BIM ENGINEERING IN CONSTRUCTION ENGINEERING & MANAGEMENT (Revolution technique in AEC Industry-Consulting)

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Abstract: This The term BIM refers to building information Modeling which mean process of converting black and white information present in documentation from various aspects as coordinating documents without any fatigue in construction domain.

INTRODUCTION

The term Building Information Modeling is predominantly referred as collection of building information from architects, structural engineers, mechanical engineers, electrical engineers, plumbing engineers from various design consultants as coordinative drafting models with a precision out let of layout drawings, BOQ, shop drawings, scheduling etc. in accurate limitations , thus reduces construction waste , material utilization, proper planning techniques in advanced level. Thus creates revolution in construction industry. Let's go green, save environment.

BIM CREDOMINANTS

Predominant relative about BIM and construction

Consider human body as building, our outer appearance is determined by architects which means its façade, elevation, ventilation, every physical stuffs be purely determined by them. Next bone the beauty through which need to be withstand its stability is proudly determined by expertise structural civil engineers, its beam, column its setout plan is determined. Next other heart ,veins, nervous, blood pump every other stuffs for communicative and also to make functionate effectively the operations for facility management is determined by MEPF engineers.

List of BIM Applicable softwares

- Autodesk Revit
- ArchiCAD
- Vectorworks
- Navisworks
- Constructor
- Digital project
- BIMx
- Graphisoft Eco Designer
- Idea Architectural
- Brics CAD
- All Plan
- CYPECAD

- Archibus

BIM TERMINOLOGIES

These were the main terminologies which are mainly used in BIM Engineering are considered below:

LOD:

The BIM's Level of Detail (LOD) - defines how the 3D geometry of the building model can achieve different levels of refinement, is used as a measure of the service level required. LOD options ranging from 100 to 500. Using the Level of Detail (LOD) industry specifications as a guide, 3D Modeling Service will create a 3D model of your projects based on the specificity required. can also deliver animation services for LOD in the sequence for virtual construction sequencing and simulation to develop insights of how and what will be constructed. expertise of delivering LOD for different levels. We adopt internationally accepted standard for LOD. These development models are purpose built for various stages of design, 3D visualization, construction-caliber quantities, scheduling, estimations, on-site production control and fabrication.

LOD-100(Concept Development):The building 3D model is developed to represent the information on basic level. Thereby, only conceptual model creation is possible in this stage. Parameters like area, height, volume, location and orientation are defined.

LOD-200(Schematic Development): General model where elements are modeled with approximate quantities, size, shape, location and orientation. We can also attach non- geometric information to the model elements.

LOD-300(Design Development): Accurate modeling and shop drawings where elements are defined with specific assemblies, precise quantity, size, shape, location and orientation. Here too we can attach non- geometric information to the model elements.

LOD-350(Construction Documents): It includes model detail and element that represent how building elements interface with various systems and other building elements with graphics and written definitions.

LOD-400(Fabrication & Assembly): Model elements are modeled as specific assemblies, with complete fabrication, assembly, and detailing information in addition to precise quantity, size, shape, location and orientation. Non- geometric information to the model elements can also be attached.

LOD-500(Facility Management/ Reverse): Elements are modeled as constructed assemblies for Maintenance and operations. In addition to actual and accurate in size, shape, location, quantity, and orientation, non-geometric information is attached to modeled elements.

Lod:

When comes to detailing it shows increase in parameters such as informative increases with respect to client requirements. Thus it might be needful for reading construction documents during operations .lod it varies depends on its accuracy of application.

c. COBIE:

Construction Operations Building Information Exchange (**COBie**) is a non-proprietary data format for the publication of a subset of building information models (BIM) focused on delivering asset data as distinct from geometric information

D.Simulation:

The technique of planning consulting with respect to considering environmental factors, resources availability to produce estimation, BOQ, duration of operations most accurate with proper hindrance is takes place here

E.AIM:

It's a respective term as BIM, but the information collective as assert valuation might as builded possibilities.

D.Scan to BIM:

Heritage structures are documented for security purpose,such as tajmahal are done by laser scanning as point cloud datas and profil;e are created using bim softwares ,documented.

BIM NOW AND BEYOND:

Building Information Modeling (BIM), also called n-D Modeling or Virtual Prototyping Technology, is a revolutionary development that is quickly reshaping the Architecture Engineering-Construction (AEC) industry. BIM is both a technology and a process. The technology component of BIM helps project stakeholders to visualize what is to be built in a simulated environment to identify any potential design, construction or operational issues. The process component enables close collaboration and encourages integration of the roles of all stakeholders on a project. The paper presents an overview of BIM with focus on its core concepts, applications in the project life cycle and benefits.

BIM PROCESS:

BIM can be viewed as a virtual process that encompasses all aspects, disciplines, and systems of a facility within a single, virtual model, allowing all team members (owners, architects, engineers, contractors, subcontractors and suppliers) to collaborate more accurately and efficiently than traditional processes. As the model is being created, team members are constantly refining and adjusting their portions according to project specifications and design changes to ensure the model is as accurate as possible before the project physically breaks ground (Carmona and Irwin, 2007). The foundations of BIM are laid on two pillars, communication and collaboration. The successful implementation of BIM requires early involvement of all project stakeholders. It means that the traditional project delivery systems (e.g. design-bid-build) have very limited role in BIM-based projects. Recently the Integrated Project Delivery (IPD) concept emerges as a natural companion to BIM. IPD brings key construction management, trades, fabrication, supplier and product manufacturer expertise together with design professionals and the owner earlier in the process to produce a design that is optimized for quality, aesthetics, constructability, affordability, timeliness and seamless flow into lifecycle management. In the United States, the IPD has become a preferred project delivery system for all major projects involving BIM.

VI. BIM Project Planning

The use of BIM in the project programming phase allows project team to analyze space and understand the complexity of space standards and land regulations, which saves time and provide the team with opportunity of doing more value-added activities. BIM Applications in the Project Life Cycle BIM applications spans over the entire life cycle of a facility. This section presents a brief overview of important BIM applications in the project programming, design, preconstruction, construction, and post-construction (operations and maintenance) phases. Recently, some researchers have investigated the integration of BIM with GIS (Geographical Information Systems) which can aid project planners in selecting appropriate site and conducting project feasibility and marketing studies. Aid in determining if potential sites meet the required criteria according to project requirements, technical and financial factors, etc. Decrease costs of utility demand and demolition. Minimize risk of hazardous materials. The advances and economy of 3D laser scanning equipment has allowed practitioners to accurately scan existing utilities and integrate them in the BIM model as show in Figure 3. In addition, 3D laser scanning can be used to scan and accurately (within industry tolerances) develop BIM models of existing facilities which can be later used for renovation and adaptive re-use of existing buildings. BIM Benefits for Project Stakeholders Before discussing benefits of BIM for project owners, designers, constructors and facility managers, it is useful to summarize BIM applications for these stakeholders. Table 2 provides this summary. The individual benefits of BIM for each stakeholder are discussed in the following sections. Project Owners Owners can achieve significant benefits on projects where BIM technology and processes are applied. Eastman et al. (2011) and Reddy (2011) summarized the following benefits of BIM for project owners: (1) Early design assessment to ensure project requirements are met; (2) Operations simulation to evaluate building performance and maintainability; (3) Low financial risk because of reliable cost estimates and reduced number of change orders; (4) Better marketing of project by making effective use of 3D renderings and walk-though Australasian Journal of Construction Economics and Building Azhar, S et al. (2012) ‘Building information modeling (BIM): now and beyond’, Australasian Journal of Construction Economics and Building, 12 (4) 15-28 22 animations; and (5) Complete information about building and its systems in a single file. Due to these and other tangible and intangible benefits of BIM, large project owners in the USA (such as the General Services Administration (GSA), the U.S. Army Corp of Engineers (USACE), etc.) are increasingly requiring designers and contractors to utilize BIM in all projects (Ku and Taiebat, 2011). BIM Application Owners Designers Constructors Facility Managers Visualization x x x x Options analysis x x x Sustainability analyses x x Quantity Survey x x Cost Estimation x x x Site Logistics x x Phasing and 4D scheduling x x Constructability analysis x x Building performance analysis x x x x Building management x x Table 2 BIM applications for project stakeholders Project Designers The project architects and engineers can take advantage of BIM in schematic and detailed design; and construction detailing phases as summarized in Table 1. Following are some of the main benefits of BIM for project designers: (1) Better design by rigorously analyzing digital models and visual simulations and receiving more valuable input from project owners; (2) Early incorporation of sustainability features in building design to predicts its environmental performance; (3) Better code compliance via visual and analytical checks; (4) Early forensic analysis to graphically assess potential failures, leaks, evacuation plans and so forth; and (5) Quick production of shop or fabrication drawings (Kymel, 2008). The early design and preconstruction stages of a building are the most critical phases to make decisions on its sustainability features (Azhar et al., 2009). Traditional Computer-Aided Design (CAD) planning environments typically lack the capability to perform sustainability analyses in the early stages of design development. Building performance analyses are typically performed after the architectural design and construction documents have been produced. This failure to analyze sustainability continually during the design process results in an inefficient process of retroactive modification to the design to achieve a set of performance criteria (Schueter and Thessling, 2008). To assess building performance in the early design and preconstruction phases realistically, access to a comprehensive set of data regarding a building's form, materials, context and systems is required. Since BIM allows for multi-disciplinary information to be superimposed within one model, it creates an opportunity for sustainability measures to be incorporated throughout the design process (Autodesk, 2008). Azhar et al. (2011) found that information for up to 17 LEED® (Leadership in Energy and Environmental Design, a green building rating system used in the USA) credits can be obtained in the design phase by performing BIM-based sustainability analyses. It means a building information model can be used as a by-product for LEED® analysis thereby saving substantial time and resources. Australasian Journal of Construction Economics and Building Azhar, S et al. (2012) 'Building information modeling (BIM): now and beyond', Australasian Journal of Construction Economics and Building, 12 (4) 15-28 23 Project Constructors In the United States general contractors are the early adopters of BIM among all stakeholders (Azhar et al., 2008a). The contractors and subcontractors can use BIM for the following applications (Hardin, 2009): (1) Quantity takeoff and cost estimation; (2) Early identification of design errors through clash detections; (3) Construction planning and constructability analysis; (4) Onsite verification, guidance and tracking of construction activities; (5) Offsite prefabrication and modularization; (6) Site safety planning; (7) Value engineering and implementation of lean construction concepts; and (8) Better communication with project owner, designer, subcontractors and workers on site. Through these applications constructors can achieve the following benefits: (1) High profitability; (2) Better customer service; (3) Cost and schedule compression; (4) Better production quality; (5) More informed decision making; and (6) Better safety planning and management. Case Study 3 This case study illustrates the use of BIM by general contractor (GC) to minimize design errors via clash detections. The project is a $35 million academic building at the campus of Emory University, Atlanta, Georgia, USA. The architectural model was developed by the project architect. The GC acquired 2D structural and MEP systems drawings from project engineers and converted them into 3D BIM models. By integrating all "single" BIM models and through clash detections in the preconstruction phase, the GC was able to rough save $259,000 as illustrated in Figure 7. (a)Integrated BIM model (b) Cost and time savings via clash detections Figure 7 Use of BIM in the project preconstruction stage (Courtesy of: Holder Construction Company, Atlanta, GA) Facility Managers In the past, facility managers have been handed over the building with boxes and piles of owner's manuals and warranties. The use of BIM provides two major benefits: (1) The same critical information is present in a single electronic file; and (2) the facility managers do not have to sift through the piles of information to gather data. As mentioned by Reddy (2011), "with the BIM database, any information about an equipment is just one-click away." The facility managers can click on any equipment or fixture to obtain information on product, warranties, life cycle of the product, maintenance checks, replacement cost, installation and repair procedures, and even place order for a replacement online (Jordani, 2010). The advances in smart phones and tablet devices (such as iPhone® and iPAD®) and Augmented Reality (AR) has made it possible to obtain complete information about a building component by just pointing the device towards it. Joyce (2012) reported an AR-based system, InfoSPOT® , developed at the Georgia Institute of Technology, Atlanta, Georgia which allows facility managers to obtain quick "on the spot" information about an equipment using their smartphones. Australasian Journal of Construction Economics and Building Azhar, S et al. (2012) 'Building information modeling (BIM): now and beyond', Australasian Journal of Construction Economics and Building, 12 (4) 15-28 24 Risks and Barriers to Implementing BIM Besides numerous benefits of BIM for project stakeholders there are many risks and barriers to implement BIM. In other words, BIM is not a panacea for every project and every firm. The BIM related risks can be divided into two broad categories: (1) Technology-related risks; and (2) Process-related risks. Following sections present brief discussion on each category. Technology-related Risks The first technology-related risk is lack of BIM standards for model integration and management by multidisciplinary teams. Integrating multidisciplinary information in a single BIM model requires multiuser access to the BIM model. This requires establishment of protocols in the project programming phase to ensure consistency in information context and formatting styles. At the moment, since there are no standard protocols available, each firm adopts its own standards. This could create inconsistencies in the model, which if not properly detected, could lead to inaccurate and inconsistent BIM model. The project team should perform frequent "model audits" to ensure avoidance of any such issues (Weygant, 2011). The interoperability issues, though significantly reduced during the last 5 years, still pose considerable risk. Interoperability is the ability to exchange data between applications to facilitate automation and avoidance of data re-entry. The introduction of Industry Foundation Classes (IFC) and XML Schemas has significantly helped to solve interoperability issues (Smith and Tardif, 2009). However, both of these approaches have their inherent limitations. The users must research interoperability while selecting BIM software applications. When project team members other than the owner and architect/engineer contribute data that are integrated into the building information model, licensing issues can arise. For example, equipment and material vendors offer designs associated with their products for the convenience of the lead designer in hopes of inducing the designer to specify the vendor's equipment. While this practice might be good for business, licensing issues can arise if the designs were not produced by a designer licensed in the location of the project (Thompson and Miner, 2007). Process-related Risks The process-related risks include legal, contractual and organizational risks. The first risk is the lack of determination of ownership of the BIM data and the need to protect it through copyright laws and other legal channels. For example, if the owner is paying for the design, then the owner may feel entitled to own it, but if team members are providing proprietary information for use on the project, their proprietary information needs to be protected as well. Thus, there is no simple answer to the question of data ownership; it requires a unique response for 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 (Thompson, 2001). To prevent disagreement over copyright issues, the best solution is to set forth in the contract documents ownership rights and responsibilities (Rosenberg, 2007). Another contractual issue to address is who will control the entry of data into the model and be responsible for any inaccuracies. Taking responsibility for updating building information model data and ensuring its accuracy entails a great deal of risk. Requests for complicated indemnities by BIM users and the offer of limited warranties and disclaimers of liability by designers are essential negotiation points that need to be resolved before BIM technology is used. It also requires more time spent inputting and reviewing BIM data, which is a new cost in the design and project administration process. Although these new costs may be dramatically offset by efficiency and schedule gains, they are still a cost that someone on the project team will incur. Thus, before BIM technology can be fully used, not only must the Australasian Journal of Construction Economics and Building Azhar, S et al. (2012) 'Building information modeling (BIM): now and beyond', Australasian Journal of Construction Economics and Building, 12 (4) 15-28 25 risks of its use be identified and allocated, but the cost of its implementation must be paid for as well (Thompson and Miner, 2007). The integrated concept of BIM blurs the level of responsibility so much that risk and liability are likely to be enhanced. Consider the scenario in which the owner of the building files suit over a perceived design error. The architect, engineers, and other contributors to the BIM process look to each other in an effort to try to determine who had responsibility for the matter raised. If disagreement ensues, the lead professional not only will be responsible as a matter of law to the claimant but may have difficulty proving fault with others such as the engineers (Rosenberg, 2007). One of the most effective ways to deal with such risks is to have collaborative, integrated project delivery contracts in which the risks of using BIM are shared among the project participants along with the rewards. Recently, the American Institute of Architects released an exhibit on BIM to help project participants define their BIM development plan for integrated project delivery (Building Design and Construction, 2008). This exhibit may assist project participants in defining model management arrangements, as well as authorship, ownership, and level-of-development requirements, at various project phases. Based on a survey of 31 contracting firms in the United States, Ku and Taiebat (2011) found the following barriers to BIM implementation: 1. Learning curve and lack of skilled personnel 2. High cost to implementation 3. Reluctance of other stakeholders (e.g. architect, engineer, contractor) 4. Lack of collaborative work processes and modeling standards 5. Interoperability 6. Lack of legal/contractual agreements They indicated that the advances in BIM technology, adoption of IPD and similar project delivery systems, requirement of BIM model by project owners, and introduction of fresh graduates with BIM knowledge in the project teams will ultimately help to avoid these barriers. Authors' Analysis and Conclusions BIM has changed the way the buildings are designed, constructed and operated. The use of BIM has led to improved profitability, reduced costs, better time management and improved customer-client relationships. BIM represents a new paradigm within AEC, one that encourages integration of the roles of all stakeholders on a project. This integration has brought greater efficiency and harmony among players who all too often in the past saw themselves as adversaries. The successful implementation of BIM had allowed project stakeholders to re-engineer and streamline their processes to take full advantage of BIM. BIM has allowed implementing manufacturing concepts such as lean design and modularization into construction. The reemergence of modular construction as a "new" trend can be tied to the rise of BIM, as reported in the SmartMarket report of 2011 published by the McGraw-Hill Construction (SmartMarket Report, 2011). BIM is helping to make the fabrication of increasingly complex building assemblies and subassemblies economically and technologically feasible. The way the BIM movement is progressing, it is not very far that BIM will completely replace CAD systems. As the market continues to adopt BIM as a standard, BIM will continue to flourish. The advances in smartphone and tablet technologies will allow users to instantly use BIM models for communications and quick decision-making. As the use of Cloud Australasian Journal of Construction Economics and Building Azhar, S et al. (2012) 'Building information modeling (BIM): now and beyond', Australasian Journal of Construction Economics and Building, 12 (4) 15-28 26 technology is growing, it would be easier for project stakeholders to quickly access BIM model virtually everywhere. The developments in augmented reality and similar virtual technologies will allow project owners and facility managers to more efficiently operate their buildings. However, there are several technological and managerial challenges ahead. The technological challenges can be broadly classified into three categories (Azhar, 2011): (1) The need for well-defined transactional construction process models to eliminate data interoperability issues; (2) The requirement that digital design data be computable; and (3) The need for well-developed practical strategies for the purposeful exchange and integration of meaningful information among the building information model components. The management challenges cluster around the implementation and use of BIM. Right now, there is no clear consensus on how to implement or use BIM. Unlike many other construction practices, there is no single BIM document providing instruction on its application and use (Associated General Contractors of America 2005). Furthermore, little progress has been made in establishing model BIM contract documents (Post, 2009). Several software firms are cashing in on the "buzz" of BIM and have programs to address certain quantitative aspects of it, but they do not treat the process as a whole. There is a need to standardize the BIM process and to define the guidelines for its implementation. Another contentious issue among the AEC industry stakeholders (i.e., owners, designers, and constructors) is who should develop and operate the building information models and how the developmental and operational costs should be distributed. To optimize BIM performance, either companies or vendors, or both, will have to find a way to lessen the learning curve of BIM trainees. Software vendors have a larger hurdle of producing a quality product that customers will find reliable and manageable and that will meet the expectations set by the advertisements. Additionally, the industry will have to develop acceptable processes and policies that promote BIM use and govern today's issues of ownership and risk management (Post, 2009). Researchers and practitioners have to develop suitable solutions to overcome these challenges and other associated risks. As a number of researchers, practitioners, software vendors, and professional organizations are working hard to resolve these challenges, the future of BIM is exciting and promising. Acknowledgements The authors would like to express their gratitude.

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