RESEARCH PROJECT:

Introduction and state of the art

The preservation of the architectural heritage is an element of great importance for the identity and history of the people; cataloguing the Cultural Heritage is the starting point for the protection, enhancement and conservation of the Cultural Heritage. In this sense, the evolution of digital technologies at the service of the representation of architecture has allowed the achievement of goals previously unthinkable for the survey, knowledge and communication of the built heritage. By integrating the possibilities offered by three-dimensional, solid and parametric modelling tools with those of systems for the management and sharing of data, BIM systems promise new scenarios for the storage and management of large amounts of information for the knowledge of Cultural Heritage.

The National Institutes of Building Sciences (NIBS) defines Building Information Modeling as the "digital representation of physical and functional characteristics of an object". This new approach allows to obtain and manage in a unified way the architectural, structural, plant design, characteristics and properties of materials, components and systems, planning of construction phases, timing, execution costs and maintenance works. The information data obtained are considered as part of a single process, extended to the entire life cycle of the building, thus making it possible to prevent and reduce errors and inconsistencies and to optimize the execution, verification and control processes. Today we speak of "digital twin", as a tool for analysis and modeling of the interactions between people and the built environment.

Through the adoption and development of the BIM methodology, the concept of "dimension" of the project has been redefined and expanded. Again according to NIBS, a "BIM based" design presents, in addition to 3D modeling, construction times, cost analysis, project management and sustainability assessment.

While 3D modeling allows you to create parametric objects that are easy to manage, defining their appearance, dimensions and materials, with the 4D dimension (programming) you can visualize the activities related to the construction process, with the generation of the Gantt diagram and timelines aimed at controlling and managing the construction phases. The 5D dimension (computations, estimations and evaluations) is instead aimed at controlling costs: from the model it is possible to derive the schedules and metric calculations, plan and control the project costs and obtain greater efficiency in the use of resources.

With the 6D (use, management, maintenance and decommissioning) the project enters the dimension of Facility Management where the BIM approach allows to use the data and information entered in the model both in the design and in the execution phase. In this way, it is possible to manage the building during its entire life cycle and take the necessary maintenance actions. Finally, 7D is the dimension of environmental, economic and social sustainability that leads to a "quality" work. This can be achieved through the adoption of strategies that make the analytical processes that characterize the work more efficient. An example of this is energy analysis, which is about to move from "stationary" to "dynamic", or life cycle, product and process analysis (LCA, etc.) as well as multi-criteria evaluation methods such as LEED, ITACA, and so on.

Research objectives

The objective of this research is to make manifest the potentialities and criticalities related to the introduction of BIM processes in the field of knowledge, transformation and management of the built heritage. These issues are closely linked to the technological development of the last 20 years which has brought about a significant change in the cultural paradigm in relation to the problems of knowledge acquisition and sharing. Moreover, the increasing need for preventive and conservative interventions on existing artefacts imposes the need for methods and tools to collect, store, compare, share and manage information on their past, present and future status.

Through paradigmatic cases, the aim is to provide a working methodology that on the one hand highlights the interdisciplinarity of the BIM system and on the other shows the complexities of the built environment. We are talking about HBIM, or Heritage Building Information Modeling, the modeling applied to our heritage.

Methodology

The research is divided into several phases described below:

STEP 1: Research and cataloguing of historical heritage architectures.

In this phase we want to research and catalogue some buildings of our historical heritage, in which BIM modelling becomes essential.

STEP 2: Paradigmatic case studies.

In this phase we want to model paradigmatic case studies in BIM environment.

The aim is to provide an accessible and easily updatable information model of buildings that are part of our cultural heritage. The next step is to hypothesize an energy recovery.

STEP 3: Synthesis of results.

The aim is to highlight the critical points of modelling, given by the not always evident geometric recognition of space in the built environment. Moreover, the choices that led to the definition of the different energy requalification techniques will be highlighted.

A common element will be the definition of a protocol that summarizes all the phases of elaboration and becomes a model for the study of cultural heritage.

Expected results

The experimentation is based on the search for a method based on a general procedure applied to particular cases. Following the recognition of serial and repeatable elements and the rules (geometric, dimensional, etc. ...) on which to affect them, it is possible to translate the relationships between the parts into a digital parametric logic, valid for each case dealt with. The parametric modeling of components of the architectural heritage offered by a complex information system such as HBIM, allows an acceleration in the construction of 3D models and that takes into account the architectural quality of each element, highlighting the differences and critical issues, as well as the different methods of reclamation.

Bibliography

Bianconi, F., Filippucci, M., Amoruso, G., Bertinelli, M., (2019). *From the integrated survey of historic settlements to the pattern book within the BIM.* In INTERNATIONAL ARCHIVES OF THE PHOTOGRAMMETRY, REMOTE SENSING AND SPATIAL INFORMATION SCIENCES, XLII-2/W9 pp. 135-142.

Dejaco, M.C., Revolti, A., Moretti, N., (2019). *A BIM approach for small construction sites,* CIB World Building Congress 2019 Constructing Smart Cities, Hong Kong, ISBN 978-962-367-821-6

Attenni, M., Rossi, M.L., (2019). *La modellizzzione del patrimonio costruito. Processi BIM a confronto per le tipologie architettoniche.* In Disegno, 4/2019.

Chiabrando, F., Sammartano, G., Spanò, A. (2016). *Historical Buildings Models and their handing via 3D survey: from points clouds to user – oriented HBIM.* In The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLI-B5, XXIII ISPRS Congress.

Bianconi, F., Filippucci, M., (2019). *Il possibile ruolo dell'università nella rivoluzione BIM. Esperienze di trasferimento di conoscenze e formazione nel territorio umbro.* In T. Empler, A. Fusinetti (a cura di). 3D Modeling & BIM Modelli e soluzioni per la digitalizzazione, pp. 358-379. Roma: Tipografia del Genio Civile.

Costa, G., Madrazo, L. (2015). *Connecting building component catalogues with BIM models using semantic technologies: an application for precast concrete components.* In Automation in construction, n. 57, pp. 239-248.

Marotta, A., Lo Turco, M., (2014). *Modellazione 3D, ambiente BIM, modellazione solida per l'Architettura e il Design.* In M. Rossi, A. Casale (a cura di). Uno (nessuno) centomila prototipi in movimento. Trasformazioni dinamiche del disegno e nuove tecnologie per il design, pp. 53-60. Milano: DigitalPrint Service.

Quattrini, R., Pierdicca, R., Morbidoni, C. (2017). *Knowledge-based data enrichment for HBIM: Exploring high-quality models using the semanticweb.* In Journal of Cultural Heritage, n. 28, pp. 129-139.