Building Information Modeling in Commercial Construction Projects

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***Abstract*—**This paper explains the scope of Building information modeling in commercial construction projects, various studies performed by different researchers, background of building information modeling, data requirement and its flow between different parties involved in construction process and the various advantages and limitations of building information modeling in commercial construction projects

Keywords*-BIM : background, requirements, limitation and benefits.*

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I. INTRODUCTION

BIM is a process for creating, processing and managing all of the information on a project – before, during and after construction at virtual world to get benefited in real world with computer-generated models containing precise geometry and data needed, this makes BIM a 'game changer' and popular day by day for large-scale projects but as we come up with this innovation which gives both risk and opportunity to the future.

In present scenario where most of the Commercial construction project are having implicit nature due to various reasons such as improper planning, conflicts between various concerned people of the project, lack of preparedness for unforeseen changes which naturally affects time, cost and quality of project. Hence we consider the necessity of BIM for commercial projects.

Building Information Modeling helps us to maintain control over the project, improves collaboration between different units, simulation with visualization of the project at different stages, resolves many conflicts even before beginning execution work, guides the sequence of steps to be followed for better completion of the project and can help in taking many managerial decisions.

II. LITERATURE REVIEW

A) **"Building Information Modeling (BIM) and Sustainability – Using Design Technology in Energy Efficient Modeling", IOSR Journal by Eng. Parisa Esmaeili Moakher and Prof. Dr. S. S. Pimplika**.

In this paper following points are discussed:

1. BIM allows architects and engineers to become digital master builders who are able to see the building, materials, structures and its performance in real time. This model can very efficiently provide a fully coordinated set of conventional documents that is accurate and reliable.
2. BIM and sustainable design are connected by utilizing the capabilities of the model to provide useful data to analyze tools that report on a design's predicted performance on key sustainable characteristics.
3. BIM allows for multidisciplinary information to be superimposed within one model incorporating structural, mechanical, electrical, plumbing and lighting (Tucker, 2010).
4. IFC used by all engineering disciplines, and which enables sharing information between all AEC/FM project participants and storing the entire valuable data in one virtual model unit that can be preserved and used beyond the life of the project (Building SMART 2011c).

2) **"Solutions for Scalability in Building Information Modeling and Simulation-Based Design", - by Sixuan Wang, Gabriel Wainer, Rhys Goldstein, and Azam Khan**.

In this paper it is deserved that the BIM technologies have widely adopted in the Architecture, Engineering, and Construction (AEC) industry. At present, there are numerous BIM software applications. The existing simulation processes are not fully integrated into the design life cycle. Various scalability issues have arisen when integrating standard BIM tools and simulation software.

In fact, the building design and simulation are two independent domains. To solve the first two issues, in (Fu et al. 2006), the authors introduced a concept of "3D to nD Modeling", encouraging designers using multi-issues (specific domains) of design information to reduce the uncertainties and realize true "what-if" analysis. One solution is to use Model View Definitions (MVD) to facilitate automated querying from the IFC model, which is a subset of IFC (Lipman 2010).

3) "Adoption of the Building Information Modeling (BIM) for Construction Project Effectiveness: The Review of BIM Benefits" - American Journal of Civil Engineering and Architecture by Lancine Doumbouya, Guoping Gao, Changsheng Guan,

In this paper author discussed the benefits of BIM which improves the project life cycle of building. Changes, performed by building designers, are updated in real-time and are made evident to all participants. Utilization in the design part of the project cycle leads to reduced document errors and omissions, reduced rework, and reduced cycle time of the design process. The study by Sacks found that three dimensional (3D) parametric modeling results in a cost reduction of drafting of approximately 80–84%. Another study by Sacks and Barak reported that the potential productivity gain from 3D modeling is estimated to be in the range of 15–41% of the hours required for drawing production.

Moreover, the effective execution of BIM can result in efficiency change in construction, operation and support stages. During the construction phase of projects, BIM provides powerful media for progress monitoring, which can be used for quick and remote analysis construction performance. More benefits are attained in the construction phase as BIM helps to plan precisely and to regulate the construction process. This blocks errors, decreases construction time and enables to quickly change materials. The benefits of BIM for the building owner, developer, and other stakeholders are also plentiful. BIM allows better understanding of energy consumption, scenario simulations and also provides the visual aspects of a building, as it contains energy parameters which under various operating conditions, specify the cost indicators.

4) **"BIM based Project Scheduling and Progress Monitoring in AEC Industry" -International Journal of Scientific Engineering and Research (IJSER) by Saini Vijay Kumar, Mhaske, Sumedh, 2347-3878 Volume 1 Issue 1, September 2013.**

It is deserved that two Dimensional Computer aided design (2D CAD) Initial drafting tools in architecture are pencil; paper etc. with these tools Architects creates different supporting drawings for a project in multiple sheets. 2D applications are nothing more than "electronic drafting boards" capable of providing only two-dimensional drawings, without the capability for 3D models.

Three Dimensional Computer aided design (3D CAD) 3D CAD programs allow users to create a spatial model of the building together with the necessary 2D documentation. Some drawings (e.g. sections or elevations) can be partially derived from the 3D model but in most cases the documentation is kept in a separate file (or set of files) from the model. Most 3D applications offer built-in visualization tools and basic quantity

calculation features (e.g. floor areas, roof areas). The technology development form 2D CAD to 4D simulation greatly improved the design process. 2D CAD developed into 3D modeling. This innovation changed the process of building design and the relationship between the structural engineer and the architectural designer. It did not only change the way building designs are visualized, but also signaled a paradigm drifting design thinking from pure visualization to simulation. Building information modeling is a building design and documentation process.

III. BUILDING INFORMATION MODELING (BIM)

A. *BACKGROUND*

The construction industry may appear through BIM appeared overnight. In traditional slow moving field, the percentage of BIM used has jumped from 28% in 2007 to 49% in 2009 and to 71% in 2012. This percentage is increased ever *higher up to 2014. With the new* technologies, the concept of BIM were first developed by academics before adopted by industry, and traced back to basic 2D and 3D CAD research in 1970s In 1984, the first ArchiCAD was released for the Apple Lisa personal computer.

The next leap BIM occurred with the introduction of 4th dimension (4D) or time. In 1986, the concept of temporal phasing was first used during phase construction of Heathrow's Terminal 3. The 5th dimension or 5D was further developed in 2000. The Autodesk Revit was allowed to cost to be associated with individual components, thus it allow to contractor to generate not only construction schedule but also cost estimates. Autodesk Revit was first used for the Freedom Tower in New York City which was completed in series of separate but linked BIM files.

The conceptual BIM systems go back to earliest days of computing. In 1962, Douglas C. Englebart gives an uncanny vision of the future architect in his paper Augmenting Human Intellect. Englebart suggested the object based design, parametric manipulations add a relation database; dreams the world become reality several years later. Herbert Simon, Nicholas Negroponte and Ian McHarg developing parallel track with Geographic Information System (GIS). Ivan Sutherland's Sketchpad program in 1963, solid modelling programs for building was developed in the computational representation of geometry. Two methods of displaying and recording shape information that appear in 1970s and1980s were constructive solid geometry (CSG) and boundary representation (brep). The CSG system uses a series of shapes that can be solid or voids, so that these shapes are combine and intersect, subtract or combine to create more complex shapes. This development is important in representing architecture as penetrations and subtraction are the common procedure in design windows, door etc.

During 1970s and 1980s the development was continued around the world. The DBS approach described as 'Building Product Models' in the USA and 'Product Information Models' in Europe. These products were merged to become "Building Information Model". Robert Aish who was a creator of generative components and also member of Autodesk Research was first documented the term 'Building Modeling' in 1986 that we can use today.

B. *BIM IN COMMERCIAL CONSTRUCTION PROJECTS*

a) Data requred:

Building information modeling requieds different types of data which can be broadly classified unders some catagories which as shown in figure 1 below.

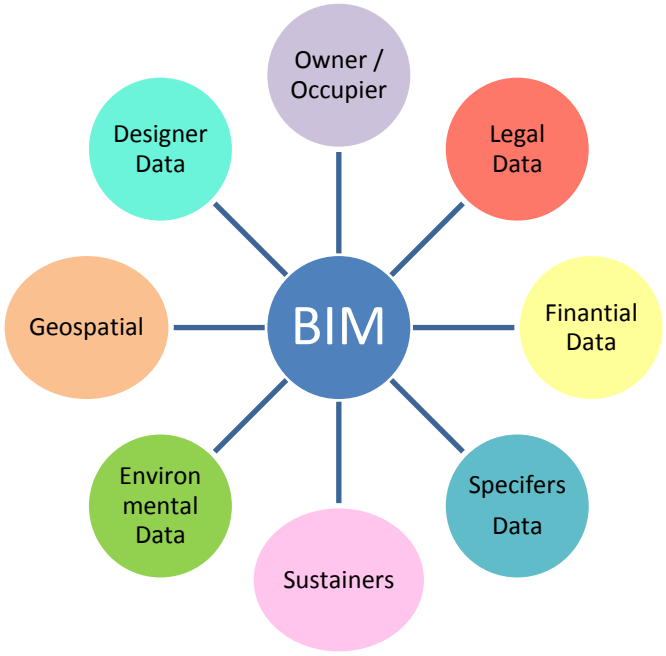

Figure 1. Data required for BIM in commercial construction projects

b) Data Flow:

Building information modeling for a commercial construction projects requires large amount of data sharing between different parties and two main zones Collection and Creation which is explained in below figure 2.

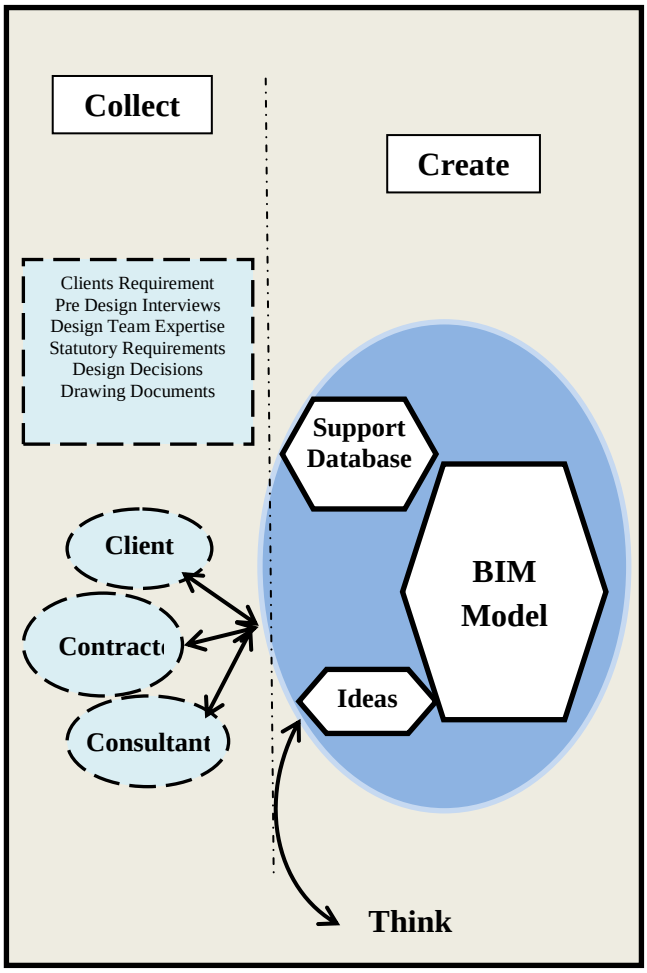

Figure 2. Data flow for BIM in commercial construction projects

IV. ADVANTAGES AND LIMITATIONS OF BIM IN COMMERCIAL CONSTRUCTION PROJECTS

A. BENIFITS OF BIM:

BIM has lots of benefits. When construction projects are managed with traditional methods and paper-based tools, it may be difficult to finish project on time and under budget. With the BIM technology, architects show every little detail in model and by minimizing the reviews and reworks, time can be saved and projects can be completed under budget by saving time and money and productivity in construction projects can be increased, collaborative design and coordination can be achieved. Accurate and faster design decisions can be done at early stages, accurate and faster quantity takeoff can be obtained automatically, material wastes can be minimized because with the ability of BIM technology design conflicts can be determined before construction starts on site and errors can be minimized that can reduce delays and cost overrun.

1) Improved Accuracy:

BIM affords integrator to increases accuracy of quantity takeoffs. Data attached to objects allows to accurate counting and price modeling, improving the accuracy of bids and pricing of project. Designers are enjoying receiving fewer requests for information and change orders. Integrator scheduling based on material availability and construction progress can be mapped visually. This allows project managers to quickly optimize construction schedules with ever changing material deliveries, seasonal costs and availability.

2) Increase Efficiency:

BIM help to reduce errors and omissions (E&O) which are in turn reduce E&O claims and professional liability. A reduction in insurance costs, positive impact and bonding fees on firm reputation should increase the number, scale and variety of opportunities available to design and integration firms. Prefabrication that reduces accidents, increases efficiency, and reduces labour time in the field.

3) Better visualization and documentation:

BIM software's Revit, AutoCAD provide to the users more better visualization comparing to the old 2D design software. With the 3D view, it is easy to get the general ideas of the site condition surrounding to proposed building look likes after and during construction. The new released software also included the alignment layout and tools that makes sharing of design standards easier across the organizations. The corridor includes tools that streamline corridor editing provided in plan, profile and section view simultaneously. The creating 3D site model could be publishes to Google Earth or to exported as DWG files to help communicate design. In addition to this the Civil Visualization Extensional is available, which subscribed by the Autodesk to download, which provided to take 3D surface and corridors, easily incorporate them in 3Ds Max design, so that we can create a compelling visualizations.

4) Single and integrated information resource:

Site linked BIM models integrate information from different project parties together as a single information resource. Before the site-linked BIM models were built, the project has more pieces of information resource, the paper drawings and structural building models. As there are pieces of information, this information can be bringing in the BIM model and all of this information could be carried by 3D site linked building Model. This resource can be shared by all the users, which will save lot of paper work, as well as improve the coordination and cooperation between the project team.

5) Time Saving Utility Design:

AutoCAD is the powerful function to create, swap or move pipe networks in the plan view; we can easily define pipe networks to contain pipes only, structures like in this case, both pipes and structures according to the real site conditions. Multiple pipes and structures are ready to use, the size and style should be always redefined after the network has been set up. For some special parts that not exist, the user can creates a part comprised of only the parts of items and save it for future use. Not like 2D paper work, by using the similar tools, the entire pipe with the same properties could be changed only one time, which saves a lot of time for engineers, and also reduces the potential mistakes.

6) Interference checking, less collisions:

Some of the BIM software's carry this functional tool: interference checking. The well defined site model with existing underground condition and the excavation pad on site, this tool could simply allow the user to identify the following two situations and can play a significant role in reducing possible collisions during future constructions.

A) If there is any interference between different pipe network.
B) If there is collision between the excavation and the existing underground conditions.

7) Energy Saving Design (BIM for Sustainable Design):

BIM helps to the civil engineers to create more sustainable land development, environmental, and transportation projects. Some of the civil engineering BIM software allows the user to analyze the storm water runoff to design solutions. For example, AutoCAD Civil 3D, this would limit the disruption of natural hydrology. For landscape architects, brings BIM to landscape can make the site design much easier, through taking advantage of the 3D model, they would maximize the possible open space and minimize site disturbance during construction.

8) Improved Coordination and Clash Detection:

A benefit of BIM are improves the coordination of documents between the various designers and engineers involved in the design phase of a project, as well as the coordination of structural elements, and with building services systems. Khanzode, Fischer, and Reed found that labour savings of up to 30% were possible due to improved services coordination of BIM. The coordination benefits of BIM was found to apply the specialist trade subcontractors such as precast concrete and structural steel manufacturers, found that "pre-building" is their part of the project, and it can help significantly to "reduce the likelihood of errors" that occurs on the construction site.

9) Accurate Cost Estimating and Cost Management:

The use of BIM allows estimators and quantity surveyors to accurately estimate building costs, which is based on the quantities and schedules generated from the BIM model. These measures was also automatically updated by the BIM software whenever changes are made in the model ensuring schedules of quantities are always accurate. If this 5D data are incorporated into the BIM model in the early concept design stages of a project, it helps to show clients financial effects of change requests and other variations. The accuracy of cost estimating with the BIM depends on the BIM model being modeled accurately by the designers. When quantity takeoffs and estimates was performed using BIM, the quantity surveyor must be careful to understand exactly what the areas and numbers represents.

Other than these benefits BIM is also help to faster and more effective processes for project information, value added and reused. It develops better design of building and proposals are analyzed easily with quickly simulations performance, enabling improved and innovative solutions. It also helps for developing automated assembly, better customer service and lifecycle data of project.

B. *LIMITATIONS OF BIM:*

BIM have the potential to improve the communication and coordination between the different stakeholders of a project. The benefits of BIM range from simple improvements in coordination and efficiency to greater client satisfaction .

It should also be aware that there are number of current limitations of BIM that must be taken into account.

1) Cost of Software and Hardware:

Every industry currently using 2D or 3D CAD drafting software can be attribute a cost element against purchasing, upgrading software licenses and maintaining. In current market the cost of BIM software is more than the CAD software available. With the BIM software, the requirements of hardware are increased. Currently, CAD software can be operating with limitations on majority of laptops. The BIM software dedicated high-specification, equivalent to advanced modeling and rendering software. A software and program requirement is ahead of hardware availability. With the BIM software, it is know exactly what parameters of hardware improve performance.

2) Cost of Training:

There is more demand of train staff quickly in market with the new software. It is not realistic with CAD proficiency will be learn new BIM software quickly or without training. The fundamental differences between BIM and CAD, training should be required for all professionals involving with designing and producing documentation. BIM provides ability to every member in the team to involve in the design and modeling process, with the complete control of the end product.

3) Transition from Drafting to Modeling

When moving from CAD drafting to the BIM modeling, a change in workflow will be surrounded that what should be used to simple drafting tasks. These tasks require higher-level skilled design drafters who understand the project and the materials used. With no knowledge of the trade, the costs associated with training and maintaining a skilled design modeler is higher than a draftsman. Some companies may be compelled that to stay out of the BIM due to the time and knowledge intensive nature of BIM.

The CAD also increasing level of responsibilities on the designer to the entire system component is coordinated with the other design professionals such as engineering and architecture services and that site issues are reduced. Company has a different business models to consider when thinking about staff training with respect to BIM.

The first option involves the training of designers to understand all design work in the BIM. The second option involves skill of drafting staff to higher technical level to understand design responsibilities. The third option is combination of the first two where is a specific set of rules and

guidelines so that design can be translated into the model clearly and effectively.

4) Compatibility between Software Platforms:

This is one of the biggest issue with early adaptors of BIM is of entire product compatibility. Due to the competition in the market, every software manufacturing company are doing something different with its software. The interoperability issues are not limited to different software platforms; due to the rapid development of the BIM software industry newer version of program within the same platform to have interoperability issues. One of the alternatives of current product specific models was vendor independent, neutral-file format.

5) Innovation:

The goal of BIM is to assign constrain and parameter to intelligent objects to improve the efficiency, there are potential to inhibit innovation which are possible to the automated process and shared knowledge that BIM provides. Those firms are implementing BIM should view the parameters and data constraints as a global database that allows designer to save time associated with the update and configure product data repetitively for different projects, hence increasing the amount of time spent on system design and innovation.

V. CONCLUSION

Commercial construction projects are getting more complex day by day and it is difficult to manage them with the traditional methods, hence Building information modeling is becoming need of the hour for large projects.

Building information modeling compile data received from various sources and gives the appropriate information at a desired level, as it improves accuracy, Increase Efficiency, Better visualization and documentation, Single and integrated information resource, saves time and energy, reduces collisions but on the other hand the cost of hardware, software and training is high, Transition from Drafting to Modeling and compatibility pushes it to the back foot.

Finally we can conclude that it hold a great future ahead as its importations spreads day by day and with more parties accepting the building information modeling as an integral part of project.

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