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GBC Historic Building®: a new certification tool for orienting and assessing environmental sustainability and energy efficiency of historic buildings

E. Lucchi[1], P. Boarin[2], M. Zuppiroli[3]

[1]Accademia Europea di Bolzano (EURAC), Bolzano, Italy. elena.lucchi@eurac.edu, corresponding author

[2]School of Architecture and Planning, NICAI, University of Auckland, Auckland, New Zealand. p.boarin@auckland.ac.nz

[3]Department of Architecture, University of Ferrara, Ferrara, Italy. marco.zuppiroli@unife.it

Abstract – *Environmental certification represents a key issue for improving energy efficiency, environmental quality, rational use of resources, and design innovation, allowing greater transparency on energy uses and environmental management in buildings. The paper presents the new rating system GBC Historic Building®, derived from the most diffused environmental sustainability assessment method worldwide (i.e. Leadership in Energy and Environmental Design (LEED®) and developed by an interdisciplinary working group, in order to evaluate the sustainability level of restoration, refurbishment, and integration in pre-industrial buildings. The protocol is structured in the already existing categories within the LEED® rating system, to which a brand new one has been added, i.e. "Historic Value", introduced to improve the knowledge on the historic building construction and a sustainable approach throughout the restoration process.*

Keywords – Deep Renovation, Historic Value, Energy Retrofit, Indoor Environmental Quality, Rating System.

1. INTRODUCTION

In the recent years, the European Commission has decided to set up a specific legislative framework to cut the CO_2 emissions, increase the share of renewable sources, and enhance the energy and the environmental performances. As underlined in the last European Directive [1], it is very important to find effective policies not only for the construction of new energy efficient buildings, but also for existing buildings' refurbishment, also considering traditional and heritage buildings. The improvement of energy performances of architectures pertaining to the cultural heritage entails a balance between different requirements related to energy efficiency, environmental sustainability, indoor comfort, and historic values. Considering energy efficiency as an effective mean rather than an added restriction for protecting the cultural heritage [2] can lead to a conjunction between the culture of environmental sustainability and the wealth of knowledge of the restoration world [3]. In this context, environmental certification is a key issue for improving energy efficiency, environmental quality, rational use of resources, and design innovation, allowing greater transparency during all the process' phases and on environmental management in buildings, while preserving their cultural identity.

2. HERITAGE VALUE AND ENVIRONMENTAL SUSTAINABILITY: A NEW TOOL

2.1 DEVELOPMENT PROCESS

Since the multiple factors and stakeholders involved within a conservation process, the understanding and delivery of cultural values represent and important asset for decision-making about what and how to conserve, and what are the priorities and potential threads [4]. To this regard, environmental sustainability assessment methods offer an effective model and structure in terms of reliability and transparency to be adopted to the heritage field. This understanding, together with the great potential regarding the historic building stock to be renovated at a national and European level [5], has led the Green Building Council of Italy to develop a new rating system called GBC Historic Building®, a voluntary and third-party certification tool for orienting and assessing the sustainability level of restoration, refurbishment, and integration processes in pre-industrial buildings. The tool is based on a local version of the LEED® rating system for New Construction and Major Renovation, named LEED® Italia, which, although applicable for existing buildings' deep renovation, it does not include specific requirements oriented towards to the historical and cultural values enhancement.

2.2 FIELD OF APPLICATION

GBC Historic Building® is applicable to the building stock constructed before 1945, the year that saw the beginning of the post-war reconstruction activity and the rise of the industrialization of the building process in Europe. Being "material testimony having the force of civilization" [6], this part of the stock is characterised by pre-industrial building process (in terms of phases, tasks and operators), pre-industrial materials and construction techniques (spontaneous and local), and technical elements made through pre-industrial processes. The existing building undergoing the assessment must have been built before 1945 (or after 1945 if pre-industrial features are recognised) for at least 50% of the existing technical elements measured in square meters of the front surface calculated without considering voids (windows and doors). In case the building was built before 1945 for a portion of less than 50% of the existing technical elements, the project can be assessed through the already existing rating systems pertaining to the LEED® or GBC® family. In addition, it is to be noticed that the protocol can be used for projects seeking restoration, rehabilitation or recovery/integration processes, which must entail a major renovation, defined as action which involves significant elements of HVAC systems and the renewal or functional reorganization of interior spaces, evaluating the possibility of a building envelope performance improvement consistent with the preservation of the cultural, architectural, and construction features.

2.3 STRUCTURE OF GBC HISTORIC BUILDING®

In GBC Historic Building® a new topic called "Historic Value" has been introduced beside the already existing LEED® thematic areas to make the rating system bespoke the historic context. Therefore, the protocol is structured in the following categories:

- “Historic Value - HV” (20 points): it pays close attention to the principles and different stages of the restoration process, while improving the overall environmental performances;
- “Sustainable Sites” (13 points): it encourages strategies for regenerating damaged areas, minimizing retrofit and building impacts, and promoting alternative transportation;
- “Water Efficiency - WE” (8 points): it stimulates a smarter use of water and its conservation holistically, considering indoor, outdoor, and specialised uses, as well as promoting metering;
- “Energy and Atmosphere - EA” (29 points): it approaches energy performance improvement from a holistic perspective, considering energy efficiency as a protection tool;
- “Materials and Resources - MR” (14 points): it minimises impacts associated with the extraction, processing, transport, maintenance, and disposal of materials, as well as the embodied energy;
- “Indoor Environmental Quality - IEQ” (16 points): it aims to achieve high standards of indoor air quality and thermal comfort for the occupants;
- “Innovation in Design - ID” (6 points): it rewards design solutions that are distinguished by the characteristics of innovation and high environment performance within the conservation process;
- “Regional Priority - PR” (4 points): it encourages design teams to focus on the environmental characteristics that are unique and specific to the region in which the building is situated.

All topic areas are made by prerequisite(s), which are mandatory, and credits, which are voluntary and rewarded with points. The distribution of scores, like other LEED® protocols, is focused on the effects of each credit on environment and human health, compared to a set of “impact categories”. The sum of the achieved points defines the level of certification attainable by the project, i.e.: i) “Certified”, from 40 to 49 points; ii) “Silver”, from 50 to 59 points; iii) “Gold”, from 60 to 79 points; iv) “Platinum”, from 80 to 110 points.

3. RECOGNITION OF HISTORIC VALUE AS A SUSTAINABILITY PARAMETER

In terms of sustainability, it is necessary to design intervention on historical buildings closely to the monumental heritage they carry and without compromising the real and potential wealth in the context in which we are asked to get involved. If sustainable development is the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [7], this ‘potential’ has to be kept in order to make future generations benefit from it. This process depends on multiple interdependent dimensions: environmental, economic (long term), social and, above all, cultural. Therefore, restoration, as the “methodological moment in which a work of art is appreciated in its material form and its historical and aesthetic duality for its transmission to the future” [8], becomes a sustainable ‘action’ itself, thus assessable through tools and methods pertaining to the sustainability context. Humanity has always dealt with the issue of maintaining, repairing, restoring effectively and/or adapting to new functions related to the continuously changing needs [9]. In the past few decades, technological-related literature has highlighted with a certain insistence that the behaviour of pre-industrial humanity could be called ‘sustainable’ as it was particularly focused to the consumption of raw materials and energy. It is often noted that regaining such behaviour could represent today a step towards a sustainable approach to development. Actually, it is incorrect to speak about the sustainability of pre-industrial humanity, because the use of techniques which allow an effective economy of resources is not motivated by the attribution of value to the resources themselves, but by their mere economic determination as a 'scarce' resource. We can speak of sustainability in the modern sense only when the sustainable action has the goal of preserving the resource whose value is recognised in view of its preservation for future generations. These are two very distant goals: in the past, preservation of resources stemmed out from their shortage at the time and because of a recognised short-term economic potential within them; on the contrary, today, resources preservation is the result of their foreseeable shortage in the future, although their preservation in the present may turn out to be economically unfavourable. Therefore, the concept of 'environmental sustainability' qualifies maintenance (intended as preservation) with respect to an already existing potential (i.e. an equilibrium between already existing potentials) whose environmental value is recognised. The concept of 'cultural sustainability' qualifies maintenance (intended as preservation) with respect to a pre-existing structure (i.e. an equilibrium between pre-existing structures) whose cultural value is recognised. It is then possible to assert that restoration, in the modern sense, identifies a sustainable action, from a cultural point of view, with respect to pre-existing monumental heritage, whose cultural value is recognised. To this regard, GBC Historic Building® is an innovative tool that, in addition to answering the needs of the market to meet high levels of well-being for users, sees restoration as the first sustainable action that concerns the pre-existing structure whose cultural value is recognised. It is precisely the holistic approach that characterises the LEED®/GBC® tools that the new rating system seeks to achieve, maintaining and transmitting the building in both its physical form and cultural values it represents to future generations. The choice of restorative actions is founded on a series of principles developed from the late 19th century up to the latter half of the 20th century. In the new topic area "Historical Value", the operational principles largely shared in the realm of restoration (such as minimal intervention, distinguishability, reversibility and compatibility) were expressly integrated for giving the designer a useful guide for intervention on pre-industrial constructions.

For a wider sustainability and for not compromising the authenticity of the subject (in material, structural and figurative terms), the intervention must be carried out through the "minimum intervention" to preserve the material, restore the image, and functionally renovate the asset. Even the structural improvements or integrations must be designed under this perspective, without introducing elements that are not strictly necessary. This principle is the basis of the preliminary analysis (HV prerequisite 1) and advanced analyses (HV credits 1.1, 1.2, and 1.3). Related to the previous one is the principle of "reversibility" of the project's works. The purpose is to allow future generations, who may potentially avail of different and more advanced technologies than our own, to get involved with a greater degree of conservation and in a more respectful manner than the current approach. To this regard, HV credit 2 should be read in favour of either traditional or contemporary techniques to ensure both authenticity and aesthetics. The principle of "compatibility", which concerns the durability of the work for posterity, can be applied to various elements that range from the ways in which the asset can be used (HV credit 3.1), to the materials used for the restoration of architectural surfaces (HV credit 3.2), and for structural consolidation (HV credit 3.3). The attention given to the "durability" of the restoration is also confirmed by the importance given to the scheduled maintenance plan (HV credit 5). To make it consistent with the asset's requirements (both environmental and conservative), the preliminary compilation of a specific risk assessment sheet has to be provided. Not at least, the elements related to the sustainability of the restoration site (HV credit 4), which is identified as the third and final stage of the process, with important and significant repercussions in terms of environment, economics and culture.

4. THE CHALLENGE OF HISTORIC BUILDINGS' ENERGY RETROFIT

The approach has a strongly interdisciplinary nature, starting from the analysis of different thematic areas related to restoration, energy efficiency, and human comfort. Similarly to other LEED® protocols, the energy and environmental retrofit is focused on building level, considering also the main effects on district level. The "energy issue" is directly and indirectly addressed in different areas.

4.1 TOPIC "HISTORIC VALUE"

Understanding the environmental behavior of a historical building is essential to identify possible modifications or operational solutions for improving its performance. Particularly, energy and environmental evaluation allows to optimize the energy efficiency level and to foster environmental sustainability, preserving and enhancing the positive qualities of a pre-industrial building. An accurate energy audit is the first step to identify the suitable energy retrofit intervention. It is «[…] a systematic procedure to obtain adequate knowledge of the existing energy consumption profile of a building […], identify and quantify cost-effective energy savings opportunities and report the findings» [10]. As stated by literature [11] and American standards [12], the protocol asks for different types of energy audit according to the analytical level to be obtained: i) "walk-through audit", for assessing the general energy quality and individualizing the inefficiencies; ii) "standard audit", for quantifying the energy loses linked to a specific issue; and iii) "simulation audit" that provides a dynamic simulation of the energy performance of the building. The "walk-through audit" is mandatory to understand the energy behavior of the building. The scheme includes also on-site measurements and None Destructive Testing to quantify energy use and performances. The IR-Thermography is suggested to reveal the most important thermal anomalies on building envelope and systems and it is useful to detect the presence of thermal bridges, non-homogeneity (different thicknesses, traces of arcs or other components, low performances, missing of insulation, different materials, etc.), damage (decay, cracking of plaster, moisture, water percolation, air leakages from windows and cracks, and losses) or malfunctioning of installations and plants (missing of insulation on boilers, high consumptions, malfunctioning, etc.). In parallel, the heat flow-meter measurement permits to determine the thermal transmission properties (C-value and U-value) on a representative part of the building envelope. Then, the criteria of reversibility and compatibility should guide the choice of the energy and environmental retrofit. Similarly, the implementation of a planned conservation plan is considered as a tool for guaranteeing the maintenance of the building, also looking at energy efficiency (HV credit 5).

4.2 AREA "SUSTAINABLE SITES"

The fundamental aspects responsible for the improvement of the liveability and the quality of the urban environment that have an impact on the energy issue are related to: i) the enhancement of public and alternative transport; ii) the recovery of high-permeability open spaces; iii) the reduction of the "urban heat island effect" phenomena, by using passive techniques with low aesthetic impact; iv) the rationalization of the illumination system, reducing the intensity of light pollution.

4.3 AREA "ENERGY AND ATHMOSPHERE"

Energy efficiency and retrofit process represent a practice for guaranteeing the building protection, not necessarily a "change" in the original material consistency. The possible design and management strategies in the topic are related to:

- energy commissioning of systems (fundamental in prerequisite 1 and enhanced in credit 3), moving also towards the envelope's commissioning as a technique for improving the knowledge and respect for the building;
- improvement and optimization of building energy performances (minimum in prerequisite 2 and optimised in credit 1) compared to a "reference case" defined in the historical context and considering all forms of energy consumption, rather than upgrading to a minimum standard energy performance. This approach is based on the consideration that each improvement on the historic building, although modest, is considered an important step for increasing the occupants' comfort, reducing the energy consumption, and cutting the greenhouse gas emissions. The evaluation can be conducted either by using static methodologies (obtaining at least an improvement of 5% of the initial energy consumption basing on the national standard) or dynamic methodologies (obtaining at least an improvement of 3% basing on the ASHRAE American standard [12]);
- integration of renewable energy sources (credit 2) produced on-site or resulting from certified off-site green energy production;
- refrigerant management (minimum in prerequisite 3 and enhanced in credit 4);
- measurements and verification of the consumption in operation (credit 5).

4.4 AREA "INDOOR ENVIRONMENTAL QUALITY"

The achievement of high standards for thermal comfort and air quality for occupants in historic buildings has to balance the requirements for the protection and enhancement of cultural heritage. Moreover, the high artistic and cultural value does not often allow the inclusion of plant terminal units or substantial intervention on the technical elements. For this reason, this topic is structured in two parts, respectively related to the conservation and preservation of historic architecture, and respect of thermal comfort and indoor air quality for the occupants. This dual approach allows the user to respect the historic environment for the protection of surfaces and high-quality materials and, at the same time, to achieve the highest levels of comfort and indoor air quality exploiting the potential offered by the boundary conditions. The possible design and management strategies in the area are related to: i) the improvement of the internal air quality; ii) the indoor pollution control; iii) the hazardous materials reduction; and iv) the control of indoor air quality for the occupants.

5. CONCLUSION

In front of the increasingly urgent need to adapt historic buildings to new uses by upgrading their overall performances, the transparent process of the third-party certification could represent a valuable mean for orienting the building sector towards a sustainable market transformation. GBC Historic Building® is a new Italian rating system born to tackle the issues connected to the integration of environmental, energy efficiency and indoor environmental quality objectives within the restoration process. The tool's aim is to support stakeholders to plan all building process phases in an effective and holistic manner, pursuing a conscious and sustainable preservation process which will allow the historic building to remain a source of cultural identity while meeting today's needs. The protocol has been released in 2015 and it is currently undergoing a pilot period for its validation through the application to real case studies in Italy, which will contribute to the tool's implementation for the local market.

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