# Application of BIM for Scheduling and Costing of Construction Project

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**Abstract -** *Building Information Modelling (BIM) has emerged as cutting edge technology for AEC (Architectural, Engineering and Construction Industry. The concept of BIM has existed since the 1970s. Since then to till date BIM applications in AEC Industry has made remarkable improvements. The AEC industry consists of many separate layers, and the amount of information a construction project contains is tremendous. Project time and cost are the two main elements that concerns all stakeholders. These elements are vital to the project, and they can be the basic foundation for decision-making, collaboration, procurement, etc. Traditional building design was largely depending upon two-dimensional technical drawings (plans, elevations, sections, etc.). Building information modeling extends this beyond 3D, augmenting the three primary spatial dimensions (width, height and depth) with time as the fourth dimension (4D) and cost as the fifth (5D). BIM therefore covers more than just geometry. It also covers spatial relationships, light analysis, geographic information, and quantities and properties of building components. The main aim of this paper is to study the Application BIM for Scheduling and Costing of Construction Project, its benefit, Adoption barriers or limitations for its application.*

***Key Words***: **BIM**, **AEC**, **3D**, **4D** & **5D**

## 1. INTRODUCTION

Building Information Modelling (BIM) has emerged as cutting edge technology for AEC (Architectural, Engineering and Construction Industry. The concept of BIM has existed since the 1970s. The term 'building model' (in the sense of BIM as used today) was first used in papers in the mid-1980s: in a 1985 paper by Simon Ruffle eventually published in 1986, and later in a 1986 paper by Robert Aish - then at GMW Computers Ltd, developer of RUCAPS software - referring to the software's use at London's Heathrow Airport. The term 'Building Information Model' first appeared in a 1992 paper by G.A. van Nederveen and F. P. Tolman.[1]

Traditional building design was largely depending upon two-dimensional technical drawings (plans, elevations, sections, etc.). Building information modeling extends this beyond 3D, augmenting the three primary spatial dimensions (width, height and depth) with time as the fourth dimension (4D) and cost as the fifth (5D). Therefore BIM is not just Building Information Modelling but in simple words it's a integration of best practices in terms of Software/s used in each discipline of Project Management e.g. Design (3 D Modelling), Project Costing and Project Scheduling.

The core essence of BIM is "I", which represents the information that the BIM models can carry. Unlike a 2D drawing, the 3D models created in modeling software are not only simple graphics of the future building; but they also record all data for a project throughout the project life cycle. .

### 1.1 Aim of the Project & Paper

The purpose of this project is to study the BIM application for Project Scheduling and Costing of Construction projects including barriers in implementing BIM.

### 1.2 Objective of the Project & Paper

The objective of this project and paper is

i) To Study conventional method of preparing 2D/3D Drawing, Project Scheduling, Quantity Take Off and Cost Estimation.

ii) To Study BIM (Building Information Modeling) for Project Scheduling and Quantity Take off by preparing 3D model in Revit Autodesk for practical problem.

iii) To Study the Benefits of BIM Applications for Project Scheduling and Quantity Take off and additional requirements if any, to be put into the model to get more benefits in terms of Project Scheduling and Quantity Take Off.

iv) To compare the conventional methods and BIM Applications of Quantity Take Off and Project Scheduling

v) To Study the barriers of an effective implementation of BIM application for Project Scheduling and Quantity Take off.

## 2. PRESENT THORIES & LIETRATURE REVIEW

To gain a thorough understanding of information handling in BIM Applications for Project Scheduling and Quantity Take Off / Costing is conducted in the beginning of the project.

In search of literature, scientific articles, books, and reports from companies and organizations in the construction industry have been reviewed. Furthermore, older Master's Thesis are studied to attain a broader knowledge of what research has been conducted in the studies and related fields.

Following are the list of researcher who has worked in that area

1) FREDRIK KULLVÉN, KATRINE NYBERG (From Division of Construction Management, CHALMERS University of Technology, Sweden) elaborated in detail about Possibilities with BIM in relation to cost estimation and scheduling, in their Master of Science Thesis in the Master's Programme Design and Construction Project Management.

2) Juan Franco, Faiza Mahdi, Hussein Abaza, Department of Construction Management, Kennesaw State University mentioned about Using Building Information Modeling (BIM) for Estimating and Scheduling, Adoption Barriers, in their Paper published in Universal Journal of Management.

3) A Thesis submitted by Dalu Zhang from North Dakota State University Of Agriculture and Applied Science gives basics about PROJECT TIME AND COST CONTROL USING BUILDING INFORMATION MODELING

The focus of present theories and practices, Literature Survey lies in the consideration of the what as well the why.

## 3. PROBLEM STATEMENT

1. Lack of communication, rework, cost and time overrun are the major problems faced by construction firms. Timely & accurate feedback of actual cost enables project managers to take appropriate corrective actions that would minimize cost overrun in a timely manner & is possible by using BIM.

2. As project progress, the process of construction monitoring & control gets more complex due to the huge amount of information that need to be measured and analysed.

## 4. METHODOLOGY

In order to achieve the objectives, the methodology adopted is follows.

i) Study of previous research on BIM Applications for Project Scheduling and Quantity Take Off / Costing.

ii) Study of prevailing industry practices for preparing 2D/3D Drawing, Project Scheduling and Quantity Estimation / Cost Estimation.

iii) Study of BIM Framework in relation with Modeling (3D), Project Scheduling (4D) and Quantity Take Off / Costing (5D)

iv) By preparing of Sample model (3D) by using Autodesk Revit / Revit Architecture.

v) Comparing process of Conventional Methods of Quantity Take Off and Project Scheduling with BIM Application for Quantity Take Off & Project Scheduling.

vi) Study of Benefits / Advantages of Using BIM Applications for Quantity Take Off and Project Scheduling.

vii) Barriers for using BIM Applications for Quantity Take off and Project Scheduling Navisworks used to confirm the model and the progress of the construction on the iPad using the apps BIM360Glue, Buzzsaw, Autodesk 360

viii) Bridge gapping measures and listing of additional inputs needed in the Software for additional benefits.

## 5. BIM MODELLING - FROM 3D TO 4D & FROM 3D TO 5D

Building Information Modeling (BIM) is a process that involves creating, generating, managing and using a digital cum graphical representation of physical and functional characteristics of the Project e.g. quantitative and qualitative database.

### 5.1 BIM Modeling From 3D (Modeling) to 4D (Project Scheduling)

The use of the term 4D is intended to refer to the fourth dimension; time, i.e.4D is 3D+Schedule (time). The role of 4D BIM is to add a new dimension to 3D CAD Drawings or Solid modeling.

In order to create a proactive management it is important for project teams to visualize the construction process in four dimensions. Creating this link between space and time

is one of the visions with BIM and referred to as the fourth dimension of CAD. The main idea is to connect activities in the time plan to objects in the 3D model enabling visual simulations of the building process by hiding and revealing objects in a sequential order. The visualized 4D models can help managers to make decisions about different method alternatives, and since every object can be coded with information such as size, material, required workforce and equipment, they can be used to make time plans, material delivery plans, purchasing schedules, etc.. In big projects with many actors it can also be possible to connect different models and optimize production together with other stakeholders.

### 5.2 BIM Modeling From 3D (Modeling) to 5D (Project Costing)

The use of the term 5D is intended to refer to the fifth dimension; Cost, i.e.5D is 3D+Cost (Quantity Take Off).

The major benefit of this system is to workout different design options those can be compared and then act as a supporting base for decision-making. Furthermore, when connected to time aspects the model can facilitate cost control in real time, giving managers the opportunity to monitor cost developments during projects.

## 6. SOFTWARES USED

The following softwares are used for the sample preparation of Case Study for BIM integration 3D with 4D and 5D

i) Autodesk Revit Architecture - For 5D
ii) Astra Power Project – For 4D
iii) Microsoft Project

## 6. SAMPLE CASE STUDY

A sample 2D drawing of Room is prepared in AutoCAD and thereafter 3D Model is prepared using AUTODESK Revit Architecture.

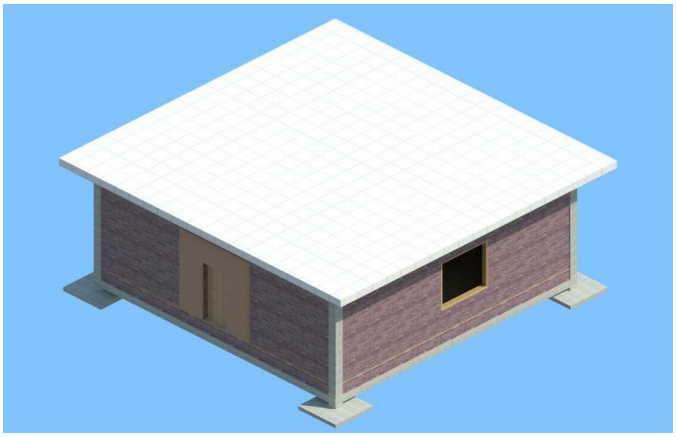

**Fig -1**: Sample of 3D Rendered image

BOQ for all Structural Items

Door Schedule

| Family | Family and Type | Height | Thickness | Width |
|---|---|---|---|---|
| Double-Panel 1 | Double-Panel 1: 68" x 80" | 2.4 | 0.05 | 1 |
| Double-Panel 1 | Double-Panel 1: 68" x 80" | 2.4 | 0.05 | 1 |
| Grand total: 2 | | | | |

Window Schedule

| Family | Family and Type | Height | Sill Height | Width |
|---|---|---|---|---|
| Fixed | Fixed: W 20 | 2 | 0.91 | 2 |
| Fixed | Fixed: W 20 | 2 | 0.91 | 2 |
| Grand total: 2 | | | | |

Floor Schedule

| Area | Family | Family and Type | Volume | Structural Material |
|---|---|---|---|---|
| 104.65 m² | Floor | Floor: Floor 0.06 | 6.28 m³ | Oak Flooring |
| 104.65 m² | | | | |

Roof Schedule

| Area | Family | Family and Type | Volume |
|---|---|---|---|
| 141.24 m² | Basic Roof | Basic Roof: Roof | 43.05 m³ |

Structural Column Schedule

| Family | Family and Type | Length | Volume |
|---|---|---|---|
| Concrete-Square-Column | Concrete-Square-Column: 0.3 x 0.3 | 5.3 | 0.48 m³ |
| Concrete-Square-Column | Concrete-Square-Column: 0.3 x 0.3 | 5.3 | 0.48 m³ |
| Concrete-Square-Column | Concrete-Square-Column: 0.3 x 0.3 | 5.3 | 0.19 m³ |
| Concrete-Square-Column | Concrete-Square-Column: 0.3 x 0.3 | 5.3 | 0.44 m³ |
| Grand total: 4 | | | |

Structural Foundation Schedule

| Area | Family | Family and Type | Length | Width | Height Offset | Volume |
|---|---|---|---|---|---|---|
| 2.56 m² | Foundation Slab | Foundation Slab: Footing | 1.6 | 1.6 | 0.15 | 0.39 m³ |
| 2.56 m² | Foundation Slab | Foundation Slab: Footing | 1.6 | 1.6 | 0.15 | 0.39 m³ |
| 2.56 m² | Foundation Slab | Foundation Slab: Footing | 1.6 | 1.6 | 0.15 | 0.39 m³ |
| 2.56 m² | Foundation Slab | Foundation Slab: Footing | 1.6 | 1.6 | 0.15 | 0.39 m³ |

Wall Schedule

| Area | Family | Family and Type | Length | Volume |
|---|---|---|---|---|
| 3.09 m² | Basic Wall | Basic Wall: Beam 0.3 x 0.1 | 10 | 0.93 m³ |
| 3.00 m² | Basic Wall | Basic Wall: Beam 0.3 x 0.1 | 10 | 0.90 m³ |
| 3.00 m² | Basic Wall | Basic Wall: Beam 0.3 x 0.1 | 10 | 0.90 m³ |
| 2.91 m² | Basic Wall | Basic Wall: Beam 0.3 x 0.1 | 10 | 0.87 m³ |
| 45.07 m² | Basic Wall | Basic Wall: Wall 230 | 10 | 10.37 m³ |
| 42.40 m² | Basic Wall | Basic Wall: Wall 230 | 10 | 9.75 m³ |
| 44.00 m² | Basic Wall | Basic Wall: Wall 230 | 10 | 10.12 m³ |
| 41.33 m² | Basic Wall | Basic Wall: Wall 230 | 10 | 9.51 m³ |

**Table -1**: Sample of Quantity Take Off

Today, most quantity information is produced manually from 2D drawings. This is a time consuming process and there is possibility of mistakes, it may be typing mistake or formula mistake, this can lead to inaccurate quantity information.

Cost overrun is the main problem in AEC industry. Peeters & Madauss(2008) stated the biggest cause of cost overrun is inaccurate estimation at the beginning of the project.

This drawback is overcome by using BIM, By using Revit 2017, quantity is extracted from a model and transfers it for cost estimation. This can save time and it is very accurate also. But for getting accurate quantity, model should be required very accurate and all detailing require to show in model.

## 7. CONCLUSIONS

By using BIM for estimation there is 80% reduction in time as compare to estimation by conventional method.It saves times. The implementation of BIM in AEC industry can make the industry more flexible, effective and innovative.

## REFERENCES

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