



25-28 June 2016 Hotel Danubius Health Spa Resort Margitsziget****, Budapest, Hungary

Creative Construction Conference 2016

Evaluation of Maturity of BIM Tools across Different Software Platforms

Ing. arch. Robert Bouška*

Czech Technical University in Prague, Thákurova 7, Prague 6, 166 29, Czech Republic

Abstract

The paper is dealing with the evaluation of usability and readiness of information modelling tools on the most common operating systems (Windows, Linux, Mac OS X). Stages of BIM maturity and availability of building information modelling tools vary dramatically on these platforms. Products are often presented only through the lenses of marketing departments, which emphasize positives and do not indicate any shortcomings and incompleteness of their solutions. In some cases, BIM is just an empty marketing phrase. What is missing is a general and impartial comparison tool, which rates the degree of maturity and usability of these tools in practice. Paper compares the current software tools, especially in terms of usability in the building process. The list of attributes that mature software platform should accommodate was created. Evaluation criteria are determined based on specific needs of the various participants of the building process, which leads to the successful project completion and subsequent management of the lifecycle of the building. Results can help facilitate orientation in the field of available tools/methodologies and help the adaptation of BIM in the construction market.

BIM; building information modeling; evaluation; software;

1. Introduction

Building information modeling (BIM) is clearly the future. Right now many countries across the world are in different stages of adopting BIM into their legislation. Although the idea of information modeling in civil engineering is already known for more than three decades, it is still rapidly changing and evolving. In many ways it is still in the innovation stage, but the construction and civil engineering industries generally recognize the need for BIM and the potential benefits that BIM will bring. According to Mr. Barnes and Mr. Davies, there are certain perceived barriers that may prevent organizations from fully engaging with BIM. The first barrier is already mentioned readiness of BIM. The second is perception that training costs are high, the education requirements are unknown and the learning curve is steep. The third perceived barrier is that investment in new technology, hardware and software is needed, and the potential cost of that investment is not justified by the potential savings that may be gained at this stage. [1]

This paper is partially dealing with the first and partially with the third barrier. The list of attributes that mature software platform should accommodate was developed. This was used to determine state of maturity of the platform through particular selected tools.

At this point, there is no real definition what BIM is, and what it is not. Also it is hard to predict what it can become. There are already some conventional categories called “Levels” and movement from one level of BIM usage to another is referred to as BIM maturity. [1] These levels are as follows:

- Level 0 – It is not really BIM at all. It uses only 2D CAD files for design and production information.
- Level 1 – It uses 3D data to represent design. This level is also known as lonely BIM. At this level it may be that there are a number of designers, but each is working in isolation dealing only with his own model. Some standard data structure and formats are used. Also some separate stand-alone finance and cost management packages can be used. But never integrated in the general BIM model.

* Corresponding author. Tel.: +420-739-425-286; fax: +420-224-355-439.
E-mail address: robert.bouska@fsv.cvut.cz

- Level 2 – At this level are BIM advantages finally more utilized. Managed 3D format is held in separate BIM discipline software tools with data attached. Another significant characteristic is utilization of COBie (Construction Operations Building Information Exchange). The formalization of this information exchange necessitates the creation of agreed principles by which data will be shared and parties will cooperate as maturity nears Level 3. It may also introduce first steps towards construction sequencing data or cost information.
- Level 3 – At this level we work with fully integrated and collaborative real-time project model. This model is likely to be facilitated by web services. It will be compliant with emerging Industry Foundation Classes (IFC)/buildingSMART Data Dictionary standards. Hurdles to software interoperability will have to be overcome, as will infrastructure and legal obstacles. At this level BIM models will utilize construction sequencing, cost information, project life-cycle and other management information, and will be driven by the development of standard libraries of object data, which will include manufactures information. [1]

There is also other way to determining BIM maturity. This approach relates to model itself and is described simply by dimensions of model. In this case we can think of 3D model as a platform onto which are built other applications that may be used through the planning, design, construction and facility operation processes. [1] This way everything that has to do something with visual model itself can be categorized as part of 3D model. That includes model walkthroughs, project visualization, clash detection, virtual mock-up models, prefabrication and other information that has to do with dimensions and space itself.

The 4th dimension (time) provides for contracture planning, schedule visualization and management. The element of time helps to better determine critical paths and visually show the dependency of some sequences on others. Now model can also include some temporary components such as cranes, lorries and others.

The 5th dimension adds money (cost) to the picture. This also fully utilizes quantity take-offs. With such an information BIM can provide not just real time cost estimating, but whole life-cycle cost.

Some literature [1,2] also mentions 6th and 7th dimension which includes facility management tools that provides improved space management, streamlined maintenance. Some experts do not see a meaning in categorizing into these “virtual” dimensions. Therefore, there is also growing trend to refer to all the extended application using 3D base platform simply as an XD.

Other important issue that has to be mentioned in context of BIM software is its impact on risk management. [3] If platform that company operates on is not stable, it can create some serious threats. That is why proper evaluation before implementation of the platform is so essential.

Main objective of this paper is with use of defined criteria determine actual state of BIM maturity on various operating systems, that are commonly used on personal computers of today.

2. BIM maturity across software platforms

First step of the research was to determine what are current market shares of operating systems amongst desktop users. This helped to determine each platforms’ importance. For this step internet users’ data were used. [4] Research focused on trends for the last ten years. As we can see from the graph (1), Windows platform is registering sudden steadily decline. Its overall market share went from nearly 90% in 2006 to 79% in 2016. On the other hand, Mac OS X is still on the rise. This, in the eighties almost dead platform, is now reaching 10% of the market share. Unfortunately, this showed only general statistics. To do research focused solely on civil engineers and their preferences is not in the capacity of this paper. This graph also does not reflect some specific markets. For example, in U.S. market share for Mac OS X was towards the end of the last year close to 18%. [5]

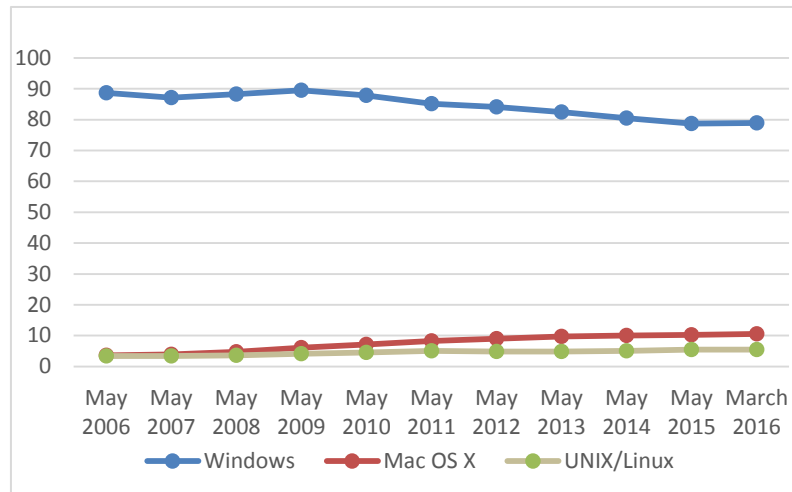


Figure 1: Graph of OS platform market share development since 2006 to 2016

The next step of the research was to define attributes of mature BIM platform. Based on generally recognized BIM levels (presented in the first chapter of the paper) and model dimensions (combined with user experience), the list of traits of mature BIM platform was created.

Mature BIM platform should provide:

- Openness, interoperability and compatibility – Software should allow wide range of data exchange. Must support import and export of IFC files and be able to support COBie. Also be able directly work with the cloud storage and offer advanced model sharing.
- Simplicity and functionality- Software should be easy to learn and understand.
- Accuracy of data – Tools should be able to give accurate information about the model. Very important are correct calculations of quantities from model.
- Expandability – Software should have option to work with 3rd party software plugins.
- Capable of advanced life-cycle and energy modeling – One of the very important requirements, since governments all over the world have pretty high goals on reducing carbon footprint. BIM tools will play crucial role in achieving that goal.
- Time management and clash detection – Tools should be able to visualize construction planning and dependencies as well as find collisions and solve collisions before the construction starts.
- Cost estimation – Software should work with the model and store data directly inside the model. It should be able to work on the fly and with respective accuracy give an overview of the expected project costs.
- Facility management – These FM systems should be able to fully utilize all the BIM data. It should help with managing day to day tasks of building maintenance as well as unexpected events.

These are in the nutshell currently known ways how to utilize building information models of today. It does not mean that people actually use all these features during the life-cycle of the building. Most projects of today are realized at BIM Level 0, 1 or 2. [6]

2.1. BIM on Windows operating system

Today it is the most used operating system family on the market. Therefore, it is logical that most software dealing with BIM is written for this platform. It is also benchmark for all the other platforms. We can find piece of software for all the features that were mentioned in the previous chapters. This paper does not go into details about all the functionality of mentioned software. More information about programs can be found through references.

There are three major tools for model creation. Autodesk Revit [7,8], Graphisoft ArchiCAD [9], Nemetschek Allplan [10]. There are also other design tools like Nemetschek Vectorworks [11], BricsCAD [12] and free tool Edificius [13] that are worth to mention.

As is apparent from Table 1., there is software tool for every category of listed BIM maturity level. Table is not even close to listing all of the BIM tools that exists for Windows platform. This is not the goal of the paper. Research is more focused on other two smaller platforms, in order to find out if they can compete in the terms of functionality and usability.

2.2. BIM on Mac OS X operating system

It is well known, that for a lot of artists and graphics designers is this a platform of choice. Some people prefer this platform over the other two because of its simplicity and user friendliness. Some programs for editing video and sound are even faster on this system than on the PC with same specification. Unfortunately, there is not as many solid software tools for architects and civil engineers. From Figure 1 is clear, that despite the fact that Mac OSX is still more and more popular, from developers' point of view it is still minor platform. Due to the fact that BIM software is highly specialized and development is fairly complex and expensive, there is not going to be any change soon. Overall on this platform dominates ArchiCAD, which was first developed for Mac and then for PC.

Despite what was said, there might be a version of Revit for Mac as well in the future. Since Autodesk revived its Autocad version for Mac in recent years.

Other types of BIM tools for this platform are unfortunately non existing. Most of those that you can use with Mac are web-based and they are not tied to certain operating system.

2.3. BIM on Linux/Unix based operating systems

Since Unix/Linux based operating systems are even more rare amongst civil engineers and architects, is situation with variety BIM tools even worse than on MAC OSX platform. The only tool that can be considered functional is BricsCad [12] from company called Bricsys. It would be naive to expect, that some company would invest their time and resource into developing software for platform, that has only 5% of the market share. The future of BIM on Unix based operating systems can come from community developers or universities. That is case of the B-procesor[14]. This software started as a university project developed by the Arhus School of Architecture in cooperation with the Alexandra institute. Unfortunately, it seems that since 2013 development of this software stopped. At picture below (2) there is example of typical B-processor layout. Right now you can use it to model just simple objects and shapes and assign some information attributes. This can be considered BIM, but it is far from actually useful tool. Since both BricsCAD and B-processor are written in JAVA, they are platform independent. That proves that they were not developed for the Linux platform itself, but its compatibility is given by the nature of their programing language.

There is still a segment where it might be interesting to develop BIM tools for Unix/Linux based operating systems. It is government. For example, French police and parliament migrated to Linux back in 2007. In was reported, that they saved over 50 mil. € on licensing fees between 2004 and 2008. [15] For this use of BIM you only need tools able to read BIM data. There should be no need for government clerks to be able to edit BIM data. At most they might need to revise and that is functionality that most of middleware BIM tools provide.

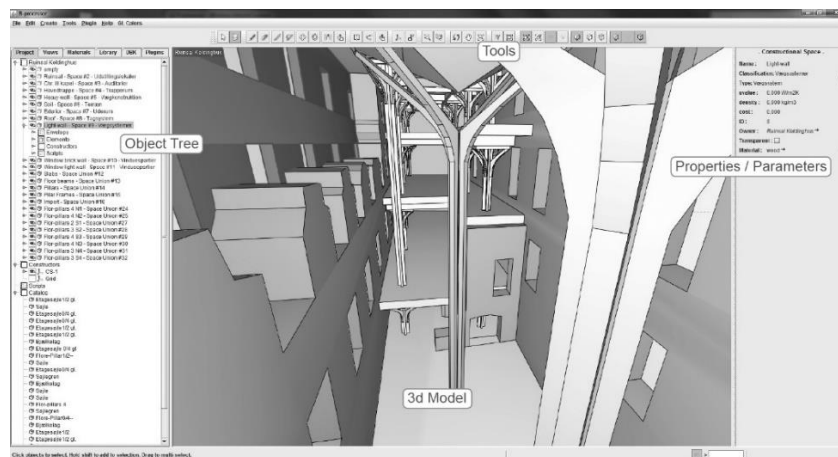


Figure 2: B-processor

Table 1. Maturity of BIM across software platforms

Types of BIM tools / Platform	Windows	Mac OS X	UNIX/Linux
BIM modeling tools	Revit	ArchiCAD	BricsCAD
	ArchiCAD	Vectorworks	B-processor
	Vectorworks	BricsCAD	
	BricsCAD		
Clash analysis	Navisworks		
	BIMSight		
	Solibri Model Checker		
Structural analysis	Revit		
	Scia Engineer		
Construction scheduling	Navisworks		
Energy analysis	Revit		
Quantity take-offs	Navisworks		
	Sigma estimates		
Cost estimating	Sigma estimates		
	Vico systems		
Middleware BIM Tools	Onuma	BIMx	Onuma
	4projects	Onuma	4projects
	BIMx	4projects	BIM+
	BIM+	BIM+	
FM software	Autodesk Revit	Archifm.net	Archifm.net
	Allfa		
	Archibus		
	Archifm.net		

3. Conclusion

This paper is focused on analyzing BIM from the perspective of operating systems. In conclusion results were as expected. BIM is still dominated by Windows platform, for which most of the software is written. Level of maturity on Windows is really high. There is still a lot of tools, that are often not fully utilized by most of the BIM adopters.

Situation on other two researched platforms is quite similar to each other. We can find few BIM design tools, but more specialized applications of BIM are missing. We also established, that Unix/Linux platform has its place at the government level. It would be beneficial for clerks to have option to use some free alternatives to payed software, since it would save money of tax payers and help accommodate BIM model as a part of procurement.

Follow-up research will be focused more closely on utilizing BIM in cost estimating. There is still a lot to accomplish at this field of research.

Acknowledgements

This work was supported by the Grant Agency of the Czech Technical University in Prague, grant No. SGS16/019/OHK1/1T/11.

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