



Effective Application of Building Information Modeling in Construction

Akhilasree D G¹, Dr. T R Sethu Raman²

¹PG Student, Sivaji College of Engineering and Technology, Manivila, Tamil Nadu, INDIA

²Principal, Sivaji College of Engineering and Technology, Manivila, Tamil Nadu, INDIA

ABSTRACT

Lack of Adequate Visualization of Construction Project, Construction Operations Often Causes Project Parties to Struggle with large Amount of Data. The Building Information Modeling (BIM) is a static model, built for Representing the Geometry of a Constructed Building and its Respective Information. However, Construction Processes are Dynamic and Require Dynamic Representation. From the Plan or Model itself, a Anyone can Understand the full Details of the Building and also to Track the Performance of Construction, which is the main aim of this Project. It Describes the Digital Representation of Building Instead of two Dimensional Plans, Drawings etc. It also Concerns with Some of the Applications of Building Information Modeling such as Automatic Quantity Extraction and Materials take off from the Model, Visualization of n-Dimensional model. This project uses Revit Architecture Software as a Platform for Building Information Modeling.

Keywords— Building Information Modeling, Quantity take off, ND Model, Parametric Modeling.

quantities and properties of building elements, cost estimates, material inventories and project schedule. The model can be used to demonstrate the entire building life cycle. As a result, quantities and shared properties of materials can be readily extracted. Scopes of work can be easily isolated and defined. 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 design team members to collaborate more accurately and efficiently than using traditional processes.

Building Information Modeling

Building Information Modeling is the human activity of using BIM software and other related software, hardware and technologies to create and use in a building information model. BIM means not only using three-dimensional intelligent models but also making significant changes in the workflow and project delivery processes

Features of BIM

BIM has some specific features that can effectively be used in project management. These features which are increasingly developed can be summarized as follows.

Clash Detection

One of the common problems of different disciplines plans for a construction project is the geometrical design inconsistencies. This issue happens when there is an overlap between the plans of different disciplines. Using BIM, it would be possible to bring the plans together and detect the clashes. Modifying the aesthetic problems is another possibility of this visual checking.

Constructability Using BIM

It would be possible for teammates in a project to review and handle constructability issues and (if needed) promote issues into RFIs. In addition, visual information can be provided from a vantage point to show the problems. This visual information accompanying markup allows further investigation for finding solutions and thus mitigates the risks. This help the project managers, designers and engineers in doing more analyses and

I. INTRODUCTION

The construction industry has long sought techniques to decrease project cost, increase productivity and quality, and reduce project delivery time. Building information modeling (BIM) offers the potential to achieve these objectives. BIM simulates the construction project in a virtual environment. With BIM technology, an accurate virtual model of a building, known as a building information model is digitally constructed. When completed, the building information model contains precise geometry and relevant data needed to support the design, procurement, fabrication, and construction activities required to realize the building. After completion, this model can be used for operations and maintenance purposes.

A building information model characterizes the geometry, spatial relationships, geographic information,

enabling better decision making is another aspect of BIM. By linking the building information models to appropriate tools, it would be possible to analyze the energy consumption of a construction project and then find better solutions such as changing materials and orientation, mass and space, etc. Moreover, light, mechanical and acoustics analyses are also available to be performed by BIM.

Time & Cost Estimation

Time and cost estimation are other features of BIM which enable project managers to visualize the construction project at any point in time and have a clear understanding of project phases. Time and cost estimation, which are generally called 4D and 5D, can be properly utilized in the first stages of a project and facilitate the decision making process with minimum cost and time needed. Furthermore, BIM has the capability to simulate the various alternatives for a construction project and hence helps project managers and executives to reliably predict the consequences of their decisions.

Integration

The project team can deal and interact with a unified model when a composite model is built from an amalgam of various disciplines' models. Having this capability, and through the different phases of a construction project, BIM can coordinate the design, analysis, and construction activities on a project and, therefore, results in integrity of projects.

Quantity Take-off

Quantity takeoffs in a BIM model can be very helpful for the project teams and managers to analyze their decision and have a clear and reliable insight to various alternatives in the design phase or even throughout the project lifecycle. Since there is a possibility of integration between the BIM model and a database containing cost estimation, an accurate estimation can be obtained faster. Moreover, these takeoff items can be used easily in procurement procedure.

Element Based Models

Since the BIM models generally are composed of objects –and not geometries, such as line, surface, etc. The whole model can be divided into a specific number of smaller objects. This breakdown makes it possible to have a defined and clear scope of projects. The distinction between the elements will result in a better management design, estimation and construction.

Collaboration and Team Building

Collaboration and team building is another key factor for BIM success on construction projects. All efforts made by various specialties on a project are unified and applied to one model. This results in direct correspondence and team building. All disciplines have to work on a unified model as a team and have an effective collaboration during a project using the BIM concept.

Communications

The Nature of a unified model to input, modify and analyze the data in BIM models will improve

communication and collaboration between all parties involved on the construction project including project managers, architects, engineers, and contractors. These unique building models facilitate the communication throughout the project and lessen the disputes between different parties.

BIM Risks

BIM risks can be divided into two broad categories: legal (or contractual) and technical. In the following paragraphs, key risks in each category are briefly discussed. 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. To prevent disagreement over copyright issues, the best solution is to set forth in the contract documents ownership rights and responsibilities. As the dimensions of cost and schedule are layered onto the building information model, responsibility for the proper technological interface among various programs becomes an issue. Many sophisticated contracting teams require subcontractors to submit detailed critical path method schedules and cost breakdowns itemized by line items of work prior to the start of the project.

The general contractor then compiles the data, creating a master schedule and cost breakdown for the entire project. When the subcontractors and prime contractor use the same software, the integration can be fluid. In cases where the data are incomplete or are submitted in a variety of scheduling and costing programs, a team member usually a general contractor or construction manager must reenter and update a master scheduling and costing program. That program may be a BIM module or another program that is integrated with the building information model. At present, most of these project management tools have been developed in isolation. Responsibility for the accuracy and coordination of cost and scheduling data must be contractually addressed.

II. REVIEW OF LITERATURE

1. Quantity take off System using BIM

Since construction projects are large and complex, it is especially important to provide concurrent construction process to BIM models with construction automation. In particular, the schematic Quantity Take-Off (QTO) estimation on the BIM models is a strategy, which can be used to assist decision making in just minutes. This paper suggests a QTO process and a QTO prototype system within the building frame of Open BIM to improve the low reliability of estimation in the early design stage.

2 Overview of BIM

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 for project stakeholders with the help of case studies. The paper also elaborates risks and barriers to BIM implementation and future trends.

3 BIM implementation using Autodesk

Step by step all companies are moving to BIM technology now days. It accelerates work and makes efforts of designers' more effective. Unfortunately, it is not so easy. Aim of this article is to provide specialists that a moving to BIM technologies with required practical recommendations. BIM technologies make work on the project much more effective and easier; however, beginning of using BIM is quite complicated. A lot of specialists have investigated privileges of BIM, but there are no recommendations about implementation.

Before starting working in BIM, it is necessary to make a clear integration plan: 1) Select the departments that will be first, 2) Choose the first project, 3) Choose person who would be BIM Manager, 3) Provide training in the basic disciplines, 4) Conduct training with collaboration, administration, etc. 5) Practice team work, 6) Create content libraries and templates, 7) Write instruction, BIM-company standard, 8) Ask for help a professional. Main recommendations are to use Autodesk software.

4 Effectiveness of BIM

The Iranian construction industry has long been criticized for being inefficient. It has been claimed that 80 percent of all content within the construction process is the same for all projects and there are therefore huge opportunities for improvements. The project manager is essential for the successful delivery of construction projects. The purpose of this paper is to analysis how BIM (Building Information Modeling) can be utilized by project managers as a good tool to simulate project condition to avoid redundant works and waste of time and cost. It was concluded that project managers generally have little knowledge concerning BIM, which makes it hard for them to see its applications. The study revealed that BIM can help project managers in the task of delivering successful projects. BIM a better basis for decisions is provided in comparison with traditional projects.

5 Evaluation of BIM

For a sustainable building, the use of energy always concerns clients and designers. In this respect, the UK national regulation on energy performance and 'carbon' accounting has asked for a greater consistency of construction information to achieve the CO2 emission target. Therefore, Clients and Industry should work closely

together in developing plans to make the transition to low carbon buildings feasible in order to meet the CO2 emission target. In this context, Building Information Modeling (BIM) can play a key role in addition to its capability to create more homogenization of the construction supply-chain. For the energy analysis packages, the designers usually receive feedback on their design; such as how much energy the building will use, what are the anticipated CO2 emissions and if the building will pass performance criteria).

III. METHODOLOGY

Create 3D Model

In this step, a 3D model of a residential apartment was created with the use of BIM software. Revit Architecture software is used for the modeling purpose. The inputs (length, breadth and depth) of the software were given to the software.

Automatic quantity takes off

Revit Architecture was used for the automatic quantity extraction from the 3D model. In this the quantities of all the items and materials of works were automatically extracted.

Cost estimation and scheduling

The cost details of the building were calculated with the use of excel software. Unit rate of materials, equipments, labours were taken from schedule of rate book published by government.

Visualisation of nD model

In this stage the n-dimensional model was visualized. The model had cost of materials, labours, equipments and work; quantity of materials, labours, equipments for each individual member.

Conclusion and suggestion

Some of the BIM applications such as automatic quantity extraction and materials take off from the model; visualization of n-Dimensional model would be implemented.

IV. DATA COLLECTION AND ANALYSIS

The data related to this project were to be collected from construction department. The schedule of rate had the details of cost of materials, labours, equipments and work; quantity of materials, labours, equipments for work. The conveyance statement contains the details of materials, distance, conveyance charge and total amount.

Creation of 3D Model

Revit building design software is specifically built for Building Information Modeling (BIM), with features for architectural design, MEP and structural engineering, and construction. It brings ideas from concept

to construction with a model-based approach. The Revit work environment allows users to manipulate whole buildings or assemblies (in the project environment) or individual 3D shapes (in the family editor environment). Modeling tools can be used with pre-made solid objects or imported geometric models. An experienced user can create realistic and accurate families ranging from furniture to lighting fixtures, as well as import existing models from other programs. Revit families can be created as parametric models with dimensions and properties. This lets users modify a given component by changing predefined parameters such as height, width or number in the case of an array. In this way a family defines a geometry which is controlled by parameters, each combination of parameters can be saved as a type, and each occurrence (instance in Revit) of a type can also contain further variations. For example, a swing door may be a Family. It may have types describing different sizes, and the actual building model will have instances of those types placed in walls where instance-based parameters could specify the door hardware uniquely for each occurrence of the door.

Use and Implementation

Revit can be used as a very powerful collaboration tool between different disciplines in the building design sphere. The different disciplines that use Revit approach the program from unique perspectives. Each of these perspectives is focused on completing that discipline's task. When considering using Revit it is important to look at a company's existing work flow process and determine if such an elaborate collaboration tool is required.

Working with Revit Architecture

Revit is a single application that includes features for architectural design, MEP and structural engineering and construction. Walls are typically created in plan views. Walls are system families in Revit, which means they exist in a project but cannot be saved as individual families. Revit makes it possible to create and customize walls to meet the needs of our design. Floors and roofs, which may seem to be simple or common building components, can sometimes prove to be difficult to model and detail in your project designs. We can start modelling the floors with generic types, which are similar to generic walls containing a single layer, and then change the generic floors to more specific assemblies later in the development of your project. Because floors, ceilings, and roofs are sketch-based objects, the method we use when creating the boundary lines is critical to the behaviour of the element to those around it. By selecting the walls to generate the sketch for the roof, we are creating an intelligent relationship between the walls and the roof. If the design of our building later changes and the wall position is modified, the roof will follow that change and adjust to the new wall position without any intervention from us. Roofs come in a number of shapes and sizes. Once the

fundamental concepts, tools, and logic pertaining to roof in Revit are understood, we will be able to design almost any roof shape.

Families are files external to the project that are preloaded in Project templates or loaded on demand into Revit Projects to represent components used to build our model, such as walls, windows, stairs, doors, etc. Each family can have multiple types, such as different size, materials, parameter variables, etc. Any change to a type is updated in every instance throughout the project. For example, when we change the window height of one of our window type, all the windows with the same window type are updated instantly. There is a list of predefined families that are shipped with your Revit software. However, we can also create your own family. Autodesk Revit software enables us to use and create component families that can be easily modified to help meet the requirements of different projects. It offers great flexibility and to help increase your modeling productivity. We can easily change the parameters defined for existing component and create new types as needed with different dimensions, appearances, visibility, and performance characteristics. By creatively working with the parameters available, we can often adapt a single component family to model a wide variety of elements in the project.

Automatic Quantity take off

Revit Architecture was used for the automatic quantity extraction from the 3D model. In this the quantities of all the items of works were automatically extracted from the model. The quantities of each individual item of works were automatically extracted from the model. The automatic quantity extraction had the details of wall schedule, doors and windows schedule, room schedule, staircase and column schedule, roof schedule.

Wall Schedule

The wall schedule had the items of area, length, volume, width, count, height, etc. The wall schedule is shown in figure 1.

Wall Schedule					
Area	Count	Length	Volume	Width	Family
14.75 m ²	1	455	2.92 m ³	20	Basic Wall
35.85 m ²	1	1070	7.17 m ³	20	Basic Wall
3.69 m ²	1	125	0.37 m ³	10	Basic Wall
4.69 m ²	1	245	0.47 m ³	10	Basic Wall
3.69 m ²	1	125	0.37 m ³	10	Basic Wall
15.08 m ²	1	450	3.02 m ³	20	Basic Wall
31.60 m ²	1	1020	6.32 m ³	20	Basic Wall
16.42 m ²	1	510	3.26 m ³	20	Basic Wall
10.17 m ²	1	304	1.97 m ³	20	Basic Wall
10.55 m ²	1	294	1.98 m ³	20	Basic Wall
9.36 m ²	1	490	0.94 m ³	10	Basic Wall
4.52 m ²	1	150	0.87 m ³	20	Basic Wall
4.52 m ²	1	150	0.45 m ³	10	Basic Wall
4.52 m ²	1	150	0.45 m ³	10	Basic Wall
4.52 m ²	1	150	0.45 m ³	10	Basic Wall
17.11 m ²	1	508	3.40 m ³	20	Basic Wall
30.81 m ²	1	1070	6.16 m ³	20	Basic Wall
4.69 m ²	1	160	0.94 m ³	20	Basic Wall
7.71 m ²	1	245	0.77 m ³	10	Basic Wall
11.56 m ²	1	355	2.31 m ³	20	Basic Wall
7.71 m ²	1	245	0.77 m ³	10	Basic Wall
23.38 m ²	1	855	4.60 m ³	20	Basic Wall
10.91 m ²	1	515	1.09 m ³	10	Basic Wall
16.42 m ²	1	500	3.26 m ³	20	Basic Wall
25.88 m ²	1	802	5.12 m ³	20	Basic Wall
11.30 m ²	1	470	2.26 m ³	20	Basic Wall
2.34 m ²	1	125	0.23 m ³	10	Basic Wall
5.36 m ²	1	160	0.54 m ³	10	Basic Wall

Figure 1: Wall Schedule

- [5] Dr.Peter Smith, 'BIM implementation- global strategies',Procedia Engineering 85 (2014) 482 – 492
- [6] Hyunjoo Kim, Kyle Anderson , SangHyun Lee , John Hildreth,'Generating construction schedules through automatic data extraction using open BIM (building information modeling) technology',Automation in Construction 35 (2013) 285–295
- [7] Ibrahim Motawa, Kate Carter, 'Sustainable BIM-based Evaluation of Buildings'.
- [8] Abdulsame Fazlia, Sajad Fathia, Mohammad HadiEnferadi , MayramFazlib, BehroozFathic,'Appraising effectiveness of Building Information Management (BIM) in project management',Procedia Technology 16 (2014) 1116 – 1125