

Development of A Bim-Assisted Tendering Process For Building Projects

Anandu Raj P R¹, Mr. Vishak M S², Mobin Raj³
SIVAJI COLLEGE OF ENGINEERING AND TECHNOLOGY

Abstract- Nowadays the construction industry is implementing new methods of digitalization for the proper management of information. Building Information Modelling (BIM) has recently gained much attention in the construction industry. The use of building information modelling has provided a means to improve overall product quality, accurate quantity determination, and reducing project uncertainties and costs. This technology can offer multiple benefits in comparison with the traditional 2D method for tendering, design, and documentation. The lack of consistency between the design and construction may lead to chances of conflict between project members and clients. BIM implementation enables the project team to effectively control the cost and the whole process of every stage of the construction. By using BIM, tenderers can confidently reach a fixed price for their project work. Troublesome areas that are detected through BIM models avoid the added time and costs that traditional tendering would fail to discover until the construction process begins. Hence, the benefits incurred by contractors investing in BIM technology are vast, particularly during the tender period. BIM is an unavoidable technology in construction industry nowadays. Its implications are not limited to a particular area or a particular stage of the construction process, but BIM has a significant role in all fields of the industry like planning, design, architecture, engineering, plumbing, electrical etc. and it is used to solve the issues of all four stages of construction process such as Pre-ward, Pre-construction, Construction and as built.

I. INTRODUCTION

Tendering can be defined as the process involving monetary estimations which can influence a whole project. It is an important process in which we can reach a fair price and best value for undertaking a particular work. As every activity involved in tendering has a time and cost implication, it is not always an easy process. However, BIM technology has emerged as a solution to this problem which is capable of rectifying some of the shortcomings of older tendering methods. The selection of the most qualified bidder is a difficult task when the information provided is unstructured and ill-defined. So, a BIM-based approach is implementing for the tendering phase where the bidders are never encouraged to present lower bids to win in the bidding process, which is a

common practice in to day's world. The use of BIM allows architects, contractors and engineers to work together throughout the project using the same database and building model. The fifth dimension claimed by BIM researchers can incorporate cost in a time scale. When it is adopted for tendering stage, contractors can effectively demonstrate their proposal and illustrate their value at each stage in the project. Because BIM model consists of all valuable information that helps in the calculation of a reliable tender price and helps to reduce uncertainties and more calculated quotations.

The concept of BIM can be explained well with the help of DIKW pyramid shown below.



II. TENDERING PROCESS

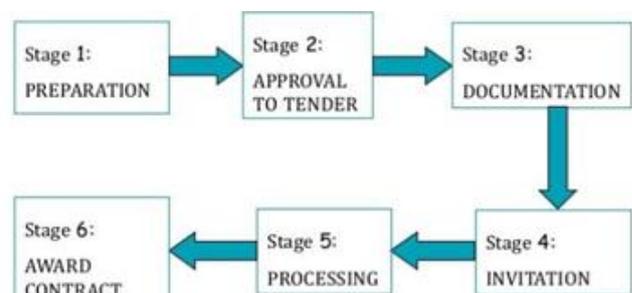


Fig1.3TenderProcess

Here, the major role of BIM comes in the documentation stage of tendering. As the extracted quantities with assistance of BIM are accurate, it gets directly reflected upon the quotations so that the risks will be eliminated. Also, BIM can detect clashes in the models and hence rework can be avoided. Hence using BIM, the rates can be reduced with the

proper risk management as it is capable to provide accurate quantities.

III. METHODOLOGY

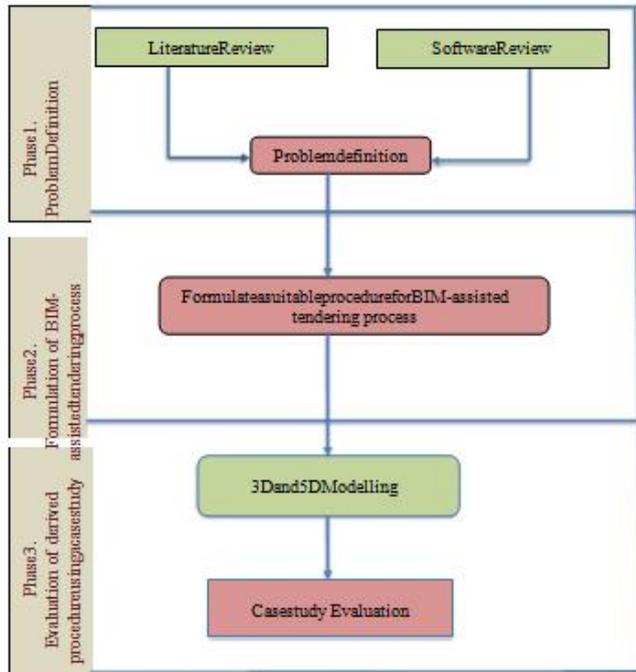


Fig3.1 Methodology Flowchart

Module	Function
Quantity Take-off	Create, edit and export quantity take-off data from the model.
Assemblies	Create, edit and assign assemblies to appropriate model elements
Assigned Items	Manipulating assemblies assigned to model elements
Schedule Animation	Run, review and edit 4D/5D schedule animations in combination with the schedule viewer
Clash Detection	Create, edit and run clash tests and export clash detection reports
Animation Form	Create and edit animations, viewpoints, walkthroughs and scenes.
Schedule Editor	Create, import and review schedule and assign model elements to the schedule tasks.
Cost Editor	This module enables the creation of cost classification and the addition of required resources for a given work.

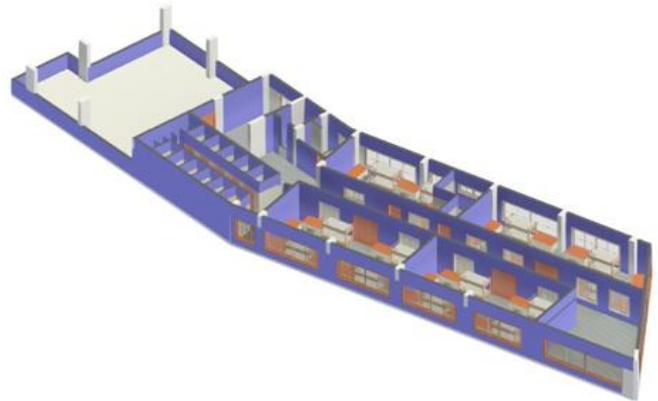
3.2 Bill of Quantities Automation

The most important aspect of the Bill of Quantities is to enable all contractors involved in tendering to price on the same information. Several attempts were made in the past to make the process of BOQ preparation automatic. The accuracy of cost estimation methods adopted earlier was very less because of the high complexity of construction projects and changes in the design. To overcome these problems, several researchers tried to automate the quantity take-off process in

construction projects. It plays an important role in tendering and bidding process. Effective use of quantity take-offs generated by Autodesk Revit can give an idea of how Bill of Quantities can be generated.

Exploration Study

In order to develop a suitable framework for BIM assisted tendering process, a detailed exploration study was conducted. The terrace floor of the new boy’s hostel of MACE was selected for the exploration study. 3D modelling of the terrace floor is done using Autodesk Revit 2021. The existing floor is modelled as a dormitory. As a first step of 3D modelling, the CAD drawing of terrace floor was converted into a BIM file by using Revit Architecture by Autodesk. Once the boundary of terrace floor was created using existing phase in Revit, the remaining partitions for rooms in the dormitory was developed using appropriate phasing technique in Revit. That means, the additional partitions for the rooms in dormitory was created under the “New Construction” phase in Revit.



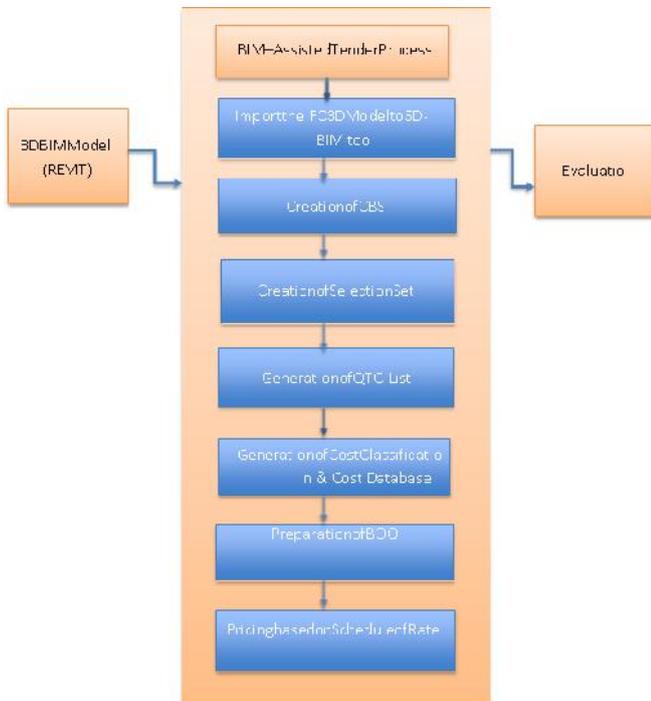
The Schedule/Quantities tool in Revit under view tab in create panel allows to create the schedule and material take-off of various components in the BIM- model. In the case of wall shaving layered structures, material take off is more useful so that we can list various sub-components or materials of the wall element in BIM model. That means, it is possible to extract the quantity of each layer of the wall separately by material take off option. The quantity of each layers such as brick, plaster, and paint for each category of wall can be obtained from Revit as shown in the figure 4.6. The following figure shows the example for layers of the wall created in Revit.

The BIM based procedure for the tendering process was developed through the following steps.

1. Import the 3D model into Bexel Manager
2. Preparation of cost estimate by generating QTO list

3. Generation of BOQ
4. Pricing based on CPWD

BIM-Assisted Tendering Process



ABIM assisted tendering process was developed using several steps as shown in the figure. The main step is to use the building model to create the Quantity take off list of building elements and price the elements based on CPWD to estimate the project cost. Also, the classification of elements based on international standards is important because the unstructured work break down structure is a major challenge in now a days.

Structural Model

- Step1: Export the building model from Revit to Quantity take-off tool (Bexel Manager)
- Step2: Export the QTO list to Excel
- Step3: Compute total project cost using DSR

The detailed workflow for quantity take off and cost estimation is shown below.

Step1: Export the building model from Revit to QTO tool

The 3DBIM model in Revit is exported to Bexel Manager as an IFC file. The following figure shows the 3D model exported to Bexel Manager.

Step 2: Export the QTO list to Excel

After the creation of necessary quantity take off tables in Bexel manager, it is exported to excel for the purpose of creating bill of quantities. The details from cost editor module can also be exported to excel for the cost estimation process.

Step3: Compute total project cost using DSR

Delhi Schedule of Rates (DSR) is produced by Central Public Works Department (CPWD) which includes the cost of various items. Once we extract the quantities from the BIM model, it is very easy to compute the cost of project with the help of rates from DSR. The following figure shows a sample BOQ generated by extracting quantities from BIM model and applying rates using DSR.

Architectural Model

The architectural modeling of first floor of the building is done as shown in the figure 5.12

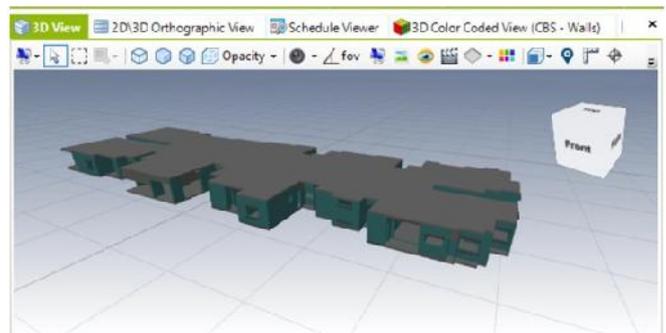


Fig 5.16 Architectural Model–First Floor

QTO - Walls		
Structure - All elements (214 Elements)	Calculated Volume (Sum)	Largest Projected Area (Sum)
Walls	347.929 m ³	1,850.779 m ²

Fig5.17 QTO–Walls

QTO - Floor Based on Selection Set		QTO - Floors		QTO - Walls	
Structure - Custom set of elements (1 Element)				Largest Projected Area (Sum)	
Selection Set - Floors				1,060.304 m ²	

Fig5.18 QTO–Floor Based on Selection Set

3.8 QUESTIONNAIRE SURVEY

3.8.1 Benefits of BIM in the tender process

The advantage gained from using BIM in the tender process is different to its purpose for the design team. BIM

enables tenderers to confidently reach a fixed price for their project work, while assuring clients that the finished construction will be like that of the initial tender.

Design and build” approach to tender

In the traditional “design and build” approach to tendering, the end-users typically set out the building project requirements and relevant information, to which contractors create a design and reach a price to be included in their tender document.

BIM helps in construction.

A new approach to design and construction, BIM helps contractors to improve cost estimates, basing their projections on the actual elements that will be used in the building process. BIM also facilitates better designs and greater interaction with the client from the initial design stage.

BIM be used for e-tendering

The proposed solution allows any user to initiate an e-tendering process using a BIM model. For instance, if a contractor wishes to purchase a specific product for a building, he can select that product (or related element) in the BIM model and launch the tendering process using the electronic platform.

BIM make tender management easier.

Searches and Data Extraction made easier: During tendering stage a lot of efforts and time is consumed while implementing Quantity Take-Offs. This further leads to errors in estimation and reports. However, with standard data feature in BIM, searches and extraction of data straight forward from the respiratory has been made possible.

IV. CONCLUSIONS AND FUTURE WORKS

The aim of the thesis was the exploration of the current tendering process and the development of a BIM-based procedure for tendering process in building projects. From the study, the current weak points in the tender process were studied and identified 5DBIM-based applications to solve those problems. Even though BIM has several advantages, its potential benefits can be accomplished only through collaborative and integrated behavior. The Integrated Project Delivery approach was identified as the effective way to prove the effectiveness of BIM in construction projects as it can create a win-win situation for the whole project team by implementing BIM and IPD together.

From the study, the efficiency of BIM in developing clash-free models is identified so that we can avoid the chances of rework in future. The BIM-based method can automate the process of quantity take-off. That means, the major complex work of determination of accurate quantities in the tendering process is solved using the proposed method of BIM.

The work flow of Bexel Manager makes the QTO process automatic and more reliable. Because the quantities of building components can be extracted from the BIM model directly. Hence, it can aid contractors for cost estimation. In future research, the proposed method can be extended to various disciplines such as MEP since the software tool enables to extract quantities related to all models so that accurate quantity take-off will be obtained and hence the uncertainties and more calculated quotations can be eliminated.

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