Heritage Conservation and Environmental Sustainability: Revisiting the Evaluation Criteria for Built Heritage

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Proceedings of:

FABRIC
The Threads of Conservation
Best practice conservation philosophy, heritage management and skills training in Australia and beyond
Australia ICOMOS Conference
5-8 November 2015
Adelaide Australia
AUSTRALIA ICOMOS
International Council on Monuments and Sites

Introduction

Built heritage plays an important role in expressing tangible and intangible values. They are visual links to the past, revealing how communities evolve socially, technologically and culturally. While some have retained their original function, some others have been adapted for new uses. Unfortunately, with the rapid increase of population and urbanization world-wide, many of these structures are increasingly under the threat of demolition, or in countries like the United States, Australia, United Kingdom and Italy they are under significant pressure to be environmentally sustainable; in other words function with reduced carbon emissions while still retaining their heritage values.

These heritage values derived from the current "values-led" approach of evaluating built heritage generally fall in the categories of aesthetic, historic, scientific, and social and include:

- Form and design
- Materials and substance
- Spirit of place
- Use and function
- Location and setting
- Traditions, techniques and management systems

Although these categories are inclusive, they are certainly not sufficient. At a time when climate change is threatening all aspects of human life, "environmental sustainability" is a value missing from the discourse of heritage assessment. A value that can serve in two important ways; first as an additional tool in the retaining of built heritage, and second as a common language between conservationists and other professionals such as architects and urban planners in the discussion of sustainable adaptive reuse.

Heritage Conservation and Sustainable Development

In the *Paris Declaration on Heritage as a Driver of Development* (ICOMOS 2011), the need to incorporate cultural heritage as a vital component of sustainable development was highlighted; however, only the historical, cultural, social and economic aspects of heritage were emphasized. Two years later, in the *Hangzhou Declaration: Placing Culture at the Heart of Sustainable Development Policies* (UNESCO 2013) where culture is deemed as important as human rights, equality and sustainability—the contribution of heritage in the context of environmental sustainability is identified in traditional knowledge and practices that "promote an ecologically sustainable pattern of production and consumption and sustainable urban and architectural design solutions."

Yet in architectural and urban planning circles, "environmentally sustainable" buildings are usually measured against rating systems such as LEED, BREEAM, CASBEE or Green Star, which follow the general principles of:

- Limiting resource consumption
- Recycling or reusing resources
- Eliminating toxic chemicals
- Applying life-cycle costing
- Focusing on quality
- Protecting nature and natural environments

Based on these principles, each rating system tabulates complex arrays of numerical and non-numerical data to provide a score that indicates the performance of a building according to the scoring and weighting system built into the method.

Indeed, when heritage buildings are adaptively reused, their performance from an "environmental sustainability" aspect is assessed using these very same rating systems, so why not include environmental sustainability in the assessment criteria of heritage buildings?

Role of Heritage Buildings in Sustainable Urban Development

As Carl Elefante famously coined, “The greenest building is one that is already built” (Elefante 2007). Existing buildings contain embodied energy and embodied carbon (ICE 2015). Embodied energy is defined as energy consumed directly or indirectly in raw material acquisition, production of materials, transportation and final assemblage into a building. The greater the embodied energy, the higher environmental impact due to greenhouse gas emissions associated with energy consumption.

The United Nations Energy Program estimates that the embodied energy of a building is 20 percent if a building is operational for 100 years (UNEP 2009). In a shorter service life, the ratio of embodied energy to operating energy is greater. When you reuse a building, the embodied energy expenditure has already occurred, and the impact on environment has already taken effect. With view to this fact, many environmentalists, conservationist and architects measure the impacts that are avoided by not constructing new buildings. Using this approach, a study conducted by the Preservation Green Lab in 2011 on the environmental impact reduction of building reuse in the United States (Preservation Green Lab 2011), found that in comparison to new construction, building reuse yielded fewer environmental impacts. The same study concluded that in terms of climate change and environmental impacts, the reuse and improved energy efficiency of existing building was almost always the best option (regardless of building type and climate), and could help communities achieve their carbon reduction goals in a shorter period of time.

Embodied carbon, similar in definition to embodied energy, is carbon emitted through building construction, including the entire cycle of material extraction, fabrication, transportation and final assemblage. Since carbon dioxide emissions is a major contributor to climate change, the embodied carbon dioxide of heritage buildings is an important consideration. A 2008 study by the U.K-based Empty Homes Agency (EHA 2008), compared new home construction to the refurbishment of common housing types in England, and found that it would take new, energy efficient homes 35 to 50 years to recover all of the carbon that was expended during the initial construction process.

Heritage buildings are commonly sensitive to local climates and the construction methods often maximize natural sources of heating, lighting and ventilation. These structures generally use indigenous building material that are inherently durable in the local climate, and in the case of refurbishment, require lower transportation requirements. One of the key factors of older buildings, is the repairability of its components. In these cases, indigenous material have the added advantage of being more readily available and requiring less energy for transportation. Repairability, rather than replacement, provides the opportunity to sustain local craftsmanship and building knowledge, as well as extending the life of products, keeping waste to a minimum. The adaptive reuse of historic buildings also ensures that building components do not end up in landfills and further exacerbate the strain on natural ecosystems as well as municipal budgets and infrastructures.

Additionally, older buildings, especially those built before 1920, were often constructed from durable, high-quality materials (such as exterior masonry) with low embodied energy per time of use since original environmental impact is divided by length of use. Less durable material, while may not expend much energy during production, may require frequent replacement, which combined with the energy needed for removal and disposal, results in higher total embodied energy over their life cycle.

Green Buildings Assessment Methods and Adaptive Reuse

Buildings are more than their individual components. Their design, fabric, type of construction, size, shape, site orientation, surrounding landscape and climate play an important role in how they perform. The key to a successful adaptive reuse is to have a complete and holistic understanding of the heritage building—meaning its attributes, as well as the existing (or lost) energy efficient aspects. Therefore, existing energy-efficient and environmentally sustainable characteristics of the building should be assessed, alongside values such as historical, architectural, aesthetic, and social, etc.

Leadership in Energy and Environmental Design (LEED)

Sustainable building assessment tools can be a helpful starting point in developing a framework for assessing the environmental sustainability value of heritage buildings. A globally well-known sustainable building assessment tool is the U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) Green Building Rating System™. This system strives to give equal attention to the environment, local community and building inhabitants, as well as the economic viability of projects. In other words, it addresses the "triple bottom line" of sustainable development. The LEED rating system allocates points for strategies that:

- improve energy and water efficiency
- select low GHG emission building materials and components
- conserve and recycle resources

- promote healthy indoor environments by eliminating or reducing toxins, contaminants and pollutants.

As of yet, a LEED rating system designed specifically for the renovation and adaptation of heritage buildings is not available. Instead, based on the type and extent of renovation or typography, existing LEED rating systems like LEED New Construction and Major Renovation (LEED-NC) or LEED 2009 Existing Buildings: Operations & Maintenance (LEED-EBOM) have been used to certify heritage buildings (USGBC 2012), or the case of larger urban developments that include the adaptive reuse of heritage buildings, LEED for Neighbourhood Development (LEED-ND).

The intention is not to use LEED rating systems to assess heritage buildings; rather to extract key categories that can be used to develop a framework for assessing the environmental sustainability of heritage buildings. For this reason, the focus will be on LEED-NC (since LEED-NC and LEED-EBOM follow the same environmental categories) and LEED-ND.

Fig 1. 1821: Pavilion IX, University of Virginia, Charlottesville, VA. LEED Certified, New Construction.

Fig. 2. 1856: New York State Executive Mansion, Albany, NY. LEED Gold, Existing Buildings

Fig 1 & 2: Source: http://www.usgbc.org/articles/200-years-leed-or-20-historic-buildings-you-probably-didn%E2%80%99t-know-were-green

Brief Description of LEED-NC and LEED-ND 2009

LEED-NC: LEED New Construction and Major Renovations

LEED considers both lifecycle costing and lifecycle assessments, and in assigning credit points for certification, the LEED-NC 2009 rating system has been broken down into five environmental categories of Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality. Each category can be summarized as follows:

1. **Sustainable Sites (SS)** addresses the environmental concerns of construction activities and building operations as it relates to the building site, in order to limit negative impacts on the surrounding environment, ecosystems and waterways. Credits are given to the prevention of pollution due to construction activity, storm-water management, heat island reduction and light pollution reduction, as well as the protection of natural habitats and open space. It discourages the development of previously undeveloped lands and rewards sites that have access to smart transportation choices, such as public transportation, pedestrian friendly walkways and bicycle lanes. A site that is easily accessible by public transportation or bicycles, with pedestrian friendly walkways has a direct impact on reducing GHG emissions associated with commuting.

   In the framework of sustainability, the location of a building is just as important as how it is built. The building's response to the local climate, its impact on natural resources and how it serves the local community in creating a sense of place and addressing community needs determines how a project can contribute to a sustainable environment.

2. **Water efficiency (WE)** addresses possible strategies and technologies that reduce potable water use and disposal. LEED addresses water efficiency through a close inspection of indoor and outdoor water usage, specialized uses and metering. The aim is to conserve water by increasing efficiency, reducing potable water use and encouraging strategies that incorporate non-potable and alternative sources of water.

3. **Energy and Atmosphere (EA)** not only focuses on materials and components used for constructions, but on construction methods as well. It assesses how efficiently various components work together. This category encourages running energy audits, identifying energy needs, and incorporating a wide variety of energy efficiency strategies including energy monitoring and tracking building energy performance; the use of efficient design and construction, as well as efficient appliances and building systems.

   It also suggests developing and implementing preventive maintenance programs to regularly monitor and optimize the performance of mechanical equipment to further reduce energy requirements, redundancies and waste.

   The use of renewable and/or clean energy generated on or off-site, such as solar panels and wind turbines is highly encouraged. An example of such strategy is seen in the LEED Platinum Certified Centennial Campus of the University of Hong Kong, which incorporates solar panels and wind turbines as part of the on-site clean energy generation strategy. These strategies reduce reliance on energy produced by conventional fossil fuel plants and directly reduces GHG emissions.

4. **Materials and Resources MR**: encourages strategies to reduce waste and reuse materials, as well as implementing recycling practices to mitigate the impacts of the built environment. It also promotes the selection of sustainably grown, harvested, produced and transported materials, as well as salvaged or refurbished products where appropriate. The aim is to divert, as much as possible, construction, renovation, demolition and operational waste from landfills, while recovering and recycling reusable materials. Additionally, this category gives credit to strategies that increase the useful life of the building space using designs that promote flexible or adaptable use.

5. **Indoor Environmental Quality IEQ**: Because the quality of the indoor environment can significantly impact occupant's health and well-being, productivity and quality of life, credit is given to strategies that increase ventilation, reduce and manage air contaminants and allow occupants to control desired settings. Additionally, credit is given to the selection of less harmful materials as well as design strategies that provide daylighting and views.

LEED 2009 vs LEED v4

In the latest version of LEED v4 (BD+C): New Construction and Major Renovation, these categories have been slightly modified. The transportation component of the Sustainable Sites (SS) category has been moved to a separate category of **Location and Transportation,** which awards credits to projects within relatively dense areas, near diverse uses, with access to a variety of transportation options or on sites with development constraints. Therefore **Sustainable Sites** now primarily focuses on encouraging strategies that minimize impact on ecosystems and water resources. Although there are some changes in the other categories as well, the overall focus remains the same.

Additionally, in the Materials and Resources (MR) category, a more holistic, life-cycle approach to buildings is adopted. The building is assessed using the LCA Calculator to reduce the following impacts (Nutcher n.d.):

- global warming potential (greenhouse gases)
- depletion of the stratospheric ozone layer
- acidification of land and water sources
- eutrophication
- formation of tropospheric ozone
- depletion of non-renewable energy resources

In both versions there are two additional categories

(a) Innovation in Design, which addresses sustainable building expertise as well as design measures not covered under the 5 environmental categories.

(b) Regional Priority or Bonus Points that acknowledge the importance of local conditions in determining best environmental design and construction practices.

LEED-ND: LEED Neighbourhood Development

LEED-ND primarily focuses on smart growth and sustainable building, the quality of life of communities as well as the protection and enhancement of natural environments, historic neighbourhoods and heritage buildings. Unlike other LEED rating systems that largely deal with green building practices, LEED-ND emphasizes site selection, design and construction elements that tie buildings and infrastructure to the neighbourhood's local and regional context. Its aim is to provide incentives for better location, design, and construction of new residential, commercial, and mixed-use developments within the exiting urban fabric.

LEED-ND has three environmental categories: Smart Location and Linkage, Neighbourhood Pattern and Design and Green Infrastructure and Buildings. Each of these categories can be summarizes as follows:

1. **Smart Location and Linkage** encourages a holistic approach to location. Transportation alternatives to private personal cars, such as public transportation, bicycle lanes and pedestrian walkways are key considerations for location selection, as well as the possible incorporation of historic, cultural or socially significant neighbourhoods/areas and the conservation of significant fabric. Furthermore, special attention is given to the preservation of sensitive lands and natural ecosystems.
2. **Neighbourhood Pattern and Design** emphasizes vibrant, equitable communities that are healthy, walkable, mixed-use and sympathetic to historic districts and areas of cultural and social importance.
3. **Green Infrastructure and Buildings** promotes the design and construction of energy and water efficient buildings and infrastructure, as well as the adaptive reuse of existing and historic structures, and other sustainable best practices.

An additional category, Innovation and Design Process, addresses sustainable design and construction issues and measures not covered under the three categories. Furthermore, bonus

Regional Credits are given to projects that incorporate local conditions in determining best environmental design and construction practices as well as social and health practices.

In summary, sustainable buildings should be climatically sensitive, energy and water efficient, built using sustainable material and be responsive to local settings and transportation linkages. In short, have as little impact on the environment and its inhabitants as possible, while at the same time strengthen the "sense of place" and economic viability of the community. The very same characteristics that can be identified in many heritage buildings.

Developing an Evaluation Framework for the Environmental Suitability of Heritage Buildings

In reviewing LEED NC and LEED ND environmental categories, the following categories can be—with some modifications—helpful in developing an initial framework for evaluating heritage buildings from an environmental sustainability aspect:

Site and geographical location, which focuses on orientation, surrounding landscape and climate, evaluates features such as a building's passive survivability that allow a building to function without depending on off-site energy sources and mechanical systems.

Urban Setting and Linkage: which, among other things, looks at the surrounding developments, infrastructure and buildings, and opportunities for alternative modes of transportation.

Water Efficiency: looks at wells, cisterns, runoff catchment systems and water storage tanks that were traditionally used to manage water.

Energy and Resources examines thermal performance, heat sink, heat loss, solar gain and thermal behaviour.

Envelope and Fabric: Investigates the design, materials, type of construction, size, shape, age and durability of building components.

Indoor Air Quality: Assesses daylighting, views, thermal comfort and natural air movement, focusing on windows, doors, roof vents, wind catchers, and such that help sustain occupant's comfort and well-being.

Similar to LEED, these categories can then be followed by sub-categories with scores that can be tabulated to quantify the environmental sustainability of the heritage building, and incorporated in a green building rating system. (See table 1).

Table 1. Environmental Assessment of Heritage Building

Site and Geographic Location	**Score**
Micro Climate	
Open Space and Area Landscape	
Prevailing Winds	
Solar Orientation	
Heat Island Reduction	
Rainwater Management	
Floodplain Avoidance	
Steep Slope Protection	
Light Pollution	
Urban Setting and Linkage	
Infrastructure Proximity	
Compact Development	
Surrounding Developments	
Access to Quality Transit	
Access to Bicycle Lanes	
Access to Walkable Streets	
Connected and Open Community	
Water Efficiency	
Outdoor Water Use Reduction	
Indoor Water Use Reduction	
Building-Level Water Metering	
Outdoor Water Use Reduction	
Rainwater Management	
Wastewater Management	

Energy and Resources	**Score**
Energy Use Assessment	
Thermal Behaviour	
Heat Sink	
Heat Loss	
Recyclable/ Reusable Fabric	
Waste Management	
Envelope and Fabric	
Size	
Age	
Type of Construction	
Sustainable Design Strategies	
Durable Material	
Indigenous Material	
Repairablilty	
Life-Cycle Impact Reduction	
Long Life-Loose Fit	
Indoor Environmental Quality	
Indoor Air Quality Assessment	
Enhanced Indoor Air Quality Strategies	
Low-Emitting Materials	
Thermal Comfort	
Interior Lighting	
Daylight	
Quality Views	
Acoustic Performance	

Conclusion

The initial application of this assessment framework on two historic mansions with comparable design and attributes in Kashan, Iran revealed possible areas of improvement in the adaptive re-use of the heritage buildings from an environmental sustainability standpoint. However much more research is required to create a more comprehensive assessment system. The categories identified in LEED do not easily apply to properties outside of the United States that do not share the same understanding of terms such as "walkable streets". In a survey of pedestrians in Kashan, the question of "walkability" raised a few eyebrows and a lot of laughs as most people considered sharing the road with cars, motorcycles and bicycles a normal part of everyday life. Another interesting issue was the perceived cost of implementing intelligent monitoring systems due to the high initial investment, an issue that may be addressed by including a lifecycle assessment.

Fig 3 Kashan, Iran. Narrow street flanked by residential buildings. (Source: Author).

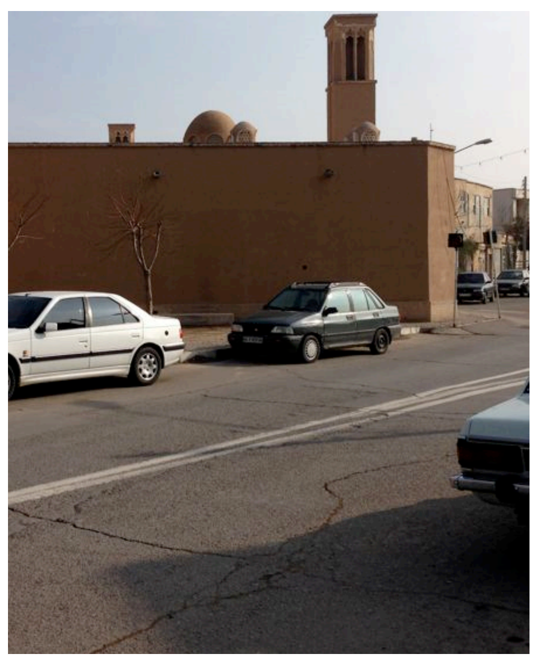

Fig 4 Kashan, Iran. Major street running alongside hotels and tourist attractions. (Source: Author).

In an era where "sustainable development" and in particular "sustainable urban development" is the mantra of countries tackling issues of urban densification, it is important to evaluate the contribution of built heritage in the context of "sustainable urban development," and develop a system that can bridge the "environmental sustainability" gap between conservation specialists, architects and urban planners, and quantify the impact of built heritage in the global sustainability agenda. This holistic understanding of built heritage can provide great insight and perhaps motivate governments or international NGOs to provide financial assistance or incentives to heritage property owners and operators for the sustainable adaptive reuse of heritage buildings.

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