International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163
Issue 4, Volume 2 (April 2015) www.ijirae.com

A Review of Building Information Modeling (BIM) for Construction Industry

N. S. Chougule*
Civil Engineering Department,
Government college of Engineering Karad,

Prof. B. A. Konnur
Civil Engineering Department,
Government college of Engineering Karad,

Abstract: The construction industry has become much more complex than ever due to large number of people and documentations involved. BIM is a new promising tool to Architecture, Engineering, and Construction (AEC) industry, allows constructing building virtually before actual construction on field. BIM aims collaboration between various stakeholders of construction industry for better and faster design and execution. BIM demands for change in traditional organizational structure. This paper overviews the status of BIM in India, it's applicability for project delivery method and in various phases of construction industry, and hurdles in BIM implementation.

Keywords: Building Information Modeling (BIM), AEC industry, Construction industry, Model, Stakeholders.

I. Introduction

Construction industry has characteristic of having each product unique and transient. With the growth of technology other industries have changed and improved their process but the construction industry is still labour intensive and following same traditional process of generating drawings by architects or designers and building is erected by contractors.2D CAD (Two Dimensional Computer Aided Drawing) represents only graphical entities like line, circle and arches. It possesses views like plan, section and elevation, in which modification in one view demands for manual modification in all other view. This process is hectic and error prone. BIM represents each object as a building component like walls, beam and column. Building model gets automatically updated in each view with modification in any one of the view which saves the time and less error prone. BIM contains all the information of each element of building from design to demolition.

The National Building Information Modeling Standards (NBIMS) committee of USA defines BIM as, a digital representation of physical and functional characteristics of a facility. BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle i.e. from earliest conception to demolition. A basic premise of BIM is the collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in BIM to support and reflect the roles of that stakeholder.

II. Status of BIM in India

Construction sector is second largest industry contributing to the Indian economy. Increasingly, large construction companies in sector such as hotels and airports are starting to implement BIM in India with distinct benefits but at a very high cost [16]. Indian industry has unwillingness to adopt new technology immediately. Survey done by Indian built environment sector, RICS school of built environment and KPMG found that 22% of respondent currently use BIM, 27% respondent reported that they are aware and actively considering BIM usage. Surprisingly 43% respondents claimed to be aware of BIM but are not sure about implementing it in their organisation near future. Additionally 8% respondents are not aware of BIM [19]. The main reason for not using BIM here is the lack of technical expertise, the professional who has heard about this doesn't know how to use it, and most of them are not even aware of this methodology [14].

The various reasons for using BIM are as shown in figure no. 1 and also reasons for not using BIM are shown in figure no. 2

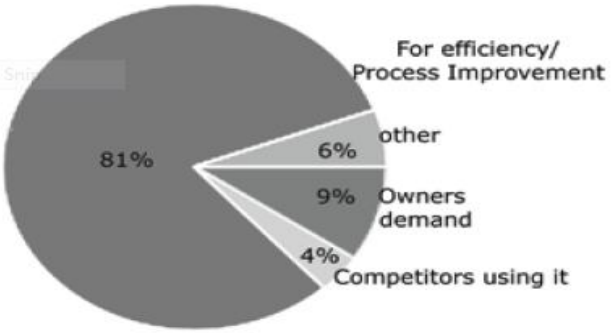

Figure no.1 Reasons for using BIM [14]

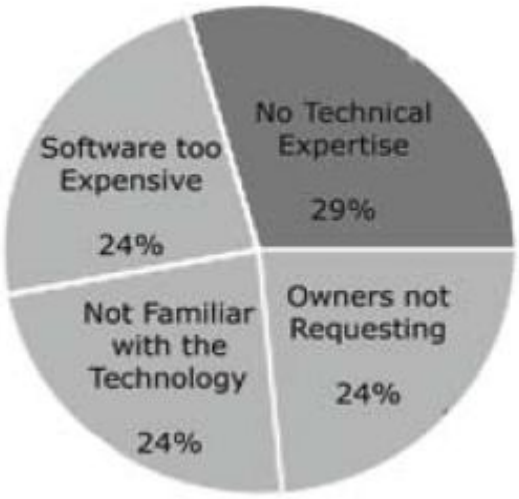

Figure no. 2 Reasons for not using BIM [14]

In Indian industry there are fewer BIM users with low knowledge about BIM. The major reasons for this condition being high cost of software, low demand from clients and lack of skilled or trained employees. The rampant myths about BIM usage and lethargic attitude of professionals towards the validating the facts are keeping the firms away from embracing the BIM technology. Moreover the AEC firms are too comfortable and are not willing to change current practices. Indian government is not involved with initiative to encourage BIM usage in construction industry and there is no initiative from education institution either, to introduce new or current global trends related to the construction industry in academics [17].

III. Applicability of BIM for Current Project Delivery Methods

Project delivery method is a method by which project is executed from concept, design, construction to the handover to owner. Construction industry is still following traditional method of Design-Bid-Build (DBB) method. Over the periods it has been tried to minimize construction time. This has resulted in adoption of Design-Build method, where bidding phase is removed by awarding project to single general contractor who will take responsibility of both design and construction.

DBB does not lend itself well to supporting the adoption of technologies or process across the project team due to many contractual divides. Typically this process is defined by the wall of deliverables whereby at the end of each phase the deliverables are handed over the wall with little or no integration or collaboration between the participants in each phase. This deliverables based approach makes it difficult to successfully implement BIM. DB method has smoother flow of information between stakeholders but still it has contractual agreement [7]. Hence DB method also is not so suitable for adoption of BIM.

The integrated project delivery (IPD) eliminates the drawbacks of the DBB and DB. Integrated project delivery (IPD) is a project delivery approach that integrates people, system, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to reduce the waste and optimize efficiency through all phases of design, fabrication and construction. Integrated project delivery principles can be applied to variety of contractual arrangement and IPD teams will usually include team members well beyond the basic triad of owner, architect and contractor. At a minimum through an integrated project include tight collaboration between the owners, the architect and the general contractor ultimately responsible for construction of the project, from early design through project handover [21].

To fully benefit from the use of VBM's (Virtual Building Model) it is important that the approach of the project suits the system of BIM [11]. While IPD is seen as the possible future of project delivery that is being fuelled by BIM, it is still the exception and not the rule [12].

IV. Benefits of BIM at Various Phases of Construction

Benefits of using BIM at various phases of construction process are explained below.

A. Design and planning:

BIM plays important role over entire life cycle of project from scratch of conceptual design to demolition of building. Use of BIM in the project programming allows project team to analyse space and understand the complexity of space standards and land regulation which saves time and provide them with opportunity of doing more value added

activities [2]. 3-D representations can be generated from the building model at any stage in the design. These can range from simple wireframe models/ complex photorealistic renders [5]. This gives consistency in data extracted from the model. This helps to designers to imagine and validate their design. The architects and engineers can take advantage of BIM application at different stages of project design namely schematic design (SD), detailed design (DD) and construction detailing (CD) [2]. BIM constructs the building virtually before actual construction. Hence owner or user can suggest the modification early in the planning and design phase according to their requirement. Also contractors can participate early in the design phase to contribute his field experience.

B. Quantity estimation:

Provided with the capability for extracting counts of components, areas and volumes spaces and material quantities, BIM quantity take-off tools enable a quicker extraction of more detailed spatial and material quantities information [8]. As quantities extracted from model are more accurate, owner is protected from over budget project.

C. Clash detection:

BIM based clash detection tools allow automatic geometry based clash detection to be combined with semantic and rule based clash analysis for identifying qualified and structured clashes. BIM-based clash detection tools allows contractors to selectively check clashes between specified systems, such as checking for clashes between mechanical and structural system, because each component in the model is associated with specific type of system. Consequently, the clash detection process can be performed at any level of detail and across any number of building systems and trades [7].

D. Productivity:

With 50% of typical construction day being non-productive, BIM application can be used to gain 33% increase by addressing late or inaccurate information, waiting on resources, multiple material handling, waiting on instruction and rework. This will have a dramatic increase in the productivity for the construction industry, making it more compatible with productivity increases in other industries like agriculture, manufacturing, transportation etc. [14] Study done by Porwal A and Hewage K. found that BIM is useful in minimizing waste rate of structural reinforcement and the result indicated a high potential for budgetary savings [18].

E. Prefabrication:

BIM offers manufacturers of building components detailed and information–rich models, which can be interrogated for manufacturing details, can reduce information request and improve output quality. A study of the application of BIM on a large healthcare project in the USA revealed that it is possible to achieve 100% prefabrication for mechanical system installations, and zero clashes in MEP installation activities. This, in turn yielded 20-30% labour savings for the MEP sub-contractors and thus savings further up the value chain [6].

F. Quality management:

BIM-based construction quality application is suitable and helpful in quality compliance management. First due to data consistency, it is possible and feasible to apply BIM for quality management and to fully utilize design information through virtualization of the construction process. Second BIM can be fit into the current industry standard practices in quality management [3].

G. Facility management:

The information collected through a BIM process and stored in a BIM-compliant database could be beneficial for variety of FM (Facility Management) practices, such as commissioning and closeout, quality control and assurance, energy management, maintenance and repair, and space management [10].

V. Hurdles in Adoption of BIM

Despite the great benefits of BIM, it has significant problems in its adoption. As BIM is not just a software application or modification to construction industry, it calls for restructuring the organisation and adopting a complete new way of working.

The use of BIM substantially alters the relationship between parties and blends their roles and responsibilities. Our legal framework however assumes a less collaborative environment with clearer delineation of responsibility. As we move forward with BIM projects, risk will need to be allocated rationally, based on the benefits the party will be receiving from BIH, the ability of the party to control the risk, and ability to absorb the risk through insurance and some other means [9].

The first legal risk to determine is ownership of the BIM data and how to protect it through copyright and other laws. For example, if the owner is playing for the design, then the owner may feel to entitle to own it, but if team member is providing proprietary information for use on the project, their propriety information needs to be protected as well. Thus there is no simple answer to the question of data ownership; it requires a unique response to every project depending on the participants needs. The goal is to avoid inhibitions or disincentives that discourage participants from fully realizing the model's potential [1].

Notwithstanding the use of BIM in projects, it is common to see parties not properly adapting the current contract framework for using BIM. The owner parties are still using current industry contract documentation with the risk allocation unadjusted. Parties are making only rudimentary changes by incorporating BIM execution plans as part of the contract requirement (but without changing the risk allocation) [4].

The BIM addendum issued by consensus DOCS gives guidance for modifications and attachments in drafting contracts to deal with BIM [15]. Also American institute of architect (AIA) has produced the protocol for BIM. The deployment of BIM requires the traditional design processes to be changed [21].

In theory BIM relies on a single information store that meets the need of all project participants. Changes to design whether architectural, structural, mechanical or electrical all occur within the model. Contractor and supplier information is integrated into the model, adding more detail to the design. That model then produces the field and shop level drawing. This level of integration has been achieved in certain manufacturing process, but is not the current construction reality. Significant efforts being made to tighten the integration between and support interoperability, but the single model and perfect interoperability is still a dream not reality [9].

Many people believe that the cost of implementing BIM is too prohibitive: way beyond their project budget. The exorbitant prices for various BIM software packages are their prevailing barrier to BIM acceptance in Indian construction domain. The cost of BIM software packages are more expensive compared to CAD software packages that are available on the market at a fraction of the cost if BIM software. Besides the initial cost of the software package, the price to keep the subscription updated is astronomically high by Indian standards [17].

Training the employee is another obstacle in adopting BIM. To train the employee organizations need to spend time and money. This creates dilemma in organizations to adopt BIM. The developing countries like India has cheap and plenty of labours are available, construction industry shows inertia to adopt costlier technology. Though the initial investment of BIM is huge, once it is adopted fully it has tremendous benefits.

VI. Conclusion

The present overview depicts that BIM is a revolutionary concept. It needs the significant alteration in traditional project delivery methods by changing the roles and responsibility of every individual in the organization. To achieve benefits from BIM to the full extent, each stakeholder of construction industry needs to incorporate it. The hurdles like legal issues, interoperability, cost, unavailability of guidance or protocol, etc. can be overcome. To keep pace with growing technology and increasing competition, AEC industry should incorporate BIM as early as possible.

References:

1) Azar S., Hein M. and Sketo B., “Building Information Modeling (BIM): Benefits, Risk and Challenges”, McWhorter School of Building Sciences University Aubum, Alabama, 2008
2) Azhar S., Khalfan M. and Maqsood T., “Building information modeling (BIM): now and beyond”, Australasian Journal of Construction Economics and Building, 12(4), 15-28, 2012.
3) Chen L. and Luo H., “A BIM-based construction quality management model and its applications”, Automation in construction, 2014.
4) Chew A. and Riley M., “What is going on with BIM? On the way to 6D”, The International Construction Law Review, 2013.
5) Davidson A. R., “A Study of the Deployment and Impact of Building Information Modeling Software in the Construction Industry”, http://www.engineering.leeds.ac.uk/e-engineering/documents/AndrewDavidson.pdf
6) Eadie R., Odeyinka H., Brownie M., McKeown C. and Yohanis M., “ An Analysis Of The Drivers For Adopting Building Information Modeling ”, Journal of information technology in construction- ISSN 1874-4753, October 2013
7) Estaman C., Teicholz P., Sacks R. and Liston K., “BIM Handbook A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors”, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008
8) Fernandese R. P. L., “Advantages and Disadvantages of BIM Platforms on Construction Site”, 2013. http://repositorio-aberto.up.pt/bitstream/10216/68980/2/49194.pdf
9) Foster P.E., “Legal issues and risks associated with building information modeling technology”, university of Kanas, 2008.
10) Gerber B.B., Jazizadeh F., Li N. and Calis G., “Application Areas and Data Requirement for BIM-Enabled Facilities Management”, Journal of construction engineering and management, vol. 138, No.3 March 1, 2012. © ASCE
11) JJRyan consulting pty ltd, “Building Information Modeling (BIM) and the Construction Industry”, Technical Report (TR-1405A),May 2014
12) Infocomm international, Building Informatin Modeling, http://www.flipdocs.com/scripts/showbook.aspx?ID=10001172_975708
13) Kuehmeier J.C., “Building information modeling and its impact on design and construction firms”, university of florida, 2008
14) Kumar J.V. and Mukherjee M., “Scope of building information modeling (BIM) in India”, Journal of engineering and science technology review 2(1), 165-169, 2009.

15) Lowe R.H. and Muncey J., "ConsensusuDOCS 301 BIM Addendum", Construction Lawyer, Volume 29, Number 1, Winter 2009 © 2009 bythe American Bar Association.
16) McGraw Hill Construction, "The Buisness value of BIM for construction in Major Global Markets: How the contractors around the world are driving innovation with Building Information Modeling", 2014
17) Nanjekar A., "Implementing Building Information Modeling (BIM) At AEC Firms In India", North Dakota State university of Agriculture and Applied Sciences, May 2014.
18) Porwal A. and Hewage K., " Building Information Modeling- Based Analysis To Waste Rate of Structural Reinforcement", Journal of construction engineering and management, vol. 138, No.8 August 1, 2012. © ASCE.
19) Sawhney A., "State of BIM adoption and outlook in India", RICS school of built environment, Amity University, May 2014.
20) Suermann P.C. and Issa R. R. A., "Evaluating the impact of building information modeling (BIM) on construction", International conference on construction applications of virtual reality: October 22-23, 2007.
21) The Contractors Guide to BIM, The Associated General Contractors of America.
22) Wang M., "Building Information Modeling (BIM): Site-Building Interoperability Methods", Wocester Polytechnic Institute, 2011.

