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# THE DOCUMENTATION OF CULTURAL HERITAGE WITH BIM OPEN SOURCE SOFTWARE

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**Abstract:**

The Building Information Modelling (BIM) software enables the users to communicate and design, understand appearance, performance and cost in the spatial and urban design process. Another important use of the BIM technology is the documentation and 3D reconstruction of cultural heritage monuments. The appropriate BIM software equips the users with tools to easily capture and analyse concepts and maintain the coordination of design data through documentation and 3D modelling. Many developments come up in the BIM field and software industry for design, construction-reconstruction, restoration and management of the cultural heritage 3D models, using BIM tools; mainly commercial as well as free or open source. Nevertheless, recently the growing popularity of open source has altered the landscape in software industry, as they attract many users.

This paper presents a review of some recent research on the topic. We review the recent developments focusing on the OSS that can be used at various stages of BIM process in the digital documentation of cultural heritage. The results show that there is more preference in the commercial software due to the fact that the OSS is not yet complete and covers all stages of the BIM process. However, lately we have the Edificius in architectural BIM design and "BIM Vision" as Industry Foundation Classes (IFC) model viewer that try to attract as many users as possible. These tools are free and they could well be used for the digital reconstruction of cultural heritage.

**Key words:** BIM, cultural heritage, digital documentation, open source software, free software, 3D modelling

## 1. Introduction

Over the last few years, in architecture, engineering and construction (AEC) industries, an increased use of specific software that processes building information models for visualisation of construction projects is observed. These are BIM tools and, nowadays, make it possible to preserve cultural heritage. Using modern modelling tools, such as ArchiCAD, Revit Architecture, Allplan Architecture etc., the models produced by the users have evolved from traditional 2D drawings and written specifications to parametric object oriented 3D models, embedded with information to describe any historical structure in detail (Singh *et al.* 2011).

As a digital visualisation of the functional and physical characteristics of the structure, BIM serves as source of information supporting many applications along the processes of visualisation or reconstruction, including structural analysis, cost estimation and specification management. In addition, BIM concept fosters the use of real time visualisations as a tool to communicate concepts and sharing information between stakeholders in a cultural heritage project (Eastman *et al.* 2008).

Nowadays, software developers have created many BIM tools dealing with various categories of historical structures information, such as the representation of cultural heritage. Mainly, these tools are quite expensive and inaccessible. This reason led the users to face major challenges; to choose what tools they can use, in which construction/restoration activity and how to use them effectively.

This paper explains the BIM software that used for collecting, processing data, parametric modelling, and evaluating the historic model across the process to finalise a cultural heritage project. We emphasise on free and OSS that are more affordable and customisable to the end-users needs.

## 2. BIM software groups

The BIM models include both geometric and non-geometric data such as object specifications and attributes. The creation of these models enables the various project participants (architects, conservators, engineers, etc.) to visualise the activities progress. This project management technique with BIM tools has the potential to improve management and delivery of the

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digital documentation, concerning any size or complexity of a cultural heritage object (Singh *et al*. 2011).

In the case of cultural heritage documentation, the objects consist of components and materials whose geometry and characteristics are not represented by libraries of typical software and thus there is a need to introduce the Historic BIM (HBIM) approach (Logothetis *et al*. 2015). HBIM is the process by which the architectural elements collected using a terrestrial laser scanner and photogrammetric survey data are converted into parametric objects (Dore and Murphy 2012).

The BIM tools are distinguished into 3 basic categories depending the licence that is a legal instrument governing the software use. The tools categorised into commercial, free and open source software (FOSS). Moreover, depending on the software use and purpose, these can be categorised into 3 types: visualisation software (authoring tools and viewers), tools for file sharing-collaboration (BIM Servers) and analysis tools.

### 2.1. BIM visualisation software

This category concerns all the tools which enable the users to provide a 3D virtual representation of the cultural heritage objects. These tools can provide renderings, walkthroughs, and sequencing of the model for better understanding of what the final structure may look like. The software divided into BIM authoring tools and BIM viewers.

“BIM authoring tools” are specific programs that allow users to produce structural models that consist of parametric objects for creating the actual model. They also include all the tools that are used during the design phase until the documentation (Eastman *et al.* 2008).

On the other hand, “BIM viewers” are programs that can access data connected to the BIM structural model without the need to extract the entire model. The most common file used is IFC developed by buildingSMART (http://www.buildingsmart.org/) in order to provide an interoperability solution between different software applications. (Eastman *et al.* 2008).

### 2.2. File sharing and collaboration tools

As a collaboration platform, a BIM Server manages, archives building data, and allows applications to export and import files from the database for checking, viewing, modifying and updating the data model. BIM Servers allow exchange 3D model data between the various applications involved in a BIM project life cycle including analysis tools, design tools, Facility Management (FM) tools, Document Management Systems (DMS), etc. (Singh *et al.* 2011).

### 2.3. BIM analysis tools

“BIM analysis tools” are programs used for the model behaviour analysis and also for the model validation to be compliant with specific standards. Normally, these tools are used in the preliminary design phase until the construction phase or the final 3D reconstruction (Quattrini and Baleani 2015). These tools are useful when a partial repair or reconstruction of a historic monument is needed.

## 3. OSS and free software solutions

OSS means that the source code, i.e. any group of computer instructions written using a human-readable computer language, is freely accessible by everyone interested in. The software can be freely used, improved, changed, copied and distributed by anyone and for any purpose (Statskontoret 2003).

In the field of cultural heritage documentation used mainly "3D BIM viewers" FOSS in most research papers. San Jose *et al.* (2013) used CityGML, an open standard data model which based on geometry, for representing 3D urban objects. Saygi *et al.* (2013) used Trimble SketchUP for the creation of 3D models, BIMserver as a platform to handle IFC data and OpenBIM for attribute data enrichment, related to building elements, zones or complete buildings. Zheliazkova *et al.* (2015) used Grasshopper 3D a graphical algorithm editor integrated with Rhino’s 3-D modelling tool. Moreover, they used MeshLab an open source system for the processing and editing of unstructured triangular meshes, which also deals with automatic 3D reconstruction.

### 3.1. Benefits of using FOSS

According to Peeling and Satchell (2001), open source and free software holds several fascinating advantages: (a) Cost. The first perceived advantage is the fact that FOSS is made available cost-free or at a low cost. Unlike most commercial packages that are expensive enough and inaccessible for many businesses; (b) Quality. OSS is closer to the professional users’ needs. A developer, who is also a BIM program user, can create what he/she wants; (c) Customisability. The availability of the source code and the right to modify it is of high importance. In fact, it enables the unlimited software improvement or the addition of new abilities. (d) Freedom. With FOSS, the users make their own decisions and do what they want with the software, to suit their individual needs.

### 3.2. Limitations in working with FOSS

In the last few years, the development of FOSS for BIM has expanded and the use of FOSS tends to be consolidated due to their advantages and the freedom that provide. However, it is possible to present some limitations when someone chooses to use this software category in some cases such as: (a) They are often intractable; because less attention is paid to the development of user interface and as a result they become less “user-friendly”; (b) Sometimes, there is data incompatibility; (c) It requires programming skills and expertise for the customisation of the application; (d) There may also less support available and there is no also a user manual; (e) Although the OSS is mostly free, there may still be some indirect costs involved, such as paying for an extra feature; (f) Small companies may not have software skills or resources to work with a few of the more complex OS BIM programs or toolkits.

## 4. Edificius and free software

Free BIM software is computer software that gives the users the freedom to run the program for any purpose. Edificius is free BIM software and can be used in cultural heritage documentation projects (ACCA 2015). It is a

professional architectural, engineering and bill of quantities/estimating software. The user can use for free the full featured program version for architectural BIM design and must pay only when there is a need for printing. Projects and professional collaborations are possible to be shared with every user; all data is stored in a single file that anyone can open.

## 5. OSS selection and future development

The OSS that we selected for future development is an IFC model viewer, the "BIM Vision" from Datacomp (BIM Vision 2011). It can be used for providing documentation of cultural heritage projects. Is a freeware IFC model viewer that allows viewing the virtual models coming from BIM systems like Archicad, Revit, Bentley, etc. (Kogut 2015). The main reason "BIM Vision" was chosen for further development, is the ability to create plug-ins that allows extension to the existing functionalities and integration with other applications. Some of the future investments in the software "BIM Vision" could be: (a) adding support for extra file types e.g.Trimble SketchUp (.skp) models; (b) exporting individual cultural heritage data files such as walls, floors, areas etc. (c) running conflict checks of the different project's parts.

## 6. Conclusions and discussion

This paper presents a review of the BIM FOSS used for the documentation of cultural heritage. The goal of this study is to identify and encourage the users to use FOSS for HBIM processes. The complexity and diversity of HBIM technology is obvious in many fields and for this reason there are many specific software, mainly commercial that offers several possibilities to their users. However, in the field of open source there are no integrated platforms to cover all stages of HBIM process. The survey showed that the users prefer commercial software BIM instead of FOSS because there is not a program that can be used for the overall cultural heritage documentation. They use only a few "BIM Viewers" to visualise the final produced historical 3D model.

We reported Edificius and BIM Vision, and we focus on the second that provides all the necessary tools to create plug-ins to expand its capabilities. This is our plan for the next research phase; to build upon this existing platform using Python programming language to create specialised plug-ins.

Moreover, we discussed the benefits and limitations of using FOSS in comparison with commercial software. Nevertheless, there is a question; can we believe the information provided on the websites about the features and functionalities of the software from their manufacturers? For open source BIM software systems is easy for users to verify, by simply downloading and testing the application. For commercial software, despite the availability of trial versions, is a huge challenge as most trial versions usually have limited scope.

In the recent years, many technological advances have taken place in the field of HBIM software. However, in the field of OSS, there could be more growth in order to reduce the prices of expensive commercial solutions. Further, given the important function of plug-ins in different areas of the BIM software, it is important to create more, which could be freely available to a community of professional designers, architects, engineers and conservators for their utilisation.

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