



# CONSTRUCTION COST ESTIMATION OPTIMIZATION USING BUILDING INFORMATION MODELLING (BIM)

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**Abstract-** Compare commercially available BIM estimating tools, performance, and new construction workflows in a 5D BIM-based construction project. At this point in the design process, the cost of the project is usually approximated due to industry segmentation and the design line's segmentation. Very far along in the design process, which means it's too late to assist various stakeholders in making well-informed judgments. Perform In the design phase, value engineering and calculating early expenses have the ability to speed things up. High-quality, cost-effective buildings are the result of a more efficient project delivery procedure. There is a focus on changes in the workplace as part of the initiative. The Building Information Model (BIM) Estimation Process has been implemented in the construction project. Several BIM-based cost estimation software packages have been evaluated to support the various stages of design in this project. Examined the benefits and drawbacks of working with this software. The project's BIM-based estimation process was analyzed for its work practices and workflow [1]. Ultimately, we came up with a multi-stage technology adoption plan.

**Keywords-** BIM, Informed-decisions, multi-stage technology, Stakeholders, Workflows

## 1 Introduction

The cost of the design process is typically assessed over time due to the segmentation and percentage of the building industry. Because of this, it is a long way behind in terms of design. Assistance in decision-making for a wide range of stakeholders. Budget difficulties and the cost development process are typically highlighted in this Cost feedback [2]. The majority of construction engineering methods lower construction costs, performance, and quality of the build. There are numerous ways in which a company can speed up the process of producing high-quality, cost-effective projects, such as through value engineering. As long as BIM-based technologies have been available, expenses are based on just a few large ones. For construction companies, this functionality has been a boon.

CAD-based (Computer-Aided Design) documentation is being replaced with BIM-based (Building Information Modeling) documentation in today's business. One of the advantages of BIM over CAD drawings is that it has a huge amount of information that can be digitally extracted. Construction projects can benefit from the application of BIM-based cost estimating methods. The primary goal of this project is to test and evaluate various workflows in BIM-based projects. As the first project to use BIM for cost estimating, this is an exciting step forward for the construction industry. Data and workflow modelling and comparison studies are the second building aspect. Lastly, to increase interest and awareness in implementing 5D BIM among key stakeholders of the Pakistan construction industry



## 2 Experimental Procedures

The modelling process begins with the selection of a representative design project. Building Information Modeling (BIM) will be used for the modelling process. Revit 2019 is the tool of choice for modelling applications. After the project has been modeled, cost information will be added to the building components. 5D BIM Cost Estimation will then be done using tools like Autodesk Navisworks Manage 2019 and Sigma Estimates. In order to complete this task, we must:

1. Several BIM-based cost estimating tools will be examined to assist different phases of design, including an assessment of current estimation methods and a comparison with BIM, suggested processes gathered from the literature (Eastman et al., 2011).
2. This software's advantages and drawbacks will be examined.
3. There will be a review of BIM-based estimating procedures and workflows.

### 2.1 Existing Estimation Processes and Workflows.

The estimating process in the classic design-build procurement paradigm is simple and easy. Paper-based and prescriptive bidding documents are still common. In order to establish a project budget for the purpose of validating sub-trades and supplier costs, documents are scanned for on-screen take-off and quantity data is entered into cost estimation software (MS Excel). There are many advantages to using integrated procurement modes, such as iterative cost and constructability validations or checks during the design phase (Figure 1).

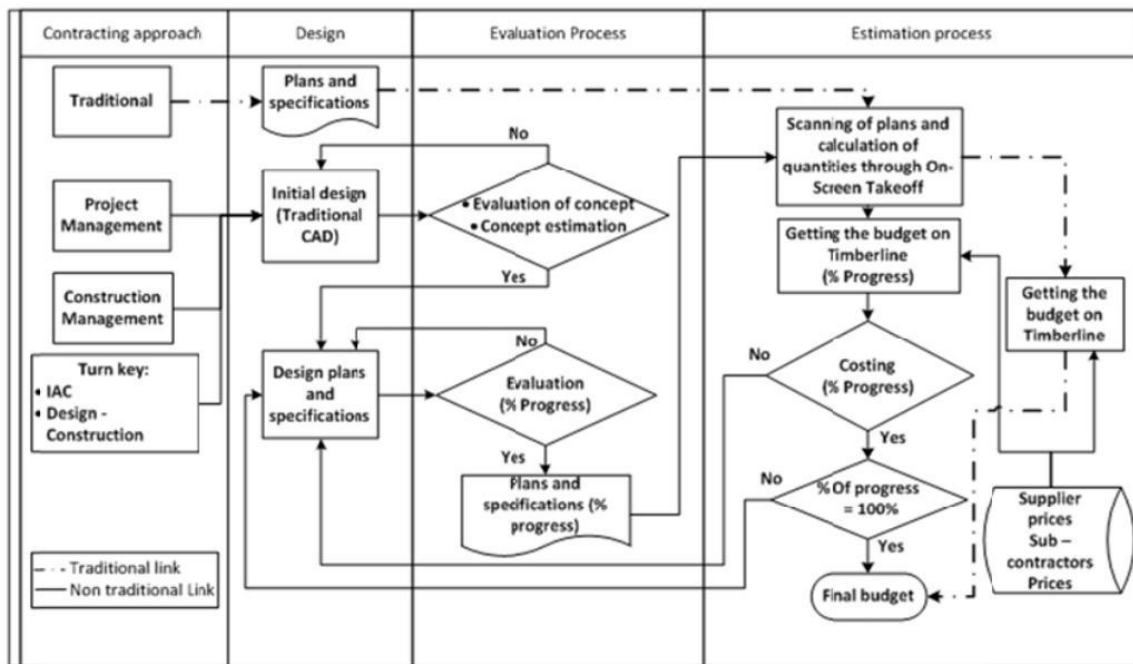


Figure 1: Existing Cost Estimation Workflows

## 3 Research Methodology

### 3.1 BIM-based Cost Estimation Using Autodesk Revit 2019

All views (with some exceptions) in Rivet are live demos of the model. This is done evenly to planning as well as Schedules. When it comes to Schedules, the model data appears in tabular form, but still offers a live view of the model. This means that there is no difference between the values shown in the schedule and the model and it also means that we can add and/or modify data in it (within logical limits) through the schedule itself.



### **3.2 BIM-based Cost Estimation Using Autodesk Navisworks Manage**

Navisworks® is a BIM (Building Information) project evaluation software that helps teams operate more efficiently together.

1. Streamline the design and construction process by integrating the two.
2. Before building begins, identify and resolve issues and countermeasures.
3. To better control the outcome, gather data from many deals.
4. Simulate model objects by animating and interfacing with them.
5. Sample projects can be used to generate schedules.
6. External project management programmes can be used to import schedules and costs.

Autodesk design applications like AutoCAD Architecture, AutoCAD Civil 3D, and Revit are common places to start a normal workflow. It is the job of an architect or engineer or other designers to determine what features (model, layouts, layers and features) to include in a design file before it is published. Once the content is selected, the drawing is published, and the file is sent to the Estimator. Designers may scan or save their work as an image file before sending it out for assessment. The process of rectifying the Quantification workflow begins after the files are received.

Open a design data source file in Navisworks. Open the Revit file by selecting Open and then browsing it.

1. Open the Workbook for Quantification
2. Create a project plan
3. Takeoff items can be created or selected.
4. Hide anything you don't want on display.
5. For objects that aren't listed in the catalogue, use measurement tools (for virtual takeoff).

Any time you wish to takeoff objects that aren't related to a model object or item, such as objects with geometry but no properties (or objects without geometry but no properties), you can use virtual takeoff. If you haven't saved the properties from the original design programme with your file, or if what you wish to remove doesn't exist in the model, this could be a problem. A viewpoint can be assigned to the virtual takeoff item in either case, making it easier to find it later on in the takeoff process. As soon as you remove the virtual object from the equation, you may begin to add characteristics to it.

### **3.3 BIM-based Cost Estimation Using Autodesk Revit and Sigma Estimates**

Software for estimating construction costs that is simple, quick, and accurate. The Live 5D Link between Revit and Sigma Estimate is the primary feature of this program.

Open the project and add the sigma estimate extension to it:

1. Select objects of the project and click on Element Properties as shown:
2. Link the objects with respective assemblies in Sigma. Make sure all objects have linked.
3. Click on Export to Sigma.
4. Select settings if required.
5. Open Sigma Estimate, see all the quantities extracted.



Go to Libraries and click update from library-it will connect the Revit model with sigma cost libraries. It will add prices to the activities. Check Resources Tab for all the resources required. Data can be exported to MS Project for scheduling and analysis.

## 4 Results

Based on our experience of these 5D BIM applications usage following are the results:

Table 1 Comparison of different software's for 5D Cost Estimation

Parameters	Autodesk Revit	Autodesk Navisworks	Sigma Estimates
Time Saving as compared to traditional methods	10 %	20 %	30 %
Accuracy of Cost Estimate	High	Medium	High
Difficulty Level of operating software	Low	High	Medium
Investment Cost for buying software	Low	Medium	High
Cost Analysis & Management	Low	Medium	High
Cost Databases	No	No	Yes
Suitable Stage for Estimation	Early Stage	After Final Design	All Stages
BOQ's	Short	Detailed	Highly Detailed

### 4.1 5D BIM Status in Pakistan

In spite of this, Pakistan has a long way to go in terms of infrastructure development due to shoddy construction methods in the industry (Maqsoom et al., 2013). It is clear that Pakistan's construction industry has a wide range of risks, including early failure and lack of facilities, planning and management changes in the scope of work/design, and corruption, complaints, and conflicts (Shabbar et al., 2017). Design errors and omissions, variations in drawing preparation and approval, deviations from drawings and specifications, unrealistic deadlines and cost estimates, improper planning, poor coordination among project stakeholders, and poor contract management have all been cited as the primary causes of the significant delay and increase in costs (Gardezi et al., 2014).

Contractors are expected to review construction drawings, specifications, and amendments as quickly as possible after they are presented to a contractor to begin building a facility and to notify any changes. In order to match CAD files and layout drawings, it requires time to analyze and compare the two. Inadequate vision, inaccuracies, and a lack of accurate information plague it (Fatima et al., 2015). As a result, the project manager will have to spend a lot of time and effort managing the site for valuable information (such as plans and specifications) and communicating with construction participants on the site and in the office (Park et al., 2016). Eventually, this results in conflict. Consequently, the Objectives of this project are on the line. A growing number of scholars in developing nations, such as Pakistan, have recognized the importance of BIM in today's building sector and have begun spreading the word about its advantages to all parties involved (Fatima et al., 2015).

In order to learn more about the current state of BIM models in Pakistan, we polled construction managers and project managers from organizations that are members of the Pakistan Engineering Council. BIM was found to be moderately well-known by 51% to 12% of respondents, while 8% were unaware of the advantages or uses of BIM. According to a survey conducted by (Maqsoom et al., 2014) [3], just 27 percent of AEC organizations in Pakistan employ BIM, while 73 percent of organizations are not involved in the BIM adoption process at all. According to these findings, Pakistan's construction industry is lagging behind in the adoption of BIM [4]. A few studies have examined Pakistani construction companies' reluctance to use BIM (Maqsoom et al., 2014). Problems that arose during the implementation of BIM were viewed as opportunities for awareness and instruction (Ismail et al., 2017 & Masood et al., 2014).



Drawings and construction data for an existing building should be redrafted using BIM concepts in order to illustrate the benefits of BIM to stakeholders in the construction sector in Pakistan. If you compare that to the typical way of doing things (Maqsoom et al., 2014) [5]. Our goal in creating this case study is to raise interest in and knowledge about the use of 5D BIM among Pakistan's construction industry's major stakeholders.

#### **4.2 Recommendations to implement 5D BIM in Pakistan**

1. BIM education should be made available in universities.
2. Complete courses of BIM should be introduced in degree programs in Architecture, Civil Engineering & Building Engineering.
3. Awareness of the benefits of 5D BIM should be given to engineers in practice by arranging seminars and workshops.
4. Private Cost database should be developed and should be available at a low price.

Technical experts of 5D BIM should be hired to get the maximum benefits of 5D.

## **5 Conclusion**

The construction sector is undergoing a paradigm shift as a result of the rise of BIM. Although it is possible to integrate more than five dimensions of information, the complexity of BIM implementation may increase significantly if more information is included. This initiative, therefore, aims to measure the next benchmark, 5D BIM, by conducting qualitative research. Observations clearly show that 5D BIM applications are practicable on a significant level. Decision-makers have been able to perform a sophisticated interpretation of information that is nearly impossible with the typical 2D CAD workflow because of information integration. A further finding implies that stakeholders who are unable to use BIM 5D may be unable to take full advantage of its features. Therefore, stakeholders who are unable to use BIM commit to building BIM capability benchmarking in the 5D BIM process. By virtualization of the 5D BIM, the project's clients will be able to participate in it with less of a learning curve. When the gap between expectations and results is filled, clients will be happier. Research on the development of best practices for 5D BIM is needed in general. Following extensive testing and evaluation, we can conclude that any of these tools can be used to create a more accurate, faster, and complete cost estimate, but it requires technical experience and expenditure.

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