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A comparison between environmental sustainability rating systems LEED and ITACA for residential buildings

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ABSTRACT

The paper presents a comparison between two different rating systems to evaluate buildings sustainability: LEED (USA) and ITACA (Italy), thanks to the application of both methods to two residential buildings located in Italy.

The LEED green building rating system encourages an integrated design approach, with a points scheme that allots credits for building design features deemed to improve sustainability, which includes reductions in energy use, improvements in indoor environment quality, protection of the construction site, reduction in water consumption and use of sustainable materials.

ITACA procedure, the environmental quality rating system adopted in Italy, consists of the compilation of a group of worksheets, one for each different performance indicator, at the aim of describing the building environmental quality, including the maintenance of indoor comfort during the entire life cycle.

The chosen buildings are located in central Italy; they are both energy efficient and designed according to the principles of bioclimatic architecture, even if they are characterized by different features. Five common areas (site, water, energy, materials, indoor environmental quality) were identified in order to compare the two methods and to normalize their score; this original approach can be transferred also to the comparison of other building environmental assessment tools.

The comparison allows to prove the main features of both schemes. Even though the two procedures give different importance to the various areas, the analysis show a proportionality between the respective normalized final score for the two examined buildings.

1. Introduction

The growing world energy demand is accompanied by heavy environmental impacts (ozone layer depletion, global warming, acid rains, etc.). In developed countries, buildings account for 30–40% of total energy use. The population growth, associated with the consequent demand of buildings, services and comfort, results in an increasing energy demand [1,2]. For this reason, energy efficiency in buildings is today a prime objective for energy policy at regional, national and international levels. Energy costs and growing environmental concerns are the catalysts for a high demand for sustainable buildings with low environmental impact. Within this context, the concept of green building, focused on the increase of energy efficiency, the reduction of the use of resources, water and materials, as well as the reduction of impacts on human health and the environment during the building's lifecycle, plays a role of primary importance. A large number of countries has already developed energy certification procedures in order to rate the energy performance of buildings. For instance, the EU introduced a Directive [3] about Energy Performance of Building to monitor and reduce energy consumption. Andaloro et al. [4] analyzed how the various EU countries implemented the main Directive. Furthermore, a range of green building assessment tools and protocols has been developed in the past 20 years with the aim of reducing energy consumption and environmental impacts in both the construction and management phases of a building. There are many examples in literature of studies concerning building environment assessment tools. Haapo et al. [5] proposed a review and a comparison of 16 building environment assessment tools. The study analyzed and categorized existing tools, according to two well-known classification system: Trusty, developed by the ATHENA Institute [6], and IEA Annex 31 [7]. Liu et al. [8] suggested a comprehensive framework for the classification of green building

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assessment tools and proposed two types of tools. The first group – involving stakeholders' interests (planners, designers, developers, users, consultants, managers, authorities) – includes the issues which describe the methods and process of green building practice such as design, plan, management. These tools are mainly designed to optimize, select, check, predict and evaluate decisions raised from building environmental science researches. The second group of tools is related to the Performance category (environmental, social, economy), they are designed for performance comparison and rating.

According to Ali and Nsairat [9], it is also possible to identify two types of tools: methods based on a multi-criteria system and methods based on the Life Cycle Assessment (LCA) approach (Table 1).

Among the multicriteria-based tools, the BREEAM (Building Research Establishment Environmental Assessment Method of Great Britain) is the first method for the performance rating of green buildings, developed by the Building Research Establishment (BRE) since 1988. It is a voluntary approach and it assesses the level of building sustainability depending on the choices made during the design phase [10]. LEED (Leadership in Energy and Environmental Design, USA) founded by the U.S. Green Building Council (USGBC), is the most widely recognized building environmental assessment scheme: the registered projects covers 24 different countries [11,12]. Green Star (Green Star Rating Tools, Australia) is a voluntary green building rating method adopted in Australia, New Zealand and South Africa and it was developed to meet the need of buildings in hot climates [13]. CASBEE (Comprehensive Assessment System for Building Environmental Efficiency, Japan) is the green building rating methods developed in Japan by the Sustainable Building Consortium; its aim is to construct eco-efficient buildings evaluating the environmental quality and performance and the environmental loads during the life cycle [14].

Besides, since the late 1990s, methods for environmental assessment of buildings based on LCA have been developed for the building sector, such as BEES (Building for Environmental and Economic Sustainability, USA) [15], BEAT (Building Environmental Assessment Tool, now integrated it into a new simulation software called BSim, Denmark) [16], and EcoQuantum (Netherlands) [17]. Further studies [9,18–22] were carried out to investigate and benchmark the green building rating system that are currently in use. Roderick et al. [18] analyzed the energy performance of a new office building located in Dubai comparing three building environmental assessment tools: LEED, BREEM and Green Star. The computational simulation was implemented using the IES Virtual Environment [23]. H. H. Ali et al. [9] developed an effective green building rating system for residential units in Jordan (SABA Green Building Rating System) that suits the Jordanian context in terms of environmental, social and economical perspectives. They focused on international green building assessment tools such as LEED, CASBEE, BREEAM, GBTool and others to define new assessment items respecting the local conditions of Jordan. Asdrubali et Al [19]. compared Italian and Spanish energy certification methods using some pilot buildings. Pérez-Lombard et al. [20,21] proposed a sort of guide for implementing building energy certification. They analyzed the origin and the historic development of energy certification schemes in buildings together with the definition and scope of a building energy certificate and critical aspects of its implementation. Thilakaratne et al. [22] explored adaptation trends in LEED system comparing projects in the US and in Asia, analyzing fifty urban office projects in the US and in Asia that achieved either Gold or Platinum level under LEED for New Construction and Major Renovations rating system versions. S. Altomonte et al. [24] focuses an aspect of LEED comparing the indoor environmental quality in LEED certified building to non-LEED rated building analyzing the occupant satisfaction.

Finally, many recent studies focused on the rating of the environmental aspects of buildings through the Life Cycle Assessment approach (LCA), showing that the operation phase is associated with the highest impacts, but at the same time, the construction phase could not be neglected [25–30].

The purpose of this study is to compare the Italian green buildings assessment tool, ITACA (Istituto per l'innovazione e Trasparenza degli Appalti e la Compatibilità Ambientale), to LEED, applying the two methods to two sustainable residential buildings located in Umbria, central Italy. The importance of the research is to evaluate ITACA procedure for the first time in an international context and to compare it to LEED, in order to put in evidence the strengths and weaknesses of both schemes.

The study is carried out on two green residential buildings characterized by innovative solutions, according to the principles of bioclimatic architecture: among other common energy saving features one is equipped with sunspaces and a phytodepuration system for the natural treatment of wastewater, while the second is endowed with roof gardens and geothermal generators.

2. Methodology for the comparison between LEED and ITACA

Two green building rating methods were analyzed in this work: LEED and ITACA Protocol in Umbria region. The LEED, administered by the US and Canada Green Building Councils (USGBC, CaGBC) is a point-based system applied to the credits that take into account environmental principles with a balance between known effective practices and emerging concepts following six major categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation in design (Table 2). Using existing validated technologies, LEED assesses the environmental performance of buildings from an overall point of view during their life cycle, starting from the design phase and during the construction and operation.

The number of points the project earns determines the level of the certification. There are four progressive levels of certification: Certified, Silver, Gold and Platinum (Table 3).

LEED for homes has been developed specifically in Italy considering the housing characteristics of the Italian context [11,31].

Table 1
Classification of green building assessment methods.

Assessment tool	Tool type	Country	Developer	Year	International recognition
BREEAM	multi-criteria	UK	Building Research Establishment (BRE) [10].	1990	more than 60 countries
LEED	multi-criteria	USA	U.S. Green Building Council [11], [12].	1998	USA and other 30 countries
Green Star	multi-criteria	Australia	Australian Green Building Council [13].	2003	Australia, New Zealand and South Africa
CASBEE	multi-criteria	Japan	Japan Sustainable Building Consortium [14].	2005	–
BEES	LCA	USA	U.S. National Institute of Standards and Technology (NIST) [15].	2002	–
BEAT	LCA	Denmark	Danish Building Research Institute (SBI) [16].	1999	–
EcoQuantum	LCA	Netherlands	IVAM Netherlands [17].	1999	–