Nat. Volatiles & Essent. Oils, 2021; 8(5): 4268 - 4277

NVEO
Natural Volatiles & Essential Oils

An Extensive Comparison between Architectural Software's of ArchiCAD® and Revit®

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Abstract:

Building information modeling (BIM) has been introduced to meet the complexity and productivity requirements of projects. The increasing demand of construction industry generates a pressure on the architects from different perspectives such as; 1) time, and 2) cost. This led some developers to implement the building information modeling (BIM) in their software which helps architects to generate more accurate, reliable, and informative 3D model. It also facilitated the integration of the model with scheduling and cost control processes. This study aims to compare two BIM software; ArchiCAD® and Revit® from an architectural perspective in order to identify the best software in term of users' satisfaction.

Keywords: Sustainable development goals, unemployment, corruption perceptions index, global hunger index, extreme poverty.

INTRODUCTION

The National Building Information Model Standard Project Committee has the following definition: "Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition" [1]. Royal Institute of British Architects (RIBA) has a different definition of BIM as follows: "Building Information Modelling (BIM) is the process of generating and managing data about the building, during its life cycle. Typically BIM uses three-dimensional, real-time, dynamic building modelling software to increase productivity in the design and construction stages" [2]. The National Institute of Building Sciences defines the BIM as: "The organization and control of the business process by utilizing the information in the digital prototype to effect the sharing of information over the entire life-cycle of an asset. The benefits include centralized and visual communication, early exploration of options, sustainability, efficient design, integration of disciplines, site control, as-built documentation, etc. – effectively developing an asset lifecycle process and model from conception to final retirement" [2].

There are no significant differences between the three aforementioned definitions. They agreed that BIM

is upgraded information of the standard 3D modeling with digital sharing of information during the life cycle which facilitates the effective development of an asset from earliest conception to its demolition. In conclusion, BIM software is capable of representing both the physical and intrinsic properties of a building as an object-oriented model tied to a database. The BIM can be used in different industry with a wide range of users. The BIM can be used in different level of the project such as; Architect, Design, Management, Operation and Maintenance, Drafting (as built). The uses of BIM during the life cycle of the project can be classified into: 1) primary uses and 2) secondary uses as shown in the below Figure (Figure 1). The primary uses of BIM includes; existing condition modeling, cost estimation, phase planning, programming, site analysis, design authoring, structural analysis, lighting analysis, energy analysis, 3D coordination, site utilization planning, 3d control planning, record model, maintenance and scheduling, and building system analysis. The secondary uses of BIM includes; design review, mechanical analysis, other engineering analysis, LEED evaluation, code validation, construction system design, digital fabrication, asset management, space management or tracking, and disaster planning [3].

In this paper, the authors have been studied the current trends of architectural software industry. It should to determine which the best software and to make it easy for users to let them know what the best software is for them depending on their requirement and project. Needless to say that projects complexity and the number of available BIM software are continuously increasing which generate the urge need to a comparison among this different software in order to select the best software. This comparison introduces several factors affect the efficiency of the software to meet the architect's needs. The comparison made from three fronts: 1) common advantages, 2) common limitations, and 3) identified factors. This study develops a comparison method based on the weighted average method and the identified factors from literature review. This method aims to calculate each software score taken into consideration the identified factors. The developed method 3 can be considered as a decision support tool and can be applied to compare other software. The application of the method shows that ArchiCAD® has an advantage over Revit® in respect to the identified factors and the evaluations of these factors by experts from different perspective. Finally, a case study was conducted using ArchiCAD® and Revit®; to demonstrate the results and to show the reliability of proposed method.

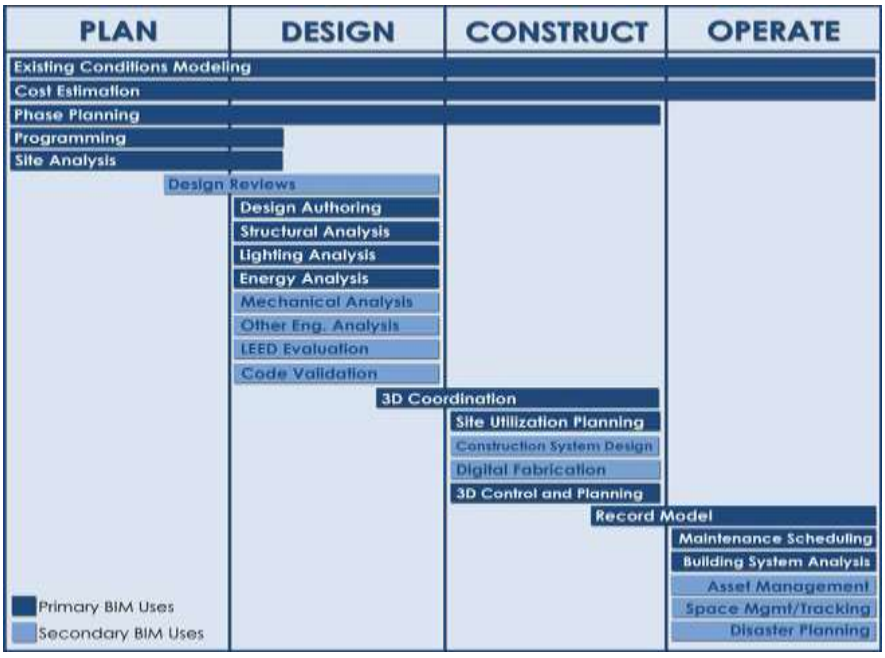

Fig 1: The Use of BIM during Project Life Cycle.

These twenty five areas (Figure 1) can benefited from application of BIM however BIM is not implemented fully in the current practice. The chart below (Figure 2) shows a comparison between the frequency of use the BIM in each areas and the potential benefit of using BIM in it

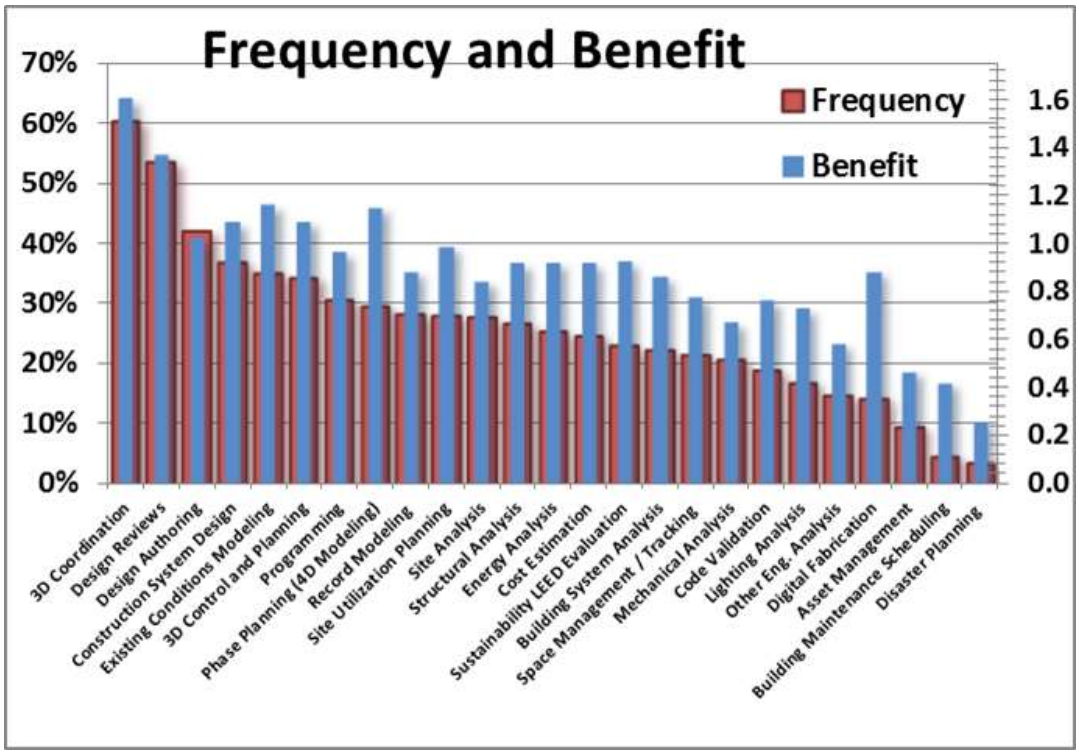

Fig 2: Comparison between Frequency of BIM Application and Its Potential Benefits.

As shown above, the development of BIM has an advantage over its implementation in all the areas except the design authoring. This means that the implementation should be increase in the industry for all the other areas especially the ones have wide gap between implementation and development such as: digital fabrication. The 3d coordination and design reviews areas have the optimum application of BIM in respect to its implementation and development.

The focus will be more on the BIM application and benefits from an architectural perspective. It also addresses the implementation of BIM in the architectural software such as: Revit® and ArchiCAD®.

II. ARCHITECTS AND BIM SOFTWARE

Building a project without designing it usually yields a solution that doesn't meet its objectives. This

may lead also to project's delay and / or cost overrun. Therefore, investing effort in project design enables project stakeholder's ability to plan for its future maintenance and / or enhancements. Architectural and Detailed Design activity produces a document that enables stakeholders to understand the interactions in the project to verify that each requirement has been addressed. In addition most BIM software now features rendering engines, an optimized feature specific taxonomy and a programming environment to create model components. The user can view and interact with the model in three-dimensional views as well as orthographic two-dimensional plan, sections and elevation views of the model. As the model is developed, all other drawings within the project will be correspondingly adjusted.

Software with BIM capabilities allows users to create constraints such as the height of a horizontal level, which can be tied to the height of specified set of walls and adjusted parametrically, creating a dynamic database model which is tied to geometry. This development answered a need in the architectural industry to be able to change drawings at multiple scales and across fragmented drawing sheets. In this respect, there is several company have been developed architectural software in the last decades to implement the BIM within their application.

1. Architect Expectation from BIM Software

BIM allows Architects to differentiate among multiple design options within a single model making the design investigation process more efficient. It facilitates the generation of construction documentation in the 3D digital realm, and allows architects to spend more time on building design. Working in the 3D digital realm creates better coordination of project documentation, and enhances space reservation. This allows architects to detect any potential clashes may exist among the model's elements. BIM uses integrated modeling, analysis and design which help the architects to work on the model itself without splitting it up into different models. This increase the accuracy of the design especially in case the model is designed by multiuser because BIM allows them to work on the same 3D model. This may speed up the design stage, while still offering considerable advantages in accuracy and complexity. These models have the ability to easily design and manage complex systems, the widest variety of components and materials with an added ability to modify them parametrically. The 3D models generated using a BIM software can also be used to easily generate accurate and coordinated 2D versions.

Furthermore, BIM increases the accuracy of design activities such as quantification and costing. It also improves the engineering accuracy in terms of measurements and context. The quality of drawing generated using BIM software increases and its generation is more flexible, automated and better coordinated. The generated visual models include several types of data which increases the value of information in respect to design exploration, and interrogation. The data embedded within the building information model is accurate and reliable, which can be used for early tasks such as schematic space planning and master scheduling. This data also can be used to real-time update of the model database and it enhances the communication and integration between different project phases such as; design and construction. In short, Architects could expect several benefits 14 from using BIM Software such as; efficient processes, effective information, 3D visualization, improved collaboration, well-informed decisions, accelerated understanding, and enhanced data quality. These benefits could lead to some

limitation or disadvantages provided by the BIM software such as: 1) Hardware requirements, 2) Network and Teamwork, and 3) Building Modeling capabilities.

2. Hardware Requirements

The 3D aspect of BIM required more capacity and usage power, more hard drive space than CAD drawings, and higher RAM capacity. The BIM software needs to simultaneously run several memory and processing-hogging programs which highlights the need for multi-processors [4]. For example, Revit® has a minimum requirement of:

a. 3 GB of RAM (8GB is recommended)

b. Intel Core 2 Duo 2.40GHz or equivalent (quad-core is recommended).

3. Network and Teamwork

Modeling the project using Network / Teamwork increases the hardware requirements of the workstation significantly. Generally, BIM software needs a backup strategy in order to reserve an original copy before any modification. In case of multi-user, the workstation may face a conflict about saving the model's final version especially when several users modify same element at the same time. The aim of teamwork or network is to decrease the time consuming toward project modeling. However, the use of network or teamwork could be generates new sources of risks as follows [5]:

a. Unequal Participation: some team members have low efficiency on the work. Conflict may occur as a result, which can have a detrimental effect on workplace morale.

b. Not Team Players: Some of team members have lack of teamwork ability and prefer to work on their own. They likely have difficulty fitting into your work culture, resulting in dissatisfaction.

c. Limiting Creativity: Teamwork may also limit creative thinking. The lack of innovative thinking may keep your company from moving forward, resulting in stagnation.

d. Longer Process: A team can sometimes takes longer to produce a desired result. It can also result in added expense, as it can tie up resources like money, manpower and equipment.

e. Inherent Conflict: Contrasting personal styles can clash and some members may have difficulty accepting ideas that differ from their own.

4. Network and Teamwork

The capabilities of building modeling could be a limitation especially if the required elements are not existed in the BIM software library. The lack of connection between model is about to design and the standard elements available in the library could lead to a significant effort for modification. This also could be time consuming in respect to library item modification. The connection of the BIM software standard library with the manufacturing industry is a very important factor because the lack in connection could lead to non-standard design. It also decreases the integration of manufacturing standards and the designed model's elements which may lead to the project delay or cost overrun because of the time and cost of manufacturing non-standard elements.

III. ARCHITECTS IN THE CONTEXT OF ENTIRE SOFTWARE PRODUCT

Changes in the profession of architecture inevitably place pressure on architectural education's to shape the trajectory of exploration after graduation, thus contributing to the future of the profession. The level of expertise required to design with BIM is significant and serious taking into consideration the

design strategy followed by architects. Looking back, even the most admired architectural never attempted to cover all the skills and knowledge that a mature architect should eventually have [6].

Software that allows for the three dimensional construction of a virtual building using a BIM software, influences project delivery and the interactions between architects and other stakeholders. BIM software introduces a new way of working using "Integrated Practice". The increased attention on BIM software and its increased availability to architects has potential to dominate all industries including construction industry [6]. Architects need to BIM Software is continuously increased, which encourages developer to implementing the BIM technology within their software to meet architect requirements. BIM Software products are important to architects, this encourage them to get involved in decision and evaluation of criteria that are relevant to architecture. The levels of the software product development [7] where experience of architects can make difference are; 1) requirements, 2) architecture, 3) design, and 4) implementation. The requirements of BIM Software focus on determination, processing, and characterization of information. The user input also represents an important focus from developer and architect because it illustrates the relationship between architect and software. In addition, The BIM software architecture focuses on selection of architectural elements in respect to their interactions, and constraints. Its framework satisfies the requirements of the user (i.e. architect) and serves also the basis for its design. Also, The BIM software design includes modularization, algorithms, functions, and procedures needed to support its architecture and to satisfy the objectives. The design optimization is also considered as an important factor since it decreases the time needed for user input processing and analysis. In addition, The BIM software implementation focuses on the representations of the algorithms and data types that satisfy the design, architecture, and requirements. The data types usually minimized in order to minimize the interference of user and increase the automation process of the software.

III. REVIT® AND ARCHICAD® IN ARCHITECTURE

ArchiCAD® and Revit® use increasingly a fairly new and popular CAD/Modelling technique known as Building Information Modelling (BIM). This technique uses predefined objects such as; doors, walls, and windows rather than shapes and lines (i.e. Standard 2D modeling) to draw and model it. The software which adopts the BIM technique inherits the ability to automatically recognise what information should be added to the elevation, plan, section and 3D view of the model once an object has been inserted by the user. Both, ArchiCAD® and Revit®, can be used to combine different views (Including 3D), technical details, renders, and product Schedules of the model on the same file. This combination enhances ultimately the volume of information provided by designer (i.e. Architect) to the end-user.

The first edition of Revit® "Revit® version 1.0" was released on April 5, 2000 by Revit® Technology Corporation which has been acquired, in 2002, by Autodesk that have also produced popular CAD and 3D modelling products such as AutoCAD® and 3D Studio Max. Autodesk enhances the interface, controls, and layouts of Revit® to be similar to AutoCAD® which has been widely used within the architecture industry at that time. These changes to the Revit® interface encourage the designers (i.e. Architects), whose are interested in incorporating BIM technique in their design, to easily implement the Revit® in their applications especially if they have experience in other Autodesk products (i.e. AutoCAD®) [8].

ArchiCAD® was the first CAD product which allows users to design in both 2D and 3D views. The original software was produced in 1987 for the Apple Macintosh and went on to be the first software to use BIM Technique. ArchiCAD® has been developed by GraphiSOFT® which is continuously improving it in order to remain as the premier BIM solution for architect worldwide [9]. The latest version of ArchiCAD® is "ArchiCAD® 17" and the latest version of Revit is "Revit 2014". The both have considerable improvements toward the BIM; however this study compares older versions of ArchiCAD® (ArchiCAD® 16) and Revit® (Revit 2013).

III. COMPARISON BETWEEN REVIT® AND ARCHICAD®

A reliable comparison of sophisticated applications such as Revit® and ArchiCAD® needs a experienced person who had use them for a few years. The Author has an architectural background and he uses ArchiCAD® since 2004 and Revit® since 2010. The author identifies three levels of characteristics as the base of the comparison between ArchiCAD® and Revit® as follows: 1. Technology (Power and Elegance); 2. Drawing Production; and 3. Work-sharing vs. Teamwork.

Each of these levels includes several characteristics each of them has been studied separately. The user's satisfaction provided by each software (ArchiCAD® and Revit®), in respect to the characteristics, represent the base of the evaluation.

5. Comparison between current and existing work

This comparison has different advantages over the existing work. It uses 21 characteristics and comparison options which makes it unique. It also highlights the commonalities and differences of ArchiCAD® and Revit® together which has never been done before. This comparison also uses multi-entry from users with different experience in various discipline. This makes this comparison more reliable comparing to the others since the previous comparison are usually based on the user experience only. This comparison uses weights for the studied characteristics which increases its accuracy compared to the existing ones. Because the important characteristic for a user could be less important, if not important, for another.

6. Comparison between current and existing work

ArchiCAD® and Revit® become very popular in the last decades as stated earlier; therefore a comparison between them is mandatory. The comparison aims to identify the best software in term of users' satisfaction. This satisfaction differs from one to another based on the needs and the complexity of the project. Needless to say that projects complexity and the number of available BIM software are continuously increasing which generate the urge need to a comparison among this different software in order to select the best software. The Comparison between ArchiCAD® and Revit® software incorporates three levels of comparison as follows: 1. Mutual Advantages; 2. Common Limitations; and 3. Differences. Based on the above differences, a comparison between ArchiCAD® and Revit® can be conducted based on the win-lose evaluation. This comparison shows that, the ArchiCAD® wins in respect to the characteristics and criteria illustrated in table 4 of differences between ArchiCAD® and Revit®.

TABLE II

A comparison between ArchiCAD® and Revit®

No	Criterion	Revit	ArchiCAD
1	3D	0	1
2	LIBRARIES	1	0
3	MATERIAL TAKE OFFS	1	0
4	ORGANIZATION	0	1
5	WORKGROUP CAPABILITY	0	1
6	CLASHING	1	0
7	DETAILING	1	0
8	HARDWARE REQUIREMENT	0	1
9	SUPPORT	1	0
10	ENGINE	1	0
11	FLEXIBILITY	0	1
12	PHASING	0	1
13	INSERTION OF IMAGES	0	1
14	MANAGEMENT OF IMAGES	0	1
15	FUNCTIONALITY OF IMAGE	1	1
16	MARKET INTEGRITY	1	0
17	TEMPLATES	1	0
18	KEYNOTES	0	1
19	FILE FORMATS	0	1
20	PRICE	0	1
21	MARKET SHARE	0	1
Score based on Win-Lose Comparison		9	12

1: mean that software win over other software in specific Criterion.

0: mean that software loose over other software in specific Criterion.

IV. CONCLUSION

The study involves the centrifugation of cane juice. The juice is subjected to centrifugation directly after milling of the cane. This treatment has been thought of particularly to clarify juices by removing the suspended particles, viz. silica, organic salts, etc. along with mud. In this paper the design pattern of the centrifuge has been shown. The effective factors such as removal of suspended particles, clarity and ICUMSA colour of the centrifuged juice has shown by the table and graph.

This comparison and its results represents the base of several conclusions generated by the author. From the discussion of these results it was concluded that ArchiCAD® and Revit® has a slightly similar scores, 0.645 and 0.632 respectively, in respect to 20 characteristics. This difference in result

illustrates the need for improvement of Building Information Modeling software from architectural perspective. The result of case study shows that the selection of ArchiCAD® or Revit®, as the BIM Software, affects considerably its objectives and characteristics. In addition to that, the criteria weighting scheme used in selection methodology contributes effectively in the comparison results. This scheme can be considerably affected by the type and level of user's experience as stated in the discussion. For example the weight of 3D characteristics can receive the highest from a user with an architectural background and the lowest value from a user with electrical background. The provided method adds more realistic and systematic methodology of comparison to the previous work in respect to subjectivity elimination. Unlike the previous work, this research includes the interrelation between the criteria of selection. The selection criteria was selected in respect to an architectural perspectives, thus including additional criteria from another perspective could increase the reliability and the accuracy of the results.

Based on the results of the comparison results and the conclusions provided by the author. It was recommended for the future researchers in BIM software comparison to consider the following:

1. Another or extended set of characteristics should be considered

2. An extended set of users with other types of experience can be considered 69

3. AHP method could be applied in order to check the consistency of the user inputs

4. The correlation between characteristics can be considered which increase the accuracy of the results.

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