TECHNICAL INNOVATION AND GIS TO QUALIFY RECOVERY PROCESSES

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Abstract

Digital technologies can contribute to improving the quality of interventions on the existing heritage, following principles of "organisational sustainability". These ameliorate the way information is managed, also considering its variability through time, during the various process stages (planning and scheduling, design, execution and later management of the working life cycle), and they also reduce the many levels of "uncertainty" characteristic of this sector of activity. The study submitted here refers to the application of Geographic Information System technologies to information management in projects involving conservation and promotion of the Cultural Heritage by the University of Genoa.

Key Words: Digitalisation, GIS, Management, Quality, Architectural Heritage

Cultural Heritage, sustainable development and digitalisation

Many view the Cultural Heritage of Italy as a potential engine for the national economy: however, it requires important actions in terms of applying protective measures, maintenance, reuse and smart management, to be carried out, one hopes, in efficient and effective ways.
Art. 29 of Legislative Decree 42/2004, the Code of Cultural Heritage and Landscape, laid down the premises for a fundamental innovation, based on the idea that conservation of Cultural Heritage can be obtained through consistent, coordinated and planned work involving study, prevention, maintenance and care. Later cultural and legislative production gave body to this idea, developing it in relation to the architectural heritage (Ministerial Decree 154/2017, art. 3, Public works involving Cultural Heritage).
Management of intervention processes on built environment, whether of ancient or recent formation, presents various degrees of complexity compared to new buildings; these depend on the need to:

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- manage numerous items of information, of various origin and kind, which can be implemented and can change over time;
- organise such information and its variability during the study and design phases, on site and during later management of the assets;
- establish the proper relationship between various kinds of information and refer them to places, recording the variations which projects and work cause on them;
- make it possible to use such information in open decision processes which cannot be determined in advance;
- schedule preventive and necessary maintenance after the intervention.

In this context, recourse to ICT (Information and Communications Technologies) may be an important advance, not only culturally but also in operational terms. ICT, properly adapted and implemented, can contribute to raising the quality levels of the whole intervention process (renovation, qualification, reuse, maintenance...) set up according to principles of "organisational sustainability".
IT systems for data management have so far been designed, structured and used mainly to design, set up sites and manage new constructions. Therefore, while the construction industry in Italy is quickly moving forward toward obligatory application of digital information modelling in public contracts for new buildings (Ministerial Decree 560/2017), these tools are still insufficiently employed for interventions on existing buildings. This lends support to the suitability of intensifying applied research, adapting existing technical tools to cultural needs dictated by the specific features of stratified items.
The reference framework for the research activities presented here therefore picks up the challenges of our times, establishing relations among goals of:
- promotion of the architectural heritage;
- improvement of the management process through use of ICT;
- adaptation of practices of conservation, maintenance and reuse to what is expressly required for public works;
- development of digitalisation processes of Public Administrations and digitalisation strategies in the construction industry.

"Data" culture in the digital era: advantages and possible risks

We can find certain analogies between the paradigmatic assumptions of the digital area – especially of Data Driven strategies – and processes for intervention on existing items: significance of the data, their reading and interpretation during the initial strategy defining phase, the relationship logic among the data.
Furthermore, digitalisation of the processes of knowledge gathering, planning and implementation offers indisputable advantages: it can in fact positively

affect conditions of "measurability" and transparency and the qualification of the planning, programming, monitoring and control phases, as well as cutting down complexity of administrative steps, allowing actors to take decisions consistently, rationally and more responsibly, and limiting risky situations related to the many levels of "uncertainty"[1].
The interest with which people look at the potential of digital tools however, must not be uncritical, but should involve awareness of certain risks tied to:
- data overload and redundancy, the search for impossible completeness ("exasperation" of the analytical phase);
- information density not set out according to hierarchical levels (data "flattening");
- the risk of falling into mechanistic and deterministic processes when managing the data for purposes of intervention.
Computational logic, on the contrary, requires a selective rather than exhaustive approach, probabilistic rather than deterministic, capable of managing simultaneously and dynamically several alternatives at once, establishing a relational logic based on specific contexts and needs.

Adapting the means to the end: managing precious heritage with GIS tools

On such premises, the most recent research, involving the multidisciplinary group headed by the Post-Graduate Course in Architectural Heritage and Landscape of the University of Genoa has been oriented towards the construction of digital tools for managing interventions on the historical heritage of monuments belonging to the same University, providing support to technical professional skills involved in such activities.
Starting out from two symbolic buildings (the complex of the Albergo dei Poveri and Palazzo Belimbau[2], a 17th century first category Palazzo dei Rolli[3]),

[1] See the report of the Parliamentary Commission of Inquiry into the Level of Digitalisation and Innovation of Public Administrations 2017.

[2] Research on these complexes were financed through various channels. In 2011, two different agreements were signed between the Department of Major Projects and Safety of the University of Genoa and the Post-Graduate School in order to launch studies and research needed to define and implement a strategic plan for complete re-use of the Albergo dei Poveri, currently on free loan to the University as headquarters for the humanities studies hub. In 2013, the research group received funds from the Ministry of Education within the framework of the Research Projects of Significant National Interest for application of a BIM model to historical heritage. In 2013, the Liguria Regional Government funded a research project on a feasibility study for energy efficiency of the Albergo dei Poveri. Finally, in 2017, an Implementation Agreement was stipulated between the Construction Development Area of the University and the Post-Graduate School in order to carry out the study required to transform the monumental rooms of Palazzo Belimbau – belonging to the University – into a museum.

digital platforms were built in GIS environment designed on the basis of the unique and non-standardisable features of these assets (Franco, Babbetto, 2016; Acacia, Casanova, 2015; Musso, Franco, 2014).
On a purely technical and professional level, the creation of a specific platform in GIS environment, intends to:
- create an information system, based on the many existing isolated and thematic data banks, to consult/acquire data of various kinds;
- identify and support analysis of the many problems associated with safety of users and of places, facilitating definition of the best strategies for improvement, reduction and mitigation of risks (including environmental risks);
- minimise unexpected events which inevitably accompany any project or site working on existing items and the ordinary management of building;
- cut down operating time and costs during the working life of the buildings (ordinary and extraordinary maintenance, re-functionalisation, regulatory adaptation...);
- avoid excessive and unsustainable (or unmanageable) levels of discretionality of choice during the planning/authorisation phase of interventions, also by the Entities responsible for safeguarding the assets;
- provide useful contributions to the development of intervention protocols on the assets being examined, which can be used by those responsible for them.

Creation of an information system for historical architectural heritage: methodology and steps

GIS technology arose in the context of geography as a set of tools designed to collect, file, study, process and show spatial data about the Earth (Department of the Environment, 1987). Its application to architecture, and more specifically to historic buildings, therefore demands adaptation, starting from the map used as a base: geographical maps must in fact be replaced by one of the possible plane representations of architecture, that is horizontal and vertical sections, with a greater level of detail.
The various geometrical entities making up the map are associated to various data/attributes which are organised in tables ("Manuale utente di QGIS", 2018). To achieve effective management of a large mass of complex data, it is advisable to make use of a spatial relational DBMS (Data Base Management System) (Casagrande et al., 2012). This choice, associated with the adoption of a dedicated server, allows one to abandon local work in favour of remote work, thus allowing for updating and consultation by more than one user (also simultane-

[3] The Palazzi dei Rolli, belonging to the UNESCO world heritage sites, are a group of Genoese noble palaces which, in the days of the old Republic, on the basis of an extraction by lot from places of accommodation (the "rolli") were assigned to host great personalities on state visit to Genoa.

ously) and managing access to data according to security levels tailored to the kind of user. Furthermore, the database can be consulted not only via a graphic interface such as a specific GIS software, but also using various applications (Acacia et al., 2016), not necessarily graphic.
When building the information system for the assets of the University of Genoa, use was made of free and open-source softwares such as PostgreSQL (as DBMS), with its spatial extension PostGIS, and QGIS (as GIS application), ensuring total interchangeability among the systems (Casagrande et al., 2012) and the possibility, in a near future, of publishing the projects as webGIS.
Research was done in the following steps:

1 Selecting and gathering data
Data concerning quantity, quality and documents were gathered, the outcome of: archive research with collection of documents, photographs, iconographic material concerning the construction and later maintenance phases); longimetric, topographic, photogrammetric and laser scanner survey campaigns (with two-dimensional return and three-dimensional modelling); spherical panoramic shooting, to allow virtual navigation in augmented reality; investigations on the material nature and construction of the assets and diagnostic campaigns, returned in special maps and three-dimensional modelling which show the state of conservation, the level of material decay and the structural reliability of individual parts or whole systems; identification and location of risk factors, structural and tied to the conditions of conservation of the spaces; investigations into the internal and external systems of accessibility, vertical distribution systems, also with reference to fire prevention regulations and escape routes (with identification of unsuitability and needs); identification of the decorations and movable items contained inside the area and the results of diagnostic investigations; energy audit (conditions of environmental comfort, identification of dispersive elements and of items of thermal behaviour which can be improved); identification of deficits in systems and technology; identification of the best kind of conservative interventions and improvements in view of the new requirements associated with use (including systems) [4].

2 Definition of the requirements of the GIS platform and of intended use in order to define the architecture of the system. Identification of the purposes of the platform itself, of the main ways of running searches, for example in a diachronic or a synchronic key, and of user profiles (to define different levels of accessibility to data depending on the kind of user and prevent information overload). Definition of search keys according to the main questions which

[4] Some data cannot be used directly staying within the GIS software, but require connection to outside applications. This happens for example when consulting immersive spherical shooting, to view photos from close up or digitally acquired archive documents.

arise, not only and not especially to increase knowledge, but also and mainly for aims of conservation and maintenance and operational purposes in general. By way of example only, before deciding which operations to carry out in order to apply ensure safety of the roof, one has to cross data about the material nature of the roof, its state of conservation, its static and structural layout, its exact historic context, in order to make suitable judgements and balance interventions (aimed at providing maximum protection to the parts which have the greatest value in terms of historical evidence).

3 Data modelling, designing tables on the base of the semantic property of the data and taking into account the rules of the relational model, first of all those of integrity (Atzeni et al., 2014): architectural complexes have been broken up into hierarchical levels, in order to file and connect data to each other, from a set level (for example the floor or vertical service, to rooms or groups of rooms) down to an elementary sub-level (a pillar, a window, etc.) (Acacia, Casanova, 2015). In the same way, data coming from the investigations of various kinds described above are organised, identifying for each a uniform data class, associated with a table, a unique key allowing one to connect it to other tables (Atzeni et al., 2014).

4 Implementing and checking the system.

Conclusions and future development: building an interoperable open access platform

Spatial relational databases built for the University's architectural heritage are a very useful tool; however, their use is confined to the context of education (technical professional skills developed at the Post-Graduate Course) and practical operation (technicians of the University offices). What can be developed in the near future will be a webGIS system, an interoperable open access platform to make available to an extended community a rich heritage of information and technique concerning the monumental buildings belonging to and used by the University of Genoa. This platform will allow for free access, providing virtual tours, based on the data contained in the various repositories, allowing the user to move inside historical buildings.
Making such an architectural heritage universally accessible and outlining efficacious protocols for its conservation and use, physical and thanks to digital and multimedia technologies, can in fact contribute to research, documentation, promotion and transmission of the cultural, material and immaterial heritage of the Genoese and Ligurian community, but also to its safeguarding and management, including measures for protection and mitigation of environmental risks.

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