analysis had a bigger focus on the certification process of each system than on the general information related to each system.

6. Results Discussion

In this chapter, the results obtained in the previous pages are analyzed. It begins with the comparison of the functional approach in all systems, in other words, comparing the activities performed in the certification process of every system that were considered being related to each of the conformity assessment function. Then, the SWOT analysis previously performed is assessed in order to acknowledge the most mature systems, to emphasize their strengths and weaknesses and to establish a comparison with the LiderA system.

Table 2 displays the comparison made between every system in terms of the

activities performed in what were considered the functions of conformity assessment.
From the analysis made, it was possible to conclude that:

- Selection: There are systems such as BREEAM, CASBEE, LiderA and DGNB that necessarily include the presence of an auditor or assessor assisting the project team. In the LEED, HQE, Green Stars and SBTool^{PT} systems, the presence of an assessor is not mandatory;
- Determination: it is possible to verify that exists in every system, the gathering and compilation by the project team, the assessor or the auditor;
- Review: it is performed by the certification body through assessment panels, verification teams, a verifier, an auditor or an assessor. The review, being performed by an independent third-party, adds a greater quality and total impartiality to the assessment.

Table 2 – Summary of systems' activities considered being part of the conformity assessment's functions

Function	System	Description of activities
Selection	BREEAM	Select and contact a BREEAM assessor (choice of the desired scheme) Meeting between the assessor and the project team.
	LEED	Selection of which scheme to follow. Gathering of the project and verification teams and their meeting.
	HQE	Contact between the interested party (project team) and the certification body/auditor. Scheduling a plan of audits. After signing a contract, formalization of objectives to pursue.
	CASBEE	Selection of the most adequate scheme, by the project team. Contact a specialized CASBEE Accredited Professional.
	Green Star	Selection of the most adequate certification scheme. Submission of the registry form. Formalization of the terms of agreement.
	LiderA	Digital project registration. Selection of the assessor and meeting with the project team.
	DGNB	Client contacts an accredited DGNB auditor. Client performs the project's on-line registration and signs a contract with DGNB.
	SBTool^{PT}	On-line project registration.
Determination	BREEAM	Gather and supply of information by the project team and the assessor, through the analysis of projects' design, measurements, assessments or tests. Reports compilation by the assessor.
	LEED	Gathering of information, performing calculations and compilation of documents that show the fulfilment of selected credits. Site visits.
	HQE	Audits and reports' compilation by the auditor or certification body. Gathering of documentation, by the project team, through measurements or analysis of documents or project's design. Verification of the construction process of the building (NF Habitat HQE)
	CASBEE	Compilation of information and documentation. Collect results from the software.
	Green Star	Organize all the necessary documentation, firstly by the project team and then by the certification panel. Analysis of the information and assessment of criteria.

	LiderA	Gathering evidence of the criteria fulfilment through the consultation of project's design, maps, measurements, tests or photos.
	DGNB	Compilation of the necessary information, by the auditor, through the consultation of project's design, maps, photos or other evidence.
	SBTool^{PT}	The project team collects project's relevant information through the consultation of blueprints or maps, measurements, the application of the on-line assessment tool and compiles other evidence.
Review	BREEAM	Sending the reports to BRE (implies review).
	LEED	GBCI and the verification team verify if the determination activities had demonstrated the fulfilment of the specified requirements (established criteria).
	HQE	The certification body initially assesses the documentation attached to the certification request made by the project team. The certification body verifies the audits' reports.
	CASBEE	IBEC verifies the results and reviews their properness.
	Green Star	The evaluation panel verifies the documentation sent by the project team
	LiderA	The verifier performs the review activities, verifying the properness and effectiveness of the evidence collected by the assessor.
	DGNB	DGNB verifies the compatibility of the information and evidence sent by the auditor. DGNB's Certification Committee performs the final review of the pre-performed verifications.
	SBTool^{PT}	iiSBE PT verifies the fulfilment of the necessary requirements. Submission of the pre-assessment results to a Auditor Qualified in Sustainable Construction Assessment (AQSCA) AQSCA verifies and validates the results and makes the necessary corrections.
Decision on Certification, Attestation and Surveillance	BREEAM	On an intermediate stage of the project, BRE takes the decision and issues the Pre-Certificate. On a final stage, BRE takes the decision and issues the Certificate.
	LEED	GBCI answer is affirmative and USGBC issues the certificate.
	HQE	Certification body answers and issue of the certificate. Surveillance: annual audits (building visits and documental analysis).
	CASBEE	IBEC answers with the decision and issues the certificate.
	Green Star	Panel responds with a favourable decision and GBCA issues the certificate.
	LiderA	LiderA's panel takes the decision and issues the acknowledgement statement (design stage) or the certificate.
	DGNB	DGNB's Certification Committee takes a favourable decision and DGNB issues the certificate.
	SBTool^{PT}	iiSBE accepts the fulfilment of specified requirements and issues the certificate.

- Decision and Attestation: the decision is taken by the certification body after a positive response from the review phase. If the decision is to affirm the fulfillment of the specified requirements, the attestation occurs through the issue of a certificate.

In some schemes of a few certification systems, more specifically in schemes that certify the operational performance of a building, there are activities of surveillance.

These activities take place during the validity period of the certification and intend to assess the building in order to verify the continuous fulfillment of the certified level of performance.

Generally, it is concluded that the certification processes are not that different from system to system. The performed activities in the different conformity assessment functions differ very little from a system to the other. Exist, however, small differences, such as in the entities involved, their role in the certification process, or in the issuing of an interim or pre-certificate.

From the SWOT analysis emerges two major worldwide brands, BREEAM and LEED, a system with great national and international value, HQE, two systems mostly used in their own countries, CASBEE and Green Star, and an emergent system, DGNB. With a reduced exposure, LiderA and SBTool^{PT} suffer from the scarce demand from the Portuguese market.

7. Conclusions

The studied theme in this thesis was initially described as the assessment of the sophistication levels of the certification models of buildings' sustainability, through its comparison with the ISO 17000 standards' criteria related to the conformity assessment. It was firstly intended to compare the certification process used by the several systems with the generic model of the conformity assessment through its functional approach. That comparison was made, through a thorough analysis of the systems' certification processes and the conformity assessment defined in ISO standards. It can be concluded that there is an obvious basis of the conformity assessment's functional approach concepts in the buildings' sustainability certification processes and that every system follow that generic approach. It is natural that some differences exist between the processes from system to system, in the entities involved, the activities performed, or in the gathered information.

The SWOT analysis was also an objective, in order to compare the advantages and limitations of the systems. From the analysis emerges two major worldwide brands, BREEAM and LEED, a system with great national and international value, HQE, two systems mostly used in their own countries, CASBEE and Green Star, and an emergent system, DGNB. With a reduced exposure, LiderA and SBTool^{PT} suffer from the scarce demand from the Portuguese market.

In Portugal, there are actually 20 BREEAM certified projects and 16 by LEED. LiderA has 60 certified projects, residential and commercial. It can be concluded that the certification process is not a very influent factor in the selection of which certification system to pursue, because there aren't many differences between the certification processes. Factors such as dimension, acknowledgement or brand's international prestige are more influent in the choice of the system, as the Portuguese market can tell.

But the systems may evolve regarding what more successful systems are doing. The existence of differentiated schemes, specific to certain type of project, is something that can be considered for LiderA. Marketing within the construction sector is also something to improve, as most of this system's recognition comes from the academic environment. Through the recognition of an independent body, LiderA's accreditation can increase the confidence level of clients, or potential clients, on this brand and, beyond that, become a distinctive element in the Portuguese market of buildings' sustainability certification.

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