THE SUSTAINABLE MANAGEMENT OF THE HISTORICAL BUILDINGS

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Summary

The sustainability is an essential topic in the field of building planning and it became also a necessary requirement of the Cultural Heritage preservation.

It's a long time since the STEP laboratory, of the University of Pavia, deals with researches on the themes of recovery and restoration of Interdepartmental Research Centre on Cultural Heritage Conservation (CISRiC). The STEP laboratory has worked on the development of analysis and energy assessment methodologies and on the sustainable management of historical buildings. In this area, a research was conduct and experimented on the southern wing of the royal palace of Monza, in Lombardy (north of Italy). Another project was focused on the creation of assessment models aimed at planning the conservation and the Life Cycle Assessment of "Minor" monuments, such as the sanctuary of the *Beata Vergine Annunciata* in Serle (province of Brescia), also in Lombardy.

The methodological features delineate a unified approach for the sustainable management of the Cultural Heritage, through the conducted case-studies.

Keywords: Sustainability of historical buildings, Assessment methods, Life-Cycle

1 Theoretical approach

The built heritage preservation has to meet to contemporary needs of a changing world and, today, a fundamental necessity has become the sustainability, in term of environmental, economic and social issues.

The paper illustrates a general overview of what is in the following defined as "Life-cycle oriented sustainable restoration" – LIFE-SuRe – approach. It is basically an holistic method to consider a wide spectrum of different and related aspects concerning restoration, valorisation and management of historical heritage in a sustainable perspective. LIFE-SuRe is based upon three main theoretical pillars, defined as:

- functional sustainability;
- energy oriented sustainability;
- life-cycle oriented sustainability.

The development of this approach is a kind of continuous process, still undergoing both at theoretical and at experimental level thought a number of research activities carried on by

the STEP laboratory at the Department of Civil Engineering and Architecture (DICAr) and among the Inter-departmental Research Centre on Cultural Heritage Conservation (CISRiC) of the University of Pavia.

The whole approach is based on the statement that is focused on the concept of cultural heritage valorisation and its relationships with the apparently antithetical concept of conservation, as defined by Italian current law: «Valorisation is focused to discipline activities aimed to promote historical heritage knowledge and to ensure best public use conditions, also by human beings with disability, in order to promote culture's development. It also considers the promotion of conservation interventions on the cultural heritage». In the following it is also stated that the «valorisation is developed in compatible manners with the preservation and not compromise its requirements» [1].

Neither a strictly preservative approach, neglecting each opportunity of reuse and public fruition of the monument, neither the opposite perspective of a huge economic exploitation of the monument itself seem to be sustainable in a mid-term perspective. On the opposite, our approach underlines that an effective strategy for sustainable restoration of cultural heritage shall consider:

- the functional compatibility evaluation between the expected use and the historical building itself;
- performance optimization of the building envelop, in the perspective of its energy efficiency increase;
- long-term sustainability of the action, with the outlook of a minimization of conservation actions trough a comprehensive monitoring strategy, which is aimed at planned preservation of the Cultural Heritage.

2 Sustainable management

2.1 Upgrade to modern needs: re-use and energy improvement

The intervention on an historical building focuses on two fundamental issues: the material preservation and the building's enhancement, which is also maintaining in use, arranged by the modern necessities. The change of use is very often due to a change in the framework of needs and the reuse arises from the definition of choices compatible with the data of the process of knowledge of the building [2]. Hence the variables depend on the social, economical and financial context, that generate the demand of use and enjoyment. So, the new use has to be compatible with the characteristics of volume, distribution and technology of the existing building. Therefore the knowledge of the building (typology, morphology, material, preservation status) is the starting point to understand tools and strategies for the design process. Each building is a different case.

The historical buildings had features in close connection with territory and climate, but also in relation with the users' needs. The social memory is less respectful than history, traditions and cultural memories and it is better compatible to transform and to reshape its heritage, to suit oneself [3]. Modern needs originate modern necessities, which the original building design hadn't considered (plant systems, indoor comfort quality, bathroom and other services, accessibility, security, safety, easy management), so the users have produced heavy architectural transformations to adapt buildings to their needs [4].

Two current main issues are energy improvement and sustainable management. Ignoring modern necessities isn't possible even if they could constitute hazards of damage, in order to avoid the risk of buildings as embalmed memories; so the restoration is the

result of two actions: the material preservation, as a priority, and the contribution of necessary new constructions – and uses –, as added value [5]. It is important to understand the level of the compatibility between the actions and the building restriction.

2.1.1 *Villa Reale* in Monza: energy efficiency improving

The research, which was developed about the case-study of the southern wing of the *Villa Reale* in Monza, aims to create guidelines for the integration of technological solutions intended for historical buildings' energy efficiency [6].

The *Villa Reale* (1777–1780) was a neoclassical royal palace designed by Giuseppe Piermarini, on commission of Mary Theresa of Austria. After various vicissitudes, the palace became the residence of Umberto I (1844–1900), king of Italy, who assigned the palace's renewal to the architect Achille Majnoni d'Intignano and the compound was transformed in according to the contemporary style. In 1934, the king Vittorio Emanuele III gave a large part of the palace to the municipalities of Monza and Milan. Sadly spoliations and decline took place immediately after the Second World War, but the southern wing became state heritage with the advent of the Republic. The restoration of the staterooms of its first main floor started in 2003; these rooms will be used for exhibitions, congresses, representative offices and other events on the occasion of the Expo 2015 [7].

Fig. 1 *Villa Reale in Monza. Photo by Stefano Stabile,Wikimedia commons, 2011.*

Fig. 2 *Southern wing of Villa Reale, King's bedroom. Photo by Valentina Cinieri, 2010.*

The design actions have been selected by a check list of possibilities, compared with the limits of the building and the users' needs, also in term of energy improvement. The intersection of the different factors begets the optimal choices.

Energy sustainability is mainly focused on the performance improvement. Any energy oriented strategy may be developed along two different directions: the reduction of heat loss and consequent decrease of the consumed energy or the investment in systems for the production and exploitation of energy from renewable sources.

The method aims to identify evaluation matrices of possible intervention strategies, rather than an exhaustive list of possible solutions. The assessment of the existing performance level purpose to understand energy behaviour of buildings and moreover it is necessary to investigate the features of existing plant systems, in order to control their efficiency and efficacy and the possible transformations and integration with buildings. A correct statement of requisites, performances and the plant response may be driven only by a clear definition of activities to be developed inside the building and of the generated

needs. In particular, it is necessary to understand that specific building destinations, like museum and expositions, need the careful control of thermo hygrometric parameters (temperature, humidity, density of CO_2), which may be different from the parameters set as adequate for human comfort. Furthermore it is necessary to evaluate possible impacts of energy efficiency oriented actions.

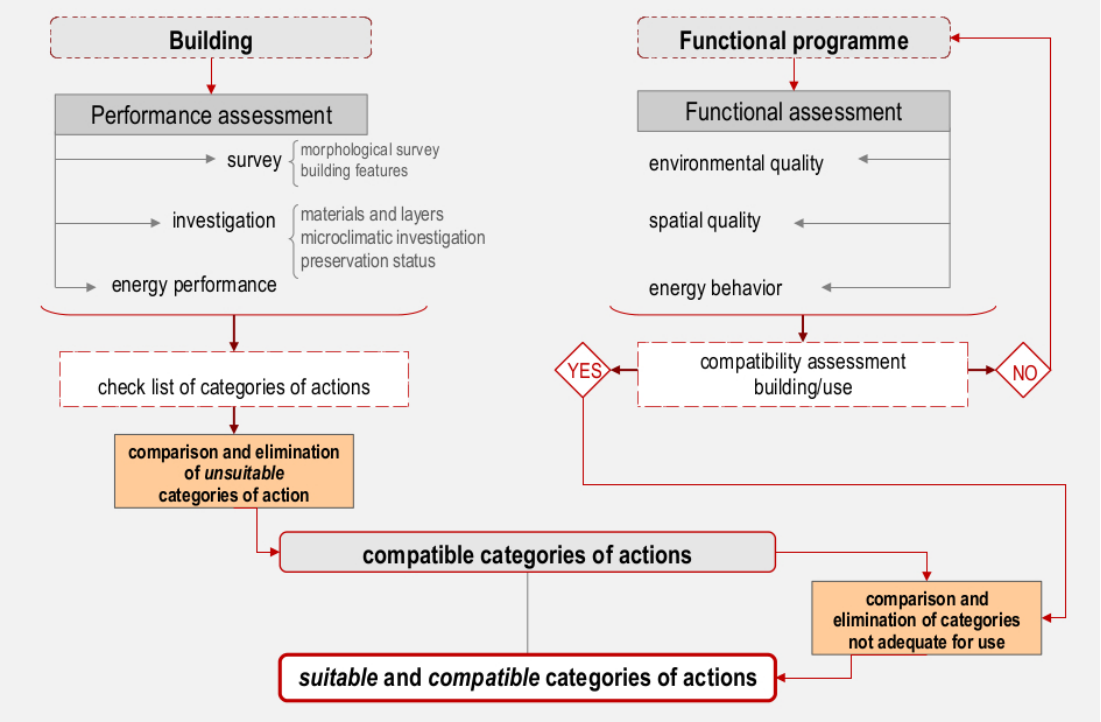


Fig. 3 *Energy improvement of Cultural Heritage. Methodological approach [6].*

2.2 Maintenance approach: preservation and social oriented management

In a sustainable perspective, the maintenance approach has assumed a great importance. The approach of action is characterized by the transition from a *post factum* restoration [8] to a long term preservation, understood as transformation control, which is necessarily dynamic and co-evolutionary [9], given that the material is constantly changing.

The Charter of Krakow (2000) also states that «The conservation of built heritage is implemented by the project of restoration, including the strategy to conserve in the long term», considering the project of restoration as «resulting from the choice of conservation policies». Maintenance and repairs are fundamental for the preservation and they «have to be organised with systematic research, inspection, control, monitoring and testing. Possible decay has to be foreseen and reported on, and appropriate preventive measures have to be taken» [10].

The maintenance management planning may prevent damage and slow down the decay. The assessment of the existing condition is always the basis of the process, including analysis of *ongoing deterioration* and of the *expected risk*.

The actions had to be organized into a hierarchy that is based on the level of urgency, conditioned by several factors (technological element, type and spread of the degradation phenomenon, historical and artistic value, interaction with other building elements); on the base of this each planned maintenance action is associated with a frequency time. The

forecast of the decay progress, the monitoring and the preventive actions may support a cost planning and expense reduction.

All aspects that influence the problem, should be considered and, so, also social issues have to be included. It is necessary to involve private owners and ordinary citizens, who can understand their interest in joining the preventive conservation plan, through appropriate divulgation and information, through the low cost of the inspections and appropriate incentives. So, it is possible to produce an extra value that is the increase of *intellectual capital* [11].

2.3 Planned preservation of "minor" ecclesiastical heritage. The sanctuary of the *Beata Vergine Annunciata* in Serle (Brescia)

The above mentioned approach has been the reference approach in the case study of the sanctuary of *Beata Vergine Annunciata* in Serle (Brescia) [12].

The sanctuary was built between XV and XVI century on the site of an ancient church – its existence has attested since 1138 – of which there are no remains, with the exception of the Romanesque steeple's base. The current structure dates back to the sixteenth-century rehash ended in 1566. The interior is characterized by a Baroque style, consisting of simple architectural lines and articulated stucco decorations [13].

Fig. 4 *The sanctuary of Serle (Brescia)[13].*

Fig. 5 *Volt adel presbiterio [13].*

The research work has been developed starting from the case study, but the main purpose of the research is the elaboration of an intervention approach exportable to other historic buildings in accordance with peculiarities of any cases.

This approach aims to involve the managing users, although they aren't generally technicians in the field of historic buildings. Indeed, within the research about the parish of Serle, a short guide has been developed to the deterioration prevention, together with an easy instrument (inspection form) for monitoring, usable also to people who are not technicians [14].

The planned conservation associates the time factor to the concept of preservation; the actions are not exceptional, but continuous process of prevention.

The method used can be divided into three interrelated stages:

- Assessment of the building preservation status
- Evaluation of expected risk and planning of interventions
- Inspection activities [15].

The first phase is about the knowledge (building performance, the materials of which it is composed, structure, etc.), which is indispensable for any design action. Therefore, there

were carried out investigations that allow to get a complete "check-up" of the building's preservation state [16], which returns information about structure (materials, building technology, morphology, etc.) and about the phenomena of degradation that have already occurred at the time of the survey (*ongoing damage*) or that are evolving (*expected damage*). All actions of survey (geometric, morphological, material and degradation surveys), historical investigations, analyses of the construction technologies belong to the stage of preservation status assessment. The building is broken down into technological units, that are useful to identify uniquely the element affected by deterioration and to indicate it easily to the experts.

This first step requires the contribution of technical experts in field of restoration, so that they explain the causes of deterioration, which affect materials, and delineate properly the appropriate preservation actions. The assessment of the building preservation status is a tool "in progress". The acquired data supply a base of knowledge, necessary for the planning of preservation and of maintenance, but the information is updated and enriched by each action and research [17].

Fig. 6 *Northern Façade of the Sanctuary of Serle (Brescia) with the deterioration patterns map*

The second stage aims to provide an evaluation of the risk to building preservation, based of what emerges from the building conservation status's analysis: architecture analysis (materials, building technologies, morphology, etc..) and analysis of phenomena that have already occurred at the time of the survey or are in evolution. In particular, the analysis of expected damages describes the situation of risk.

In this second phase is still necessary the presence of specialists, accountable to understand the expected phenomena of deterioration. Preservative actions and their urgency level are established in relation to some parameters as diffusion, stability of the phenomena, interaction with other elements' preservation, in order to create a hierarchy of maintenance actions. In this way, the "preservation program" is outlined. It is the means that indicates the necessary check-actions in connection with both the performance and the

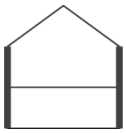
conservation of technological elements, analyzing the issues related to potential causes of degradation and to lack of performance action [18].

The third and final stage comprises the building status monitoring and the participation of the users of goods. The monitoring, carried out through appropriate expeditious inspections, is crucial in a preventive approach. In several cases, inspections can be conducted by the managing users in respect the indication of technicians who realized preliminary investigations (study of degradation and of damages and analysis of the risk). However, some inspections require specific competence and tools and it is necessary to consult specialists; for this reason it is useful to plan the frequency of planned preservation actions in a logic of management optimization.

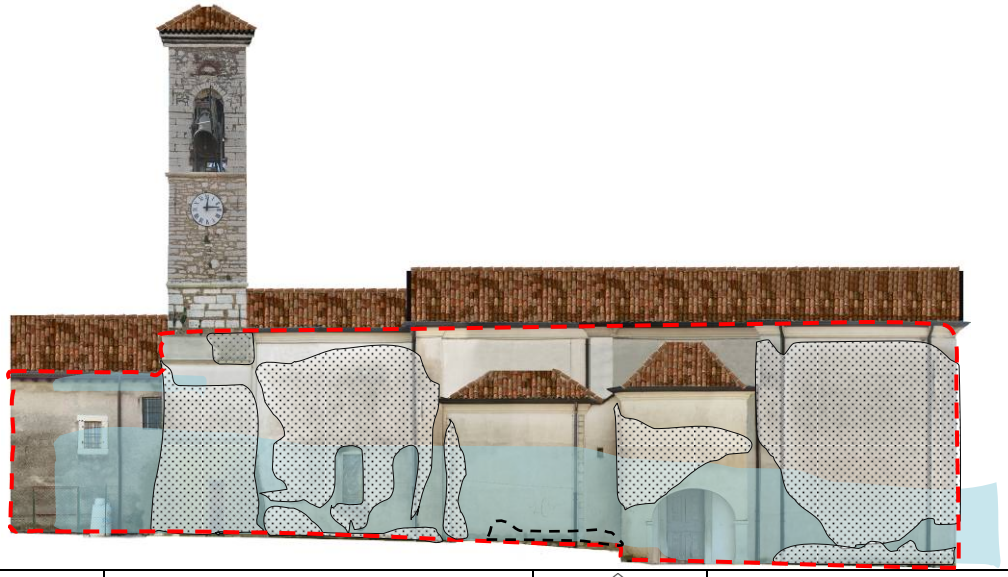
In the case of physiological deterioration, which is related to the nature of materials, it is advisable to plan appropriate actions to slow down the damage evolution process that can't be permanently stopped. On the other hand, if there are pathologies connected with executive faults of the structure or with causes that are extrinsic to its nature, the elimination of these causes should be necessary; otherwise, it is appropriate to act with periodical maintenance works.

Each control produces a recalibration of the preservation program which is a constantly updating tool.

Tab. 1 *Ongoing damage's form*

01. ONGOING DAMAGE				
Santuario della Beata Vergine Annunciata di Serle (BS) – NORTHERN FACE				
Technological element	Vertical structures, Claddings/decoration			
Architectural element	Plaster, masonry			
Material and techniques	Plastered stone masonry			
DECAY DESCRIPTION				
Damage	**Instability**	**Diffusion**	**Interaction with other element**	**Urgency level**
Plaster detachment	in progress	About 10 %	Supporting masonry	Medium
Plaster missing	steady	< 5 %	Supporting masonry	Low
Biological colonization	in progress	About 60 %	Supporting masonry	High
Water staining	in progress	About 80 %	External and internal (painted) plaster	Very high

Tab. 2 *Attended damage's form*

01. ATTENDED DAMAGE			
Santuario della Beata Vergine Annunciata di Serle (BS) – NORTHERN FACE			
			
Technological element	Vertical structures, Claddings/decoration		**Legend:** Water staining Biological colonization Plaster crumbling Mortar joint crumbling
Architectural element	Plaster, masonry		
Material and techniques	Plastered stone masonry		

DECAY DESCRIPTION		**Visual control**		
Damage	**Interaction with other element**	**Alarm signals**	**Actions to be done**	**Check methods**
Water staining	External and internal (painted) plaster	- Water stain - seepage - rising damp	- Refurbishment of roofing and cleaning of gutters - surfaces cleaning and biocide treatment - (if possible) redesign of the external flooring slope: water stagnates at the wall base	- Visual and touch control - control of the preservation status of roofing - control of the system for stormwater disposal to the ground - check of the cleanness of gutters
Biological colonization	Supporting masonry	- Water stain - dark stain		
Cladding crumbling	Supporting masonry	- Water stain - plaster detachment - biological colonization		
Mortar joint crumbling	Plaster (missing)	- Plaster detachment - missing plaster		

3 Conclusions. Towards a Life-Cycle oriented management

The proposed methodological approach has been developed starting from experiences, which have been implemented on some case-studies, and it is leading to evolve a Life--Cycle oriented approach.

"Life Cycle" is defined as "the time interval from beginning of design of the entity to the end with its disposal" (UNI EN 13306:2003. Maintenance, Terminology). If the life cycle is connected with the concept of "useful life" and so with the capacity to provide performances, the usefulness of an historical building is supposed to not decay over time and not be disused [19]. However, the potentiality of this methodology is due to the fact that it permits to assess with adequate advance issues, which are associated with each phase of the building life cycle. This preventive approach includes all the sustainability issues, because it ensures long-term benefits in term of costs minimization and degradation slowing down and it includes also the environmental and social issues as necessary design needs.

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