Sustainability and Heritage Buildings

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Abstract

In recent years a worldwide rise in environmental concerns has placed sustainability at the forefront of the political agenda. Many governments have introduced policies for conserving energy, increasing renewable energy sources while reducing carbon emissions. Within the stock of existing buildings are those buildings that have been identified by their communities as being heritage buildings. Where heritage buildings suffer from weaknesses in green building performance which can be corrected through the rehabilitation process. This paper discusses the opportunities and issues related to the rehabilitation of heritage buildings to be sustainable and green. it also explores the potential synergies between heritage preservation and sustainable development. Through theoretical analysis and case study examples the paper illustrates how the most suitable intervention can be done in ways that respect the heritage value of the buildings and how it is related to the degree of intervention that is carried out to achieve sustainable conservation.

1. Introduction

It is recognized that the retention of heritage building has environmental sustainability benefits. Conserving heritage buildings reduces energy usage associated with demolition, waste disposal and new construction, and promotes sustainable development conserving the embodied energy in the existing buildings. Building conservation and energy efficiency are both key aspects of sustainability. Traditionally-built properties contain a considerable amount of embodied energy and were built to last; many have been standing for hundreds of years, and well-maintained properties will continue to stand for many more. In order for them to continue to be continue to be comfortable in the future- without putting occupants at risk- there is a range of viable interventions that can be adopted to improve their energy efficiency. Good levels of energy efficiency could protect the sustainability of heritage building.

1. Sustainability

Sustainable development meets the needs of the future without compromising the ability of future generations to meet their own needs; it is the capacity of the environment to accept demands without irreversible or otherwise unacceptable change. As Thornton notes:

Many newly green technologies can be imbedded in our historic buildings in unobtrusive or invisible ways. Also, the adaptive reuse for new interiors of otherwise historic shells opens the door for application of entire range of sustainable materials in any layer of construction. This is an area where the preservation and Green communities' interests clearly overlap. The preservation dictum of saving as much "existing fabric" of the original building as possible supports the green goals of reuse (while designing) to reuse large pieces of existing structures provides greener cost, structure, and durability arguments that parallel the philosophical one of saving historical material as a record. [11].

There is ubiquitous agreement among researchers that adaption can make a significant contribution to sustainability of existing buildings. Here, Langston makes a good point, " From a sustainability perspective, it is preferable to minimize new additions to the (already built stock), but at the same time to remove those layers of poorer quality stock that absorb excessive operating resources " [7]. There is growing support that adaptive reuse satisfies a key concept of sustainability by extending the useful life of existing buildings. This reuse lowers costs in relation to materials, transport, energy and pollution when compared to the erection of new buildings. The use of adaptation however, requires clients and designers to shift their thinking from focusing on rationalistic

consumption to environmental protection. [2],[3], [8],[11].

2. Heritage Building

Briefly, a Heritage building is one that gives us a sense of wonder and makes us want to know more about the people and culture that produced it. It has architectural, aesthetic, historic, documentary, archaeological, economic, social and even political and spiritual or symbolic values; but the first impact is always emotional, for it is a symbol of our cultural identity and continuity- a part of our heritage. If it has survived the hazards of 100 years of usefulness, it has a good claim to being called historic or heritage building. [1].

3. Causes of Decay

Of the causes of decay in a heritage building, the most uniform and universal is gravity, followed by actions of man and then by diverse climatic and environmental effects- botanical, biological, chemical and entomological. Human causes nowadays probably produce the greatest damage. Consequently , when analyzing the causes of deterioration and loss in a heritage building, the following questions must be posted:

(1) What are the weaknesses and strengths inherent in the structural design and component materials of the object?
(2) What are the possible natural agents of deterioration that could affect the component materials ? How rapid is their action.
(3) What are possible human agents of deterioration that could affect the component materials or structure? How much of their effect can be reduced at source.

Nature's most destructive forces are categorized as natural disasters, and include earthquakes, volcanic eruptions, hurricanes, floods, landslides, fires caused by lightning, and forth. After natural disasters, less drastic agents accounts for the normal and often prolonged attrition of cultural property. All these agents fall under the general heading of climate. Climate is the consequence of many factors, such as radiation (especially short- wave radiation), temperature, moisture in its many forms: vapour clouds, rain, ice, snow and groundwater, wind and sunshine.

Man-made causes of decay need carful assessment, as they are in general the by-product of the industrial productivity that brings us wealth and enables us to press the claims of conservation. Neglect and ignorance are possibly the major causes of destruction by man, coupled with vandalism and fires. it should be noted that the incidence of arson is increasing, putting heritage buildings at even greater risk. [1]

4. Heritage Building and the Green Approach

Within the stock of existing buildings are those buildings that have been identified by their communities as being heritage buildings. A heritage building is one that has a heritage value that typically springs from the following attributes:

- Aesthetic Value
- Architecture Value
- Cultural Value
- Historical Value
- Scientific Value
- Spiritual Value
- Technological Value
- Traditional Value

They enjoy the advantages of embodied energy and due to their age they have often been built with superior craftsmanship and materials that support a long physical life. they have often been well design in terms of passive heating and lighting and ventilation and are in often in good locations.

the process of heritage building preservation is by definition the ultimate in sustainable development as it is driven by the goal to preserve an asset so that it be enjoyed by both present and future generations. it is built on the ethos of stewardship and seeks to extend the useful life of building as much as is feasibly possible, including recycling them to alternative uses when necessary.

In addition to the sustainable benefits attributable to existing buildings in general, it has addition social and economic benefits. In a social sense heritage buildings create a sense of place and help educate and provide social cohesion and identity. thus they build and maintain " social capital".

In an economic sense heritage buildings can provide additional economic benefits to a community by promoting heritage tourism. they also create a " sense of place" that attracts and retains immigrants.

On the top of this there are the social and productivity benefits for the occupants of heritage buildings relating to " feeling good" about occupying and helping preserve something of value to the community, as well as the businesses bathing in the reflected glory of being socially as well as environmentally and economically responsible.

However, it must be recognized that where it is necessary or desirable to "green " a heritage building additional challenges may be faced,[10].

5. Degrees of Intervention in Heritage Building

A number of philosophical approaches or preservation strategies have been developed to deal with the broad range of architectural artefacts in the built environment. These approaches involve varying levels of physical intervention and are usually ranked by preservationists from the most conservative (prevention of deterioration) to the most radical (Reconstruction), based on the degree to which the building is altered. There are seven degrees of intervention as pertains to historic preservation. The seven degrees are : (1) prevention of deterioration; (2) preservation of the existing state; (3) consolidation of fabric; (4) restoration; (5) rehabilitation; (6) reproduction; (7) reconstruction. . [1]
The preservationist's rule of thumb is :"It is better to preserve than to repair, better to repair than restore and better to restore than reconstruct". Experience has shown that the greater the level of intervention, the greater the risk of ruining a historic building as an artefact. Since historic buildings are often unique and irreplaceable, preservationists are cautious in choosing and executing a preservation strategy.

5.1. Prevention of deterioration (PD)

Prevention entails protecting cultural property by controlling its environment, thus preventing agents of decay and damage from becoming active. Neglect must also be prevented by sound maintenance procedures based on regular inspections. Regular inspections of cultural property are the basis of prevention of deterioration. Maintenance, cleaning schedules, good housekeeping and proper management also aid prevention. Such inspections are the first step in preventive maintenance and repair.

5.2. Preservation (Pr)

Preservation refers to the process of retaining the existing material, form and integrity of a building or site. Preservation involves accepting a structure as it is and maintaining it in that state. Any changes that were made to the building over the years are retained as evidence of the building's development. Interventions are limited to the application of preservative treatments and the installation of protective systems, such as fire and security alarms. These are done to protect and maintain the building without altering its appearance. [5].

Repairs must be carried out when necessary to prevent further decay. Damage and destruction caused by water in all its forms, by chemical agents and by all types of pests and micro-organisms must be stopped in order tp preserve the structure. [1]. This strategy is said to protect the building's integrity, meaning that it is still true to its own character and history. [5].

5.3. Consolidation (Direct Conservation) (Con)

Consolidation is the physical addition or application of adhesive or supportive materials into the actual fabric of cultural property, in order to ensure its continued durability or structural integrity. In the case of immovable cultural property, consolidation may for example entail the injection of adhesives to secure a detached mural painting to the wall and likewise grouting of the structure. the utilization of traditional skills and materials is of essential importance. However, where traditional methods are inadequate the conservation of cultural property may achieved by the use of modern techniques which should be reversible, proven by experience, and applicable to the scale of the project and its climatic environment, [1].

5.4. Restoration (Res)

Restoration is the practice of returning a structure or site to its appearance at some earlier stage of its development. The particular period selected is usually determined by its historical association for reasons of aesthetic integrity. Restoration involves the removal of any changes which were made after that period and the replacement of any missing earlier features. Since the value of restoration is measured by its accuracy and authenticity, extensive research and highly specialized expertise are required to accomplish both accurate removal and authentic replacement of building components. Meticulous restoration is therefore slow and costly, [5].

5.5. Rehabilitation (Reh)

Rehabilitation is the process of modifying a historic building which is still being used for its original or a similar function so that it will meet current building codes. The aim is to retain those features which are historically, architecturally or culturally significant. Rehabilitation may involve modifications such as the replacement of old fixtures or hating systems and the repair of deteriorated architectural features. Every effort is made to minimize the impact of these modifications to avoid destroying the character of the existing structure.

Adaptive Re-Use : is the process of modifying an existing so that it can be used for a new function. The building's significant features may or may not be retained. Many of the alterations will necessary to meet today's building codes. Often an original interior must be gutted if it is compatible with the proposed new use, [5].

5.6. Reproduction (Rep)

Reproduction is the process of piece - by - piece re-assembly of a structure's original building components, either in its original location or on a new site. This may be an appropriate method when the original building components have been torn apart or scattered throughout the site as a result of a disaster such as an earthquake, [5].

5.7. Reconstruction (Rec)

Reconstruction is the process of re-creating a building which no longer exists, on the basis of archaeological and historical evidence. the value of reconstruction is in its accuracy, but attaining this may be virtually impossible, [12].

It is obvious that the lower degree of intervention in historic building is the better for realizing sustainability as it lowers costs in relation to materials, transport, energy and pollution when compared to the erection of new buildings. So it can be said that there is a preferable direction for choosing the best intervention in historic building starting from the most conservative (prevention of deterioration) to the most radical (Reconstruction), based on the degree to which the building is altered, as in figure 1.

6. Green Heritage and the degree of intervention

A heritage building is often the subject of planning controls that seek to protect the building from inappropriate development. The ultimate aim of such controls should be facilitate the conservation of the building which defined by the International Council on Monuments and sites (ICOMOS) as " the processes of caring for a place so as to safeguard its heritage value",[6].

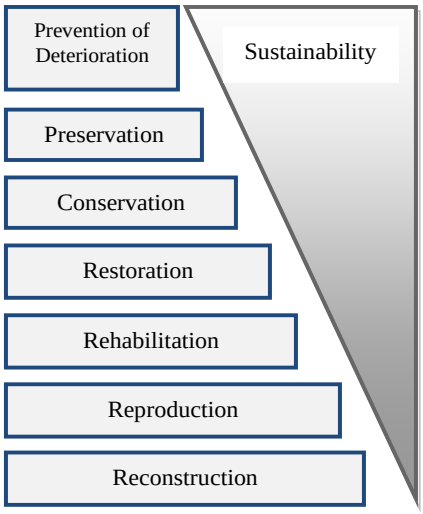

Figure 1. The Degrees of Intervention and Sustainability

The following standard of ethics must be rigorously observed in conservation work:

(1) The condition of the building must be recorded before any intervention.
(2) Historic evidence must not be destroyed, falsified or removed.
(3) Any intervention must be the minimum necessary.
(4) Any intervention must be governed by unswerving respect for the aesthetic, historical and physical integrity of cultural property.
(5) All methods and materials used during treatment must be fully documented.

Any proposed interventions should (a) be reversible or repeatable, if technically possible, or (b) at least not prejudice a future intervention whenever this may become necessary; (c) not hinder the possibility of later access to all evidence incorporated in the object; (d0 allow the maximum amount of existing material to be retained; (e) be harmonious in colour, tone, texture, form and scale, if additions are necessary, but should be less noticeable than original material, while at the same time being identifiable; (f) not be undertaken by conservator/restorers who are insufficiently trained or experienced, unless they obtain competent advice, [1].

ICOMOS also promotes the concept that the least intervention that is carried out to achieve conservation the better. The ICOMOS New Zealand states that conservation should involve the least degree of intervention consistent with long term care.

In order to green a heritage building, may well require that invasive intervention is necessary, particularly with mandated upgrades.
The challenge is to rigorously debate whether such intervention is warranted and if it is what is the most appropriate way of doing this,[6].
Greening Heritage buildings may also require subsidies in order to put in place interventions that conserve the heritage value of building, while achieving the environmental outcomes required. In some situations, to achieve a good heritage result may be more expensive than an alternative method. For example refurbishing existing timber windows may be more expensive than replacing them altogether with cheap replacement windows.
The requirement to conform with additional planning constraints may add to cost and time involved in greening a heritage building and in some circumstances an application to green the building might be declined altogether. There may also be a loss of heritage value as a result of greening process.
In general however, where heritage buildings suffer from weaknesses in green building performance these weaknesses can be corrected as part of a rehabilitation process.

7. Sustainability Measures in Conserving Heritage building

The following are the sustainability measures that should be taken into consideration to develop appropriate design strategies for the improvement of energy efficiency in heritage building and to achieve the integration of sustainability and heritage conservation.

7.1. Embodied Energy Conservation (EEC)

Embodied energy is the energy consumed by all of the processes associated with the production of a building. This includes the mining and manufacturing of materials and equipment, transportation of materials and administrative functions. The existing building stock has recognized globally as a significant source of energy consumption. However, the retention of existing heritage buildings helps to conserve embodied energy and contributes to a substantial saving in energy consumption through savings in building construction. Many traditional building materials, such as timber, concrete and brick , have lower scale embodied energy than modern materials such as glass, steel or aluminium.

7.2. Optimizing Existing Traditional Building Performance (OETBP)

Optimizing the existing traditional building performance of heritage buildings may assist in achieving energy efficiencies and broader sustainability objectives. Maintenance and repairs to heritage buildings will assist in ensuring the ongoing significance of the place and enhance its longevity. This contributes to improved energy efficiency and sustainability outcomes.

7.3. Reducing Energy Consumption in Existing Buildings (REC).

The installation of new sustainability measures, such as energy efficient heating, hot water systems, water tanks or other systems, may offset some of the less energy compliant fabric and features of the heritage place. Modifications to existing fabric may also be possible.

7.4. Maximizing Energy and Water Efficiencies in New Work to Existing Building (MEWE).

Where new work is proposed to an existing heritage building, energy efficiency and water sustainability measures should form an important part of the design process. Consideration could be given to :

- Orientation : the location of the new work and the orientation of windows and other openings to maximize passive heating and cooling.
- Proposed construction materials: the energy ratings of the building materials proposed and how these materials may enhance both the energy efficiencies and heritage values of the place.
- Shading devices for the new work: the design of screens, awnings, window hoods, verandas or porches where they will not have any adverse impact on the significance of the heritage building.
- Proposed energy efficiency of heating and cooling systems.
- Additional water consumption and water saving measures as a result of the new work.

7.5. Monitoring of Energy and Water Consumption (MEWC).

Establishing a management plan for monitoring future energy and water consumption in existing building, or as part of monitoring future energy and water consumption as a result of new work, may contribute to beneficial energy efficiency and water conservation outcomes. The plan could include:

- Retaining, monitoring and comparing energy and water accounts
- Purchasing green energy
- Providing public information on energy and water consumption to ensure a holistic effort in increasing energy efficiency awareness as part of the ongoing management of the building, [4] .

8. Case Studies

Two examples are chosen to show different degrees of interventions of heritage buildings and measures of sustainability. The paper shows how evaluation process could be taken into consideration to determine the sustainability indicator and the percentage of applying the measures of sustainability.

8.1. First example :The Sinnary House (1209 AH / 1794 AD)

The Sinnary House was built in the era of the Ottoman Empire. This house was one of the remaining opulent palaces that were built for the elite in the Ottoman Empire in the middle of Cairo (district of Nasiriyah - Elsayeda Zeinab.). The house contains most of the features of that era: the seat, which overlooks the inner courtyard, a hareem room (a space for ladies), and wind tunnel (Malkaf) faces the hall from the north side to reduce the sense of temperature during the summer. At the front of the house there was a large garden.

When the current renovations were carried out by a working group of Egyptian and French members, the building was adaptive reused as a centre of art and book store.

The importance of Sinnary House is that it holds between its walls the aesthetics of decorative architecture, which makes it a rare masterpiece in the form of historic House. It also completed form configuration, as evidenced by what appears in the unique architecture of the existence of the marvellous mashrabiyya overlooking the main street. While mediates the house from the inside a distinct courtyard fountain.

(Mission française de cooperation pour la sauvegarde du Caire Islamique (French Co-operative Task Force for the Conservation of Islamic Cairo) did the restoration mission starting with several stages to reduce the level of groundwater, followed by selection craftsmen who have experience to work in the restoration mission; it was important to reduce the level of the street next to the house; to return it to the same level it was in the last century, which has allowed the emergence of the main entrance to the full for the first time. Also the halls of the house, the mashrabiyya and wall cupboards were renovated.

This work was done by a working group of Egyptian and French members, so as to exchange experiences between the two sides as well as the training of nearly a hundred craftsmen to work in the restoration process. To return the house to its original state, according to a document which describes pause time of its establishment, as well as drawings of the French campaign for it. UNESCO has contributed to the restoration of the House.

The process of conservation of The Sinnary House follows the standard of ethics in conservation work, and was an important aspect of keeping past and present separate physically, but occupy the same space experientially. it is a unique experience to practice modern activities and look back to behold an 18 th century structure.

The historic building has restored as a centre of art and book store and its court is used for cultural meetings and symposiums. It can be noticed that the adaptive reuse of the building satisfies a key concept of sustainability by extending the useful life of existing building. This reuse lowers costs in relation to materials, transport, energy and pollution when compared to the erection of new buildings.

The process of conservation of The Sinnary House uses the following measures of sustainability that indicated in table (1). The Table shows the evaluation process that could be taken into consideration to determine the sustainability indicator (degree of intervention in the heritage building), and the percentage of applying the measures of sustainability.

Table (1) Table of Sustainability Review of Heritage Building for The Sinnary House .

			Measures of Sustainability				
			EEC	OETEBP	REC	MEWE	MEWC
Sustainability Indicator	1	PD					
	2	Pr					
	3	Con					
	4	Res					
	5	Reh					
	6	Rep					
	7	Rec					

Table (1) shows that three degrees of interventions are used in the Sinnary House : Consolidation (Con), Restoration (Res), and Rehabilitation (Reh). It also shows that three measures of Sustainability are used : Embodied Energy Conservation (EEC), Optimizing Existing Traditional Building Performance (OETBP), and Reducing Energy Consumption in Existing Buildings (REC). This means that the sustainability indicator used in the Sinnary House is Medium, and the used measures are 60% of the total measures.

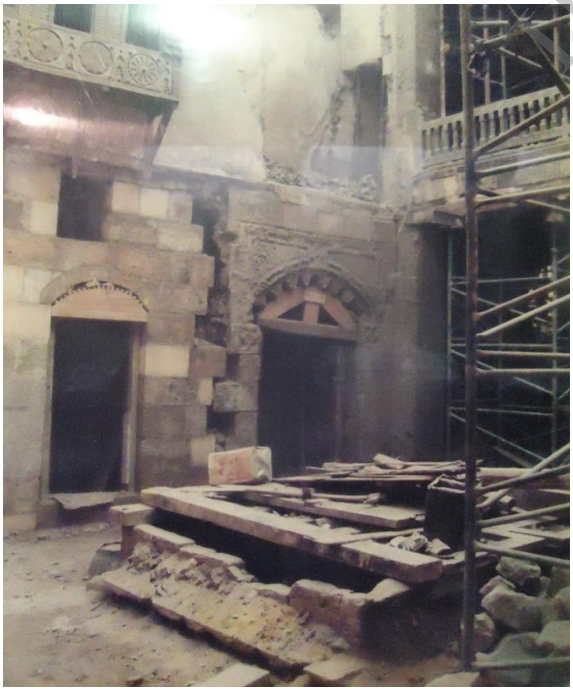

Figure 2. The Sinnary House before restoration

Figure 3. The Sinnary House after restoration

8.2. Second example :The Maolawian Tekkia

Was a good example for changing the original use of the building to a museum and celebrating hall.
it dates back to the Ottoman Empire 400 years ago, and the building was a refuge for those who do not have homes, widows and the elderly people, as well as the poor and passers-by. The hall «Hearing hall» is the most important section of the place and consists of a round wooden platform with a coloured circle on the floor contrasting to the colour of the seating area surrounded by « wooden handrail». The hearing hall has two doors for entering the darawish (loving god people), and the second floor of the hearing hall is connected by a wooden staircase leads to the irregular spaces seating been to the audience and viewers, including women veiled from the public.
A dome covers the theatre of the hearing hall which is one of the most important hallmarks of Tekkia. It is built on twelve wooden columns, each one of them contains a name of the twelve imams (religion lord) at Shiaa Muslims, followed by rectangular areas with cumulative writings in Arabic letters. The dome was

decorated with a landscaped groves and Turkish flags and floral motifs .

Most of the halls inside the Tekkia was restored by the experiences of Italian, and now the Tekkia is dedicated mostly to the development of scientific and professional skills of workers in the field of archaeology.

Figure 4. The Maolawian Tekkia from inside

Figure 5. The Maolawian Tekkia from outside

The process of conservation follows the standard of ethics in conservation work. A steel structure was added to carry and support the wooden platform of the hearing hall in the basement area where the space is used as a museum . Adaptive reuse for the historic building satisfies a key concept of sustainability by extending the useful life of existing buildings. This reuse lowers costs in relation to materials, transport, energy and pollution when compared to the erection of new buildings.

The process of conservation of The Maolawian Tekkia uses the following measures of sustainability that indicated in table (2).

Table (2) Table of Sustainability Review of Heritage Building for The Maolawian Tekkia.

			Measures of Sustainability				
			EEC	OETEBP	REC	MEWE	MEWC
Sustainability Indicator	1	PD					
	2	Pr					
	3	Con	■	■	■	■	
	4	Res	■	■	■	■	
	5	Reh	■	■	■	■	
	6	Rep					
	7	Rec					

Table (2) shows that three degrees of interventions are used in the Maolawian Tekkia: Consolidation (Con), Restoration (Res), and Rehabilitation (Reh). It also shows that four measures of Sustainability are used : Embodied Energy Conservation (EEC), Optimizing Existing Traditional Building Performance (OETBP), Reducing Energy Consumption in Existing Buildings (REC), and Maximizing Energy and Water Efficiencies in New Work to Existing Building (MEWE) . This means that the sustainability indicator used in the Maolawian Tekkia is Medium, and the used measures are 80% of the total measures .

The examples above show two different approaches. The Sinnary House preserves the past within the present while the Maolawian Tekkia creates the experience of a coincidental past and present.

These two case studies focus on adaptive reuse not only for historical reasons, but also for sustainability. Both of them use the medium degrees of intervention that can match with the new activity of the building, and apply the possible measures of sustainability.

9. Conclusion & Recommendations

To meet both the preservation objectives of heritage building and sustainability we should use the least degree of intervention consistent with long term care. This approach requires clients and designers to shift their thinking from focusing on rationalistic consumption to environmental protection. There is growing support that adaptive reuse satisfies a key concept of sustainability by extending the useful life of existing buildings. This reuse lowers costs in relation to materials, transport, energy and pollution when compared to the erection of new buildings. Adaptive Reuse make better use of the heritage buildings we already have and of the residual life of the total measures bedded in them by addressing sustainability and preservation.

Not all heritage buildings can be considered good examples of sustainable building and are far from green. Some heritage buildings will need to make way for new green buildings but an increasing number of case studies demonstrate that heritage buildings can successfully be made green.

The paper recommends to use the table of sustainability review of Heritage Building that developed in the paper to enable the designers and conservation experts to review the degree of sustainability of their works in heritage buildings and to enable them to keep in consideration the measures of sustainability.

Governments in particular should be more responsible than to needlessly build new while ignoring sound rehabilitation or adaptive re-use alternatives.

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