



APPLICATION OF BUILDING INFORMATION MODELING FOR THE RESIDENTIAL BUILDING PROJECT

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ABSTRACT

Building Information Modeling (BIM) is a technical tool that allows a project to build virtually before being built physically. It creates consistent, coordinated, computable information about a construction project. The digital information about building can be used for production of high-quality construction documents, design decision-making, cost-estimating, construction planning and eventually for managing and operating the facility. The purpose of this paper is to see the impact of BIM implementation on the traditional conventional building design methods. The BIM extends methodology into three dimensional (3D) drawings in the three primary dimensional width, height and depth. With the above, time as the fourth dimension (4D) and cost as the fifth dimension (5D). 4D model based scheduling can be used to monitor the progress at site without being actually present there. It also helps in monitoring delays in relation to a planned schedule. 5D model based on estimating produces accurate quantities for the efficient estimation of architectural, structural and services components. These quantities can be extracted at various stages: at concepts stage for generating budgets, at the end of design development stage for floating tenders, and at GFC stage for verifying contractor bills. The BIM tools is to be helps for design, defining the building form and spaces, visualisation to analysing costs, time. It is a construction management (CM) tool useful for a simulation process of the ongoing building project.

KEYWORDS: Building Information Modeling, Construction Management, 3D Model, Visualisation

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INTRODUCTION

1.1) Overview

The primary purpose of this research project is to extend building information modeling (BIM) into the construction process and to create a single repository of facility for the owner. Construction planning, scheduling and cost estimating are important part of any construction

project. To translate a design to a construction schedule involves several steps of human interpretation and requires knowledge in the planner's mind. Now the current planning process is largely manual and time-consuming process. Current construction project planning involves a number of techniques that model dependencies and sequencing of project activities. Some of the

techniques involve bar charts, CPM, PERT based network diagrams, and time-changes diagram. None of these techniques have the capability of modeling and visualizing both the sequencing an execution pattern of activities. The BIM model is linked with architectures, civil engineers, structural engineers, MEP system engineers, builders and owner of the project.

1.1) Definition

The National Building Information Model Standard (NBIMS) defines BIM as “a digital representation of physical and functional characteristics of facility and it serves as shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle from inception onward” (Smith and Edgar 2006). BIM represents real world elements such as walls, doors, windows, beam, column etc. as three-dimensional (3D) objects. In addition to geometry details, other information can be attached to these objects including schedule, and cost estimates.

1.1) Objectives

In this study the building project used for basic concepts of the BIM, the planning, and the implementation processes. It determines the BIM is effective tool in the most critical phases of a project’s lifecycle. The procedure of BIM based in real ongoing building project is the main development method used, meaning hands on trials with the state of the software’s, consultations and support by the participating in the organisation, and required data collection from case study projects. After that, a case study of building project in India is presented to develop and use of a building model. The use of BIM has provided for increasing total quality of project, providing accurate quantity takeoffs, and improving scheduling timetables, consequently diminishing total project contingencies and costs. In this case study we have to learn how to generate the 3D model using Revit 2014 software and how to improve productivity, better coordination, and reduce error, and rework.

1) BACKGROUND

2.1) BIM for Construction Managers

The traditional design-bid-build project delivery method is based on an owner requirements and design prepared with the help of architect and

consultants. Construction Management at Risk, Design/Build and Integrated Project Delivery (IPD) methods are the most common project delivery approaches in the industry. Construction managers or general contractors can use BIM model to extract quantities of work to prepare cost estimates. Furthermore, they can provide powerful 3D renderings to the building project. Moreover, schedule integrated BIM known as 4D BIM can be used for animations, safety analysis, and to prepare site logistic plans. Construction managers can use BIM to coordinate work with subcontractors and update schedule and cost of project.

2.2) BIM in Construction Management

There are many uses of Building Information Modeling for each project such as planning, design, construction and operation phases. During the design phase, the BIM can maximize its impact on a project since the ability to influence cost is the highest. During the construction phase the impact of cost in a project reduces as the construction progresses. Several uses include sequencing, cost estimation, fabrication and onsite BIM. During the post construction phase, maintenance scheduling, building system analysis, asset management, and space management and tracking, disaster planning, and record modeling can be recorded with the building throughout its lifecycle.

2.3) Visualization

Building Information Modeling (BIM) is a great visualization tool. It provides a three dimensional virtual representation of the building. During the bidding phase of the project, the construction manager can provide better communication with the renderings, walkthroughs, and sequencing of the BIM model concept in 3D. It takes away thought process of bringing the different traditional 2D views together to the 3D view of a detail.

2.3) 3D Coordination

Collaboration of construction team with the architect, engineer and the owner is preferred to be started on early stages of design phase. If architect is only providing 2D drawings, then the construction manager should convert the 2D drawings to 3D intelligent models. The 3D

coordination can be started after the model is created to ensure that the same space interference (hard clash) or clearance clash (soft clash) conflicts are resolved.

2) APPLICATIONS OF BIM

3.1) Design/Modeling

The object-based parametric modeling feature in BIM allows architects, engineers, structural engineers to leverage multiple functions on the same building model for their own use. With accurate building information and object models, the design/modeling process is dramatically facilitated. The design accuracy and information sharing at all the phases of the design/modeling process also benefit the subsequent activities such as accurate quantity takeoffs and the construction phase for the project control.

3.2) Construction Planning and Monitoring

The construction planning involves scheduling and sequencing of the model to coordinate virtual construction in time and space. The utilization of scheduling introduces time as the 4th dimension (4D). The planning using BIM tool enhances site utilization, space coordination, and product information. The construction manager can use various 4D BIM enabled tools to the quality control process. Overall, construction planning and monitoring with 4D BIM is a great process to build a facility per the designed model.

3.3) Cost Estimating

There are two main elements of a cost estimate quantity take-off and pricing. BIM user generate accurate and reliable cost estimates through automatic quantity takeoff from the building model and get a faster cost feedback on changes in design. If pricing for certain activity is not available in the database, cost estimator may need a further breakdown of the element for more accurate pricing. Cost estimator may need details of the model to figure out the unit price which consists of the unit material cost, unit labour cost, overhead and profit. Once unit price is attained, the cost of entire activity can be attained by multiplication of the total quantity extracted from BIM and unit price.

3.4) Clash Detection

The designs from all organizations can brought together and compared the geometric

clashes between architectural, structural and MEP systems will be detected, checked and modified. Coordination among different organizations is enhanced and errors and omissions are significantly reduced, thus speeding up the construction process, reducing costs, minimizing the likelihood of legal disputes, and shortening the construction period.

3.5) Energy Analysis

The capability to link the building model to energy analysis tool allows users to conduct the energy analysis in the design phase. Traditionally, a separate energy analysis can be conducted at the end of the design process and it is not possible for the users to modify the design to improve the building's energy performance. By using BIM technology, the building model can be linked to energy analysis tools for the energy evaluation during the early design phase. The analysis allows users to make energy-conscious decisions and to test the energy-saving ideas without postponing the design process.

3) BIM Tools Used

There are plenty of Building Information Modeling tools represents the development and use of computer generated n-dimensional models to simulate the planning, design, construction and operation facility. It helps architects, engineers and contractors to visualize what is built in simulated environment and to identify potential design, construction or operational problems. BIM has recently attained in the Architectural, Engineering and Construction (AEC) industry. The following table no 1 depicts the BIM authoring tools and their primary functions. Different software used in BIM tool some of these software's are also capable of scheduling and cost estimation.

Table 1. BIM tools and their primary functions

Product Name	Manufacturer	Primary Function
Revit Architecture 2014	Autodesk	3D Architectural Modeling and parametric design.
Revit Structure 2014	Autodesk	3D Structural
Naviswork	Autodesk	Simulate for

s Manage 2014		whole-project review & generate 4D and 5D model base scheduling.
ArchiCAD	Graphisoft	3D Architectural Modeling
Bentley BIM Suite (Micro Station, Architecture , Structural)	Bentley Systems	3D Architectural, Structural, Mechanical, Electrical, and Generative Components Modeling



Figure 2. 3D Model of a Building

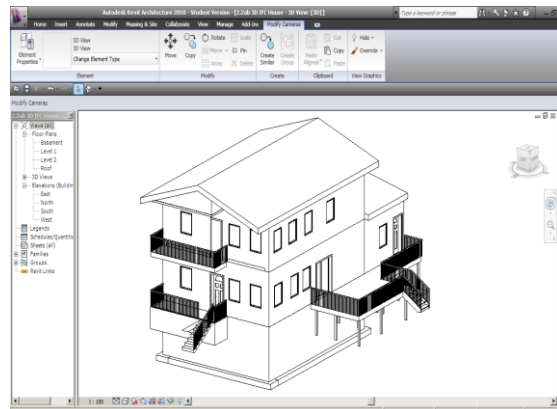


Figure 3. prototype Revit house Model.

4) METHODOLOGY

There are two case studies presented in this project. The first case study, MIT Koch project, and second case study, a prototype house project, examined the 3D and 4D Building Information Modeling as well as BIM based scheduling.

5.1) MIT Koch Institute

MIT Koch centre project used as a case study to understand the use and benefits of BIM in detail. The study includes the utilization of BIM for visualization, 3D coordination, prefabrication, construction planning and record model in a cancer research facility.

5.1.1) 3D Modeling of a House

Revit Architecture was used to develop a 3D house model. First, a new Revit file was created and saved, and then the perimeter walls were created. After the perimeter walls completed, the interior walls are created with the given dimensions. Then, the foundation walls, flooring, doors windows, roof, stairs, deck was created. No mechanical, electrical, plumbing elements were created for this study. The differences of 3D modeling and 2D drafting were reviewed.

The 3D modeling is shown in Figure 2. It referenced floors, grids, and 2D designer drawings, etc. At the design and development phase, the architect generated two-dimensional (2D) CAD drawings. The construction manager developed base Building Information Model from 2D drawings. The BIM software Autodesk's Revit, was used to produce the 3D model. Figure-3. Shows prototype Revit house Model.

5) CASE STUDY

6.1) General

For the case study two-story building in Atpadi is to be selected and the required data is collected from Consultant Company i.e. floor plans, time required for construction etc. The building is 1238 sq ft and is equipped mainly with curtain walls and masonry insulation with hall, one bed room, one master bedroom, one kitchen and stairs on each floor. Figure 4 shows the ground floor plan of the building.

6.2) 3D Modeling of a House

The creation of a 3D housing model using the Revit Architecture 2014 is the powerful tool of BIM. The creation of element on a view such as floor plan translated correctly to a different view such as elevation view. This saved a lot of time in comparison to traditional 2D view. The Revit Architecture 2010 is not very flexible with generation of new elements. In other words, BIM tool easily supported to the alteration of currently available elements, but required time and more

investment to build new elements. For the prototype model, the exterior insulated finish system (EIFS) has metal stud was changed to EIFS on wood stud in the element properties, to save time for the housing project.

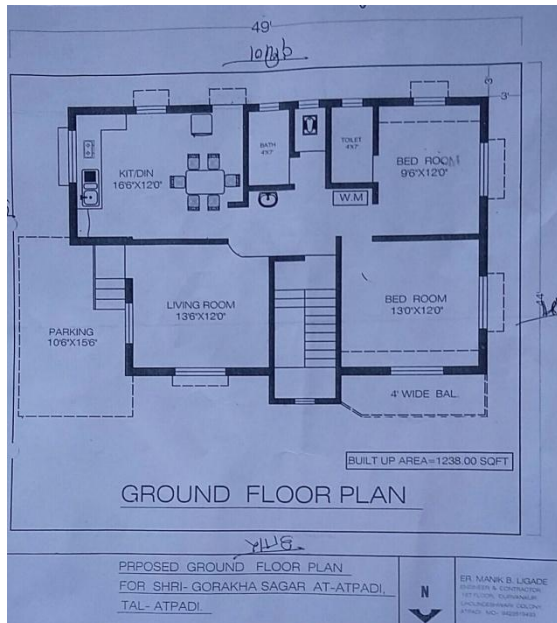


Figure 4. Ground floor plan of the building.

Granularity of objects was another challenge for BIM tools. Revit Architecture 2010 supported the use of splitting, and grouping. For instance, the wall splits between each floor to enable the 4D BIM on a floor basis. However, decomposition of the elements is not available. If the EIFS on wood stud wall was modelled in the Revit model then the breakdown of the elements which included sheetrock, finishing, studs, insulation, exterior skin, could not be separately selected in the model.

Since this hindered the usability of detailed components for estimating, and scheduling purposes. The below figure 5 shows the 3D view of a ground floor plan of a building project using Revit Architecture.

The structural member like foundation, column, beam, floor and roof are added in the above drawing to develop final 3D Model of the building. The first floor plan in 3D is drawn with the help of 2D Auto-CAD plan. Snapshot of computer screen is taken to show final model of building, shown in figure 6.

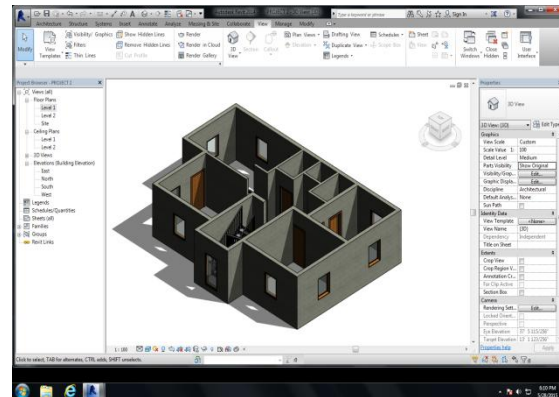


Figure 5. 3D Model for ground floor plan.

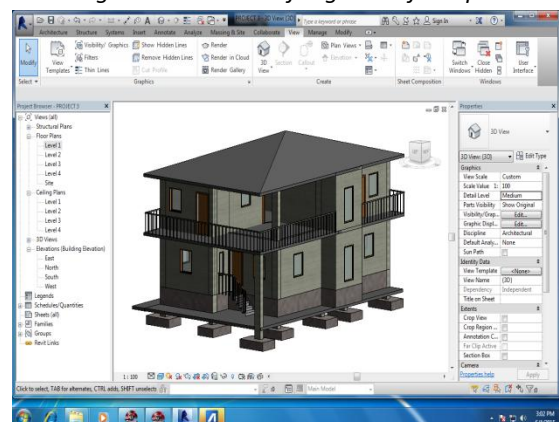


Figure 6. Snapshot Of 3D Model for a construction site using Revit.

6) LIMITATION OF BIM IN INDIA

BIM has no limitation but its application can be perceived only because of resistance adoption and implementation. The BIM is an emerging technology; it is have several risks and liabilities that go along with it. Obviously, one of the biggest risks in firm takes with BIM errors accuracy. BIM technologies, such as training, software costs and required hardware upgrades, are costly and it is very time consuming to implement them into an existing process. Adequate training is required in different areas and levels of expertise can vary. The problem is that because of large amount of data is exchanged among team members, there is the group could endanger the entire project. These new projects are fast-tracked and mandates are being issued to include the very latest building technologies such as BIM. India has large and relatively inexpensive labour available which decreases the value of the productivity improvements that BIM offers. Lower cost of employing workers discourages efforts to replace field labour with automated solution using

BIM. However, BIM offers time savings and competitive advantage and it helps in quick turnarounds in the intense time pressured and competitive environment of India.

7) CONCLUSION

During the construction for better understand and communicate project risk, intent and options before a project, 3D model is helpful. Streamline design tasks with the discipline-specific tools that incorporate parametric controls, support engineering standards, and provide design validation rules. Evaluate constructability and identify design conflicts before construction begins. In construction process data is shared at the same consistent across the project lifecycle. In the building construction project in planning can produce a 3D Model to increase visualisation of the building. Revit Architecture is easy to handle software used in BIM for the construction industry.

8) REFERENCES

- [1] Scope of Building Information Modeling (BIM) in India - by J. Vinoth Kumar and Mahua Mukherjee, Indian Institute of Technology, Roorkee, India. December 2009.
www.jestr.org/downloads/volume2/fulltext/2909.pdf
- [2] A Review of Building Information Modeling (BIM) for Construction Industry by N. S. Chougule Civil Engineering Department, Government college of Engineering Karad.
www.ijirae.com/volumes/Vol2iss4/17.APAE/10106.pdf
- [3] Innovative Generation in Cost Management through BIM Environment - by Mushui LIN, March 2013.
- [4] Benefits Of Building Information Modeling For Construction Managers And BIM Based Scheduling – by Mehmet F. Hergunsel, May 2011.
- [5] Developments In Cost Estimating And Scheduling In BIM Technology – by Xinan Jiang, The Department of Civil & Environmental Engineering, Construction Engineering & Management, North eastern University, Boston, Massachusetts, August 2011.
- [6] An experimental and interview-based approach on site to Develop and implement new work methods - by Adam Lindström, Department of Civil and Environmental Engineering, Division of Construction Management, Goteborg, Sweden 2013.
- [7] Building Information Modeling (BIM): Site-Building Interoperability Methods – by Menglin Wang, September 2011.
- [8] BIM Quantity Take Off: Assessment of the quantity takeoff accuracy as an automatic process. The special case of Revit and Vico office – by David Couto Cerqueiro, 29 August 2014.
- [9] Assessment of 4D BIM Application for Project Management Function – by Alberto Urbina Velasco, 26 August 2013.
- [10] An Investigation on Some Benefits of BIM Application – by Aliye Dalci, Eastern Mediterranean University, August 2014.
- [11] A Guide to Estimating With Building Information Modeling and Traditional Modeling Using Autodesk Quantity Takeoff – by Gregory Hsu, 3 April 2012.