

buildingSMART International (2022)

455-PROFESSIONAL Professional Research using openBIM

STATE OF PRESERVATION DOMAIN TO DOCUMENT EXISTING AND HISTORIC BUILDINGS



ZnWJaVve

Entrant details

Role or Job Title on the Project | Researcher

Employer

| University Federico II of Naples

Employer Role | Academic or Research Institution

Are you or your employer a member of buildingSMART? | No

Entry details

Entry Details

By checking this box I understand and acknowledge that this awards program is to assess information about openBIM, and that openBIM is not only about the use of solutions. openBIM is about setting up an environment where every party in a team can work in the optimal way ("how they prefer") without putting limitations on others.

It is about freedom to take control over your data and workflows, while keeping that freedom for others as

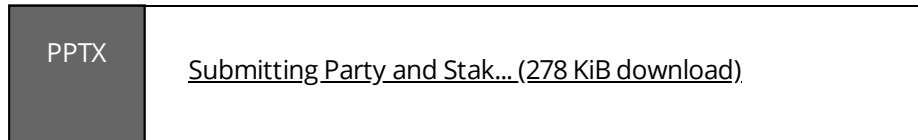
well. Full use of open standards is not mandatory for this mission.

Location

Department of Architecture, University Federico II of Naples, Via Forno Vecchio, 36, 80134, Napoli, Italy.

ACCA software S.p.A., Contrada Rosole, 13, 83043, Bagnoli Irpino, Avellino Italy.

Submitting Party and Stakeholder Logos (compiled into one .ppt/pptx file for upload)



Entry Description

The application of BIM to architectural heritage and therefore the parameterization of its elements show a certain complexity, because the historical built environment must be subject to systematic readings, in order to detect an information system based on ontologically defined elements, which must be associated with data able to document their material, historical and constructive peculiarities.

H-BIM, understood as Heritage or Historical BIM or, more generically, E-BIM understood as the application of BIM to the Existing built environment, is an area of interest for many researchers due to its complex theoretical and applicative implications.

The objective, in the field of BIM applied to construction, is to identify appropriate procedures that are able to translate the complexity of reality, without losing the specificity and uniqueness of the individual case.

Obviously, such systems need reliable document bases capable of restoring the metric and material determinations of the artefact but, above all, its state of preservation.

It is well known that there is no possibility of automatic semantic enrichment of these data in BIM models. It therefore seems opportune to identify knowledge systems that guide operators and fully exploit the information potential of BIM also for historical buildings.

In fact, in cognitive investigations, in addition to the definition of shapes and dimensions, it is important to record a great deal of information on structural and material conditions. To do this, it is necessary to recognise the various pathologies - understood as degradations and alterations - that may affect building parts and building materials, through the analysis of signs and symptoms. A correct formulation of the pathological picture is indispensable to plan or carry out design interventions aimed at safeguarding the building over time.

To date, there are no BIM tools designed specifically for the specific characteristics of historic buildings. Although some BIM authoring software provides specific functions for graphically documenting degradation data, there are some critical issues regarding the way in which non-graphical information is structured with a view to its full sharing between different users and skills.

The absence of univocal solutions and the management of data bound to specific proprietary platforms are in fact a limitation in the proper transmission of information.

Furthermore, the operational complexity connected to the mapping process of degradation and alteration phenomena does not allow the application of automatic procedures in the recognition of the material characteristics of artefacts. Therefore, it is desirable to use systems that tend to standardise the process of documenting the state of conservation of architectural artefacts in H-BIM systems in order to determine a single and shared approach among the various professionals working in the field.

The aim of the presented project consists in structuring a domain standard for the documentation of the state of preservation of existing artefacts. Its definition relates the type of material analysed to the different pathologies that may affect it and, through the operational activities carried out in the field of the survey, it specifies the documentation in order to support the decision-making processes of intervention.

The aim is to give rise to a common language developed in an openBIM perspective, supporting AEC operators and facilitating public administrations/contractors in validating an H-BIM product with respect to the information content it must possess for projects, interventions and the management of existing artefacts. Furthermore, the information is structured

through a precise codification that makes it interpretable even by artificial intelligence, thus facilitating and optimising the entire information mapping process.

WHAT THE PROJECT DOES:

The usBIM.bSDD application made available by ACCA software was used to create the 'state of preservation' domain with related classes and properties, according to the buildingSMART Data Dictionary (bSDD) - an online service that hosts classifications, standards, dictionaries and related properties, permitted values, units and translations.

The workflow was subsequently applied to the documentation of the state of preservation of the Church of San Pietro in Vinculis (Naples, Italy), as a representative artefact of the assets of historical interest to be known and safeguarded. The workflow realised for the experimentation was born in Italy due to needs strongly rooted in the national fabric, since the country is very attached to its history and to the preservation of its architectural heritage. It is in fact based on the use of nomenclatures, data and definitions deduced from regulations, technical recommendations and modus operandi already consolidated in Italy.

WHY IT IS OPENBIM:

The entire project has been implemented with openBIM standards and methodologies, using exclusively non-proprietary open formats, to guarantee an interoperable and collaborative workflow, free of any technological constraints or limitations related to the use of specific software or formats, guaranteeing data quality and information consistency.

End users of the bSDD can check the validity and conformity of data, can work on their own BIM freely, implementing the necessary data and without binding others.

A standardised workflow is therefore proposed that is consistent with the openBIM concept in that it provides constant control over information and workflows within a rigorous methodology.

INNOVATIVENESS:

The 'buildingSMART Data Dictionary' (bSDD) is a library of object concepts and related attributes based on the IFD standard (ISO 12006-3). It is used to identify objects in the built environment and their specific properties regardless of language. The bSDD is open and international and enables designers, builders and owners, but also manufacturers and suppliers, to share and exchange product information. The bSDD reduces costs and improves the quality of the construction process because it offers definitions, classifications and object libraries that are shared, reusable and available for all software, worldwide according to openBIM standards and methodologies.

With this in mind, it was decided to define the domain on the state of preservation, encoding the different pathologies that afflict the built environment in appropriate classes, characterised by attributes that decline them in their own specificities.

By associating the information structured in this way with the elements of the IFC model, each documented pathology acquires its own significance, increasing knowledge through data that are appropriately organised in this approach.

What stage of completion is the entry content representing? | Beta Testing Stage

Stakeholder Statements

- Researchers, managers and operators of the built heritage;
- Administrative authorities;
- AEC operators (Architecture, Engineering and Construction);
- Software house.

In particular, ACCA software S.p.A.:

ACCA software is actively engaged in numerous and various initiatives and projects aimed at supporting the digital transformation of the construction sector, through the application of revolutionary and disruptive technologies and innovations, typical of the digital world, with a strong potential for growth on new national and international markets. ACCA carries out activities for the promotion and dissemination of innovation practices in the processes of "digital transformation" in companies, declining the term innovation not only on a technological level, but also on a strategic, social and environmental level. The projects and initiatives, both completed and in progress, therefore want to contribute to providing companies in the engineering and construction sector with useful digital tools to face global challenges and digitization processes of their business, support growth processes and development paths aimed at the transition from

traditional methodologies and processes to the most recent digital alternatives aimed at improving and optimizing the entire construction process.

The industrialization of the construction process requires a high level of automation; it is a challenge that can only be faced with a openBIM (Building Information Modeling) process, using software tools that allow the workflow to be managed in a unified and global manner.

Therefore, to favor the passage of the construction world from the traditional sector to the digital and industry 4.0 era, and in particular to favor and promote the introduction of BIM and openBIM in the construction process, which is revolutionizing the construction world forever.

Upload a 2 minute video to show the scope of the entry.



Problem Statement

In the context of activities involving the existing architectural heritage, documentation of the state of conservation of the materials of which it is composed is fundamental and unavoidable. In fact, the choices regarding the methods of intervention depend on a precise knowledge of the pathologies of decay affecting the artefact and its materials.

The analysis of these pathologies and the relative degree of extension/development contributes to defining possible diagnoses, as well as the greatest urgencies, and guides operational choices in the maintenance, conservation, restoration and management of the architectural heritage. It is clear, therefore, that it is fundamental to identify unambiguous methods for the documentation and representation of degradation and all related information, in order to avoid misunderstandings and make the documentation produced effective - in design terms. Very often, in fact, there are some ambiguities that derive from the fact that the documentation of the state of preservation may be limited solely to graphic representation. Instead, it is a survey operation that must be conducted with logical rigour and systematicity so that the resulting representation is objective and explanatory of a univocally recognised state of affairs.

The challenge that the project intends to address is to achieve this univocity of information, proposing an operational workflow and a standardised organisation in the structuring of data on the architectural heritage with reference to the state of conservation/preservation of the materials of which it is composed, in support of the valorisation and management of artefacts of historical-architectural interest through shared digital documentation procedures.

Previous efforts and limitations

In traditional documentation processes, information on degradation pathologies is made explicit through their representation in two-dimensional technical drawings created in a CAD environment with the support of orthographic images of the artefact under investigation. These representations, which at one time replicated the phenomenon in the drawing in a mimetic manner, were subsequently replaced with special screens, codifying the information and making complex mappings of the various forms of alteration or decay possible. The graphic indications are also usually associated with data sheets, sometimes pre-filled, detailing the knowledge acquired through visual surveys or specific instrumental applications. The sheets make it possible to add information that the CAD drawing would not be able to make explicit, such as the type of mechanism, climatic conditions, the results of chemical analyses, data that is certainly useful, but which are totally unrelated to the representation.

Although this operative practice allows for a complete mapping of the state of conservation, knowledge of it is still linked to a few two-dimensional representations, which are not always such as to make the phenomenon understood in its entirety. In this way, in fact, the overall vision is limited to the definition of a few views, also affecting the understanding of those decay that develop on different planes.

In BIM systems, the issue of documenting degradation also deserves specific attention. In fact, although there are unquestionable advantages in the management of processes and, above all, in the constant relationship between graphic and informative data, a rigorous and shared methodology for documenting the state of preservation has not yet been introduced.

Some research focuses on the geometric representation modes by taking advantage of the three-dimensional characteristic of the model and the semantics underlying object-oriented modelling. Through a previous research carried out by the team

belonging to the University of Naples Federico II in collaboration with ACCA software, for example, specific tools were identified to implement the BIM modelling software Edificius with specific functions for mapping alteration and decay pathologies in 3D directly on the BIM model, guided by data from three-dimensional reality-based acquisitions (point clouds and orthophotos).

By overcoming the limitation of the orthophoto view, in fact, the quantification of the surface affected by a specific pathology is no longer limited to an areal zoning relative to a single point of view but, rather, is able to return the total value following the real trend of the phenomenon. The relationship established between the architectural element and the pathology, moreover, allows a greater clarification of the phenomenon with reference to the parts of the building, going beyond the mere visual representation.

Beyond Edificius (ACCA's BIM authoring software), in many BIM modelling platforms, the modelling of degradation pathologies is often only achievable through compromises, artifices and arbitrary adaptations of tools originally designed for other purposes.

In any case, even if one overcomes criticalities from a graphical point of view, there is still no homogeneity in the results in terms of information implementation and related interrogation, thus rendering modelling efforts partly in vain.

In this regard, the research of which this contribution is the subject was concerned with the structuring of an operational workflow aimed at identifying standard and openBIM procedures for the informative classification of the state of preservation of artefacts, with a view to making it possible to share the information collected by the operators in a homogeneous manner, making it accessible without the risk of incurring ambiguous readings.

Research method

The digital analysis of architectural artefacts in BIM is strongly based on semantics that encodes the relationships between forms - and thus the digital representation of the building and its parts - and information data - mostly heterogeneous and pertaining to different sectors.

The workflow implemented takes this double value into account in the definition of the identity characteristics of the model, concentrating, in particular, on the possibility of providing a systematic application support for the univocal and shared documentation of the state of conservation of the material surfaces, in order to support decision-making processes in maintenance operations through a precise organisation of knowledge.

Specifically, the work team collected the indications and documentations of proven validity that constitute the major references in Italy on the subject. Alongside this, it took on board the observations and technical suggestions of professionals and academics from the AEC world in order to achieve the transposition into openBIM of the parameters useful for verifying the state of conservation of material surfaces according to procedures in line with professional practice. In this way, the individual pathologies to which an architectural artefact is usually subject have been defined, distinguishing Alterations from Decays: the first describe a change that has taken place in a material that, while changing some of its characteristics, does not necessarily jeopardise its preservation (a typical example concerns the chromatic variation due to exposure to sunlight); the latter concern gradual processes that lead an architectural or structural element to lose its characteristics of form, resistance, reliability and durability, until it becomes unsuitable for the function for which it was originally intended.

For each alteration and each decay, the properties and variables necessary to characterise the specific case under investigation have been codified. The latter start with the identification of the general characteristics that contextualise the pathology (date of documentation, presence of previous interventions, nearby polluting sources, exposure to water sources, climate, etc.); they continue with the more exclusive properties so that the specific case can be better circumscribed (size, colour, mechanism, typological specificity, morphology, etc.); they conclude with an initial suggestion for intervention, i.e. offering operators the possibility of providing a preliminary estimate of the type of intervention that the symptomatology suggests. In the latter case, the critical historical value gradient relative to the relationship between the pathology and the evolutionary history of the artefact was taken into account, in consideration of the more conservative restoration theories. All this constituted the 'state of preservation' knowledge domain, formalising the related ontology in Classes, Relationships, Properties, Restrictions and Instances.

Using the bSDD - buildingSMART Data Dictionary, the properties of the elements representing the pathologies (alterations and decays) of an IFC model were quickly edited, generating a new, further computerised IFC file.

In a nutshell, the workflow performed consisted of the following steps:

- 3D graphical mapping of decays and alterations in a BIM model using ACCA's BIM Authoring software 'Edificius';

- export of the model in IFC format;
- in-depth study of existing prescriptions and indications concerning the documentation of the state of preservation of building materials;
- identification of typical materials of buildings of historical interest (stone materials, wood, metals);
- identification of pathologies divided into alterations and decays;
- identification of the properties and parameters required to define individual alterations and decays;
- systematisation of information into classes, subclasses, properties and property sets in usBIM.bSDD;
- export of the .json file and validation in bSDD;
- application of the "Conservation State" domain to the IFC model through the usBIM cloud and the specific tool usBIM.bSDD;
- verification of results with an IFC viewer.

Findings/Validation

By following the bSDD guidance on .json files and using the "editor" functionality of usBIM.bSDD it was possible to create the classification and properties related to the "State of Conservation" of the materials of a building, and to associate the corresponding properties to each identified class.

The connection to the bSDD via usBIM.browser made it possible to associate the classification with the IFC model of the Church of San Pietro in Vinculis, a church in Naples (Italy) affected by numerous degradation phenomena, the analysis of which provides documentation of enormous support for the integrated planning of maintenance and restoration work. Intervening directly on the model in IFC format, a series of identifying attributes (classes, properties and corresponding values) were associated with the representative objects of degradation previously modelled using the ACCA Edificius BIM Authoring software. In addition, using special tools of the tool developed by ACCA, it was possible to highlight the elements of the IFC model by classification type, to support the process of verifying the status and correctness of the compilation. In conclusion, the modified and updated IFC file was consolidated and saved on the cloud.

The result of this implementation in the documentation of the artefact made it possible to obtain a useful tool to support the designer for a correct sharing and exchange of information aimed at defining the state of conservation of the architectural asset functional to the subsequent identification of the building intervention.

The work process validated by this project has made it possible to devise a "state of conservation" classification structure that will be able to suggest to the professional how to intervene on an artefact, taking into account the pathologies from which it is affected and relying on a precise organisation of the information determined by the survey investigations. In fact, the various technical (causes/effects), constructional, environmental, atmospheric and material aspects (whose identified properties are a synthetic and significant expression) have been organised to identify the building's state of conservation in an overall view, from which the design of the intervention will derive.

The user can therefore modify and update IFC models with specific classes and properties, using buildingSMART Data Dictionary (bSDD) according to standardised workflows, with obvious advantages in terms of data quality and reliability.

Conclusion/Contributions/Limitations

The contribution aims to contribute to the development of openBIM solutions that facilitate the work of professionals and administrations in the management of existing architectural heritage, especially if of historic-artistic interest. The identification of standard procedures for documenting the state of preservation is fundamental so that there are no misunderstandings and misinterpretations of data. The work presented is still in the development phase and needs further study in the definition of classes and properties in order to cover a sufficiently wide range of situations encountered in professional practice, taking into account the symptoms and intrinsic characteristics of existing materials and construction techniques.

Example Use

Software Ecosystem Map

PPTX	software map.pptx (290 KiB download)
------	--

Process Maps

PPTX	process map.pptx (358 KiB download)
------	---

openBIM Data Metrics Summary

PPTX	metrics.pptx (43 KiB download)
------	--

Upload .ifc file(s) or other technical files to support validation of the research results.

<https://service.usbim.com/link/62a074e68df9e6d234e5e875>


Use Cases

I agree to be contacted for more information about the project BIM uses outside of this awards program.




Documentation on use case(s) as a single file upload

Log in to awards.buildingsmart.org to see complete entry attachments.



1_TITLE OF PROJ... 365 KiB

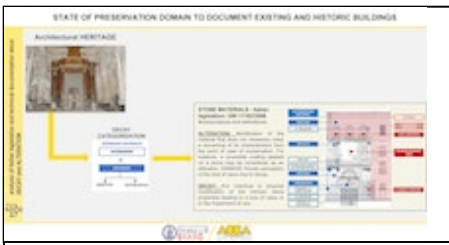

2_ANALYSIS OF... 769 KiB


3_BSDD EDITOR... 365 KiB


4_UPLOADING I... 339 KiB


5_CONSULT IFC... 264 KiB


6_PARTY OF PRO... 268 KiB



2 ANALYSIST OF... 1.2 MiB

