Review on an Integrated Approach for Planning & Estimating Building Costs in a World of BIM

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Abstract :

Current building practice relies upon drawings. Building designs are communicated through dozens or even hundreds of separate, often inconsistent documents. However, CAD documents usually exclude the very information necessary for effective design evaluation and construction, such as bid and contract documents, Bills of Materials, timelines, specifications, price lists, installation and maintenance guides, cable lists and labels. Nowadays, many companies in the Architecture/Engineering/Construction industry are using Building Information Modeling (BIM) in achieving a faster, sustainable and more economic project. Among the new developed concepts and BIM applications, two of the concepts most frequently used with the support of BIM technology in the planning, organization and scheduling of projects are 4D and 5D in which a 3D model is tied to its time execution (4D) at any point in time and its corresponding cost (5D).

The objectives of this paper are to explore a review of current industry trends and issues with BIM implementation.

Keywords :

BIM Information Modeling; Integrated Framework; Quantity Surveying, Cost Engineering, Detailed Cost Estimation; Construction Scheduling

Introduction :

For the first time in the history of the construction industry, there is an IT-based integrated platform, BIM, which facilitates the flow of information between the many and diverse construction disciplines involved in the design, construction and life of construction projects. One of the most useful tasks that can be automated through the BIM use is quantity takeoff. BIM based quantity takeoff is reported to provide simpler and yet more detailed and accurate cost estimates of the project, reducing time and expenses. In this Project, I have presented the costing system BIM estimate which allows to estimate costs directly on the basis of the BIM model.

A process in which BIM can be used to assist in the generation of accurate quantity take-offs and cost estimates throughout the lifecycle of a project. This process allows the project team to see the cost effects of their changes, during all phases of the project, which can help curb excessive budget overruns due to project modifications. Specifically, BIM can provide cost effects of additions and modifications, with potential to save time and money and is most beneficial in the early design stages of a project.

- Precisely quantify modelled materials
- Quickly generate quantities to assist in the decision making process
- Generate more cost estimates at a faster rate
- Better visual representation of project and construction elements that must be estimated
- Provide cost information to the owner during the early decision making phase of design and throughout the lifecycle, including changes during construction
- Saves estimator's time by reducing quantity take-off time
- Allows estimator's to focus on more value adding activities in estimating

such as: identifying construction assemblies, generating pricing and factoring risks, which are essential for high quality estimates

- Added to a construction schedule (such as a 4D Model), a BIM developed cost estimate can help track budgets throughout construction
- Easier exploration of different design options and concepts within the owner's budget
- Quickly determine costs of specific objects
- Easier to strain new estimators through this highly visual process

Why accurate cost estimation drives the efficiency of a construction project?

Cost estimation means, predicting the most realistic figure at different – or any given stage in a project. This prediction is done based on the interdependency of time, cost and activities. Highly accurate estimations; lessen the changes of uncertainties and risks.

The accuracy of cost estimations is also very pivotal for bids and tenders, as after the assessment of risks and uncertainties, overheads are added to the estimates and turned into tenders.

Traditional and BIM :

In the traditional process, the project plans and specifications were the primary means by which this was determined, and as such, there was a direct correlation between the project's level of definition and the expected accuracy of an estimate. It is reasonable to expect a similar convention exists in BIM, and that as a BIM contains more project definition, it also impacts the potential accuracy of an estimate.

Designing a building is the responsibility of architects, whereas assessing the cost to build it is the domain of estimators. In general, the architect's scope of work doesn't extend to material takeoffs or cost information. That's left to the estimator. When preparing their cost estimates, estimators typically begin by digitizing the architect's paper drawings, or importing their CAD drawings into a cost estimating package, or doing manual takeoffs from their drawings. All of these methods introduce the potential for human error and propagate any inaccuracies there may be in the original drawings. By using a building information model instead of drawings, the takeoffs, counts, and measurements can be generated directly from the underlying model. Therefore the information is always consistent with the design. And when a change is made in the design – a smaller window size, for example – the change automatically ripples to all related construction documentation and schedules, as well as all the takeoffs, counts, and measurements that are used by the estimator. The time spent by the estimator on quantification varies by project, but perhaps 50-80% of the time needed to create a cost estimate is spent just on quantification. Given those numbers, one can instantly appreciate the huge advantage of using a building information model for cost estimating.

By automating the tedious task of quantifying, BIM allows estimators to use that time instead to focus on higher value project-specific factors - identifying construction assemblies, generating pricing, factoring risks, and so forth that are essential for high quality estimates. For example, consider a commercial project slated for construction in northern Minnesota in the winter. The estimator will realize that winter heating and dewatering will be needed for a portion of the concrete substructure. This is the sort of specialized knowledge only professional estimators can factor in to the cost estimate accurately. This construction wisdom, not "counting," is the real value professional estimators bring to the cost estimating process.

There are a variety of ways of getting quantities and material definitions out of a

building information model into a cost estimating system. Broad categories of integration approaches include:

1. **Application Programming Interface (API)** to commercially available estimating programs from vendors such as U.S. COST or Innovaya (which then integrates with Sage Timberline Office Estimating). This approach uses a direct link between the costing system and Revit

2. **ODBC connection to estimating programs such as CostX or ITALSOFT** - popular Australian and Italian cost estimating solutions, respectively. ODBC is a tried and true standard, useful for integrating data-centric applications like specification management and cost estimating with building information modelling. This approach typically uses the ODBC database to access the attribute information in the building model, and then uses exported 2D or 3D CAD files to access the dimensional data.

3. **Output to Excel**. In comparison to the approaches outlined above, quantity takeoffs done within Revit and output to a Microsoft® Excel® program may seem lackluster, but the simplicity and control is perfectly suited to some costing workflows. There are no right or wrong approaches – each integration strategy is based on the estimating workflow used by a specific firm, the costing solutions they have in place, the pricing databases they use, and so on.

BIM Building Information Modeling, was coined in early 2002 by industry analyst Jerry Laiserin to describe virtual design, construction and facilities management.

The BIM Plan for the project cannot be developed in isolation. No one party within the project team can adequately outline the execution plan, while also obtaining the necessary team member commitments for successful BIM implementation. In order to have a successful project using BIM, full coordination and collaboration by all parties is an absolute necessity. The planning team should conduct a series of planning meetings to develop the execution plan. [3]

Each description includes an overview of the BIM Use, potential benefits, required team competencies, and selected resources that can be referenced for additional information about the BIM Use. An example of a BIM Use description is shown below in Figure 1-a.

Cost Estimation

Description:

A process in which a BIM model can offer a reasonable accurate quantity take-off and cost estimate early in the design process and provide cost effects of additions and modifications with potential to save time and money and avoid budget overruns. This process also allow designers to see the cost effects of their changes in a timely manner which can help curb excessive budget overruns due to project modifications.

Potential Value: (improvements in project / process)

- Precisely estimate material quantities and generate quick revisions if needed
- Stay within budget constraints with frequent preliminary cost estimates while the design progresses
- Better visual representation of project and construction elements that need to be estimated: taken off and priced
- Provide cost information to the owner during the early decision making phase of design
- Focus on more value adding activities in estimating like identifying construction assemblies, generating pricing and factoring risks then quantity take-off, which are essential for high quality estimates
- Exploring different design options and concepts within the owner's budget
- Saving estimator's time and allowing to focus on more important issues in an estimate since take-offs can be automatically provided
- Quickly be able to determine costs of specific objects

Resources Required:

- Model-based Estimating Software
- Design Authoring Software
- Cost Data

Competencies Required:

- Ability to define specific design modeling procedures which yield accurate quantity take-off information

Figure 1-a: Typical BIM Use Description

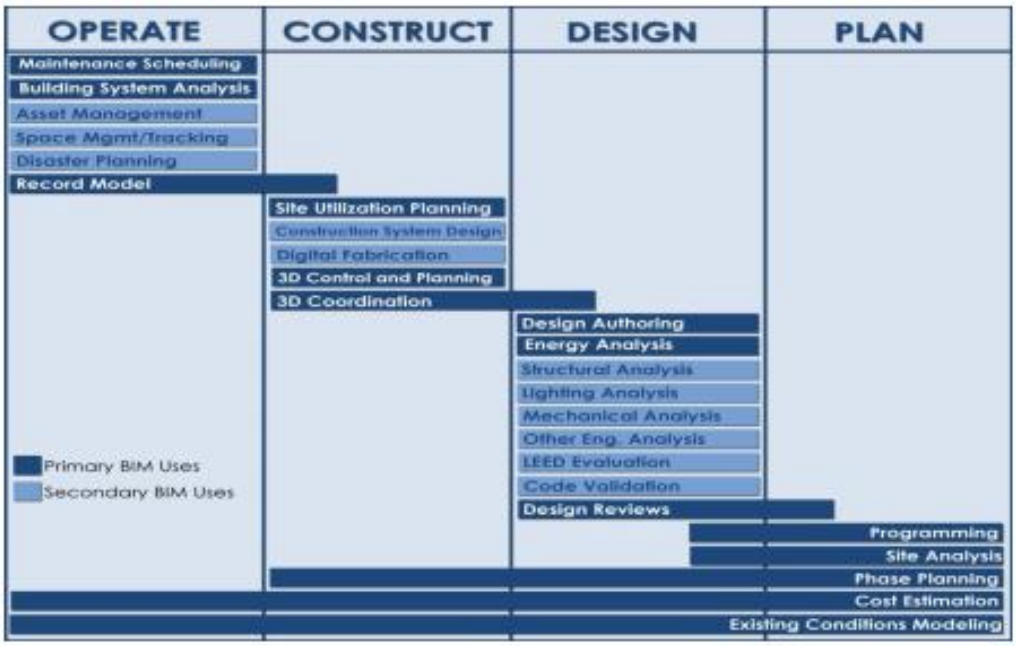

Figure 1-b: BIM Uses throughout a Building Lifecycle

What Technologies Can Be Used to Implement Building Information Modeling? [4]

Although building information modeling is an approach and not a technology, it does require suitable technology to be implemented effectively. Examples of some of these technologies, in increasing order of effectiveness, include

- CAD
- Object CAD
- Parametric building modeling

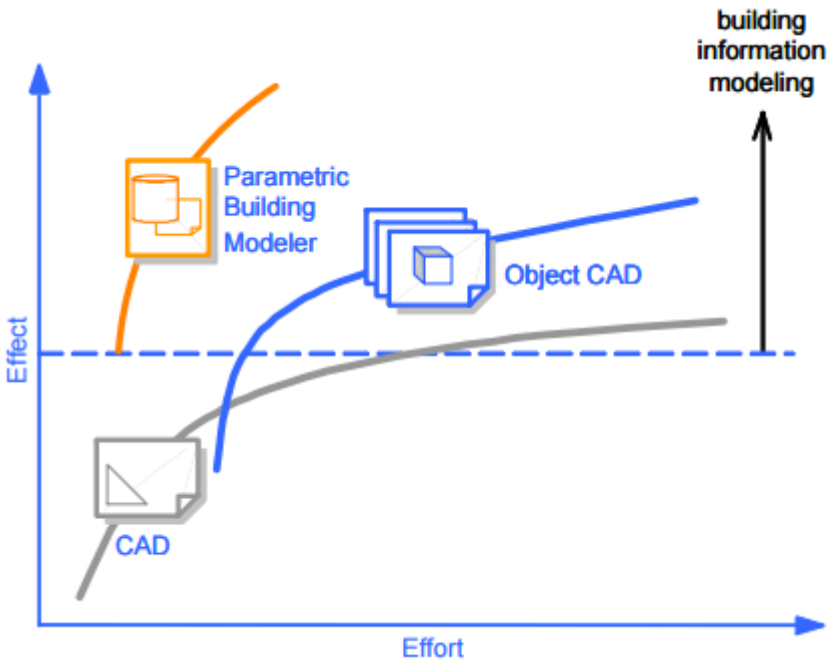

Figure 1- c

The figure (1-c) shows the overall effectiveness or benefit level of each of these three different technologies (vertical axis) measured against the effort required to achieve those benefits (horizontal axis). In addition, the horizontal dashed line represents the minimum degree of effectiveness that can be properly characterized as building information modeling. Below this building information modeling threshold are existing, traditional industry processes that are well-supported by traditional drafting and task automation. Above this line are increasing degrees of building information modeling effectiveness. The three solid lines show the effectiveness achievable at a given level of effort using these three different technologies.

Quality of the BIM Model

The quality of BIM models was the major concern. The use of BIM models require the input of vast amounts of interconnected data and information that is typically complex. Whilst BIM models have clash detection facilities there are limitations in terms of checking all information. Clients also need to be prepared to invest in the proper development of a quality model – often the limitations are brought about by consultancy fees that are insufficient to develop the model to the level required. The concept of 'Rubbish In Rubbish Out' certainly holds true for BIM models. The liability for the use of inadequate or incorrect information in the model is also a major concern. The integrated WBS achieves cost and schedule integration as well as the integration between the product model and the construction process model. However, it is developed manually based on construction knowledge of a building project (6)

Frequently, BIM models do not exactly tally the needs of the quantity surveyors in terms of quality and information. This creates difficulties for the quantity surveyors in managing and searching for the required information within the model for the development of cost estimates. Hereby, the arguments arise as to what information needs to be included in BIM models for the benefit of quantity surveyors. All these factors have to be carefully evaluated to improve the use of BIM in cost estimating.

Conclusion:

Cost estimate and control are important tools to track and monitor construction projects. BIM can be summarised as the process and technology for producing, managing and sharing physical and functional data of a facility in a collaborative environment using digital representative models throughout project lifecycle processes. From the Quantity Surveyor point of view, BIM's capability of automating measurement is its key benefit and it clearly speeds up the traditional estimating process. The ability to automate the process of preparing a bill of quantities is one of the key advantages for the estimator. Such possibility is provided by the BIM model.

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