



# UTILITY OF BIM ON QUANTITY SURVEYING TECHNIQUE

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## Abstract

Building information modeling (BIM) plays an important role in the performance improvement of quantity surveying practice. Quantity surveyors are responsible for the cost management throughout the entire life span of a project from the feasibility and design stages until building completion. It appears that quantity surveyors are still lagging behind in BIM application compared to other professionals. Lack of awareness of the potential of BIM application is the main reason for low adoption of BIM. Quantity surveyors are still unsure of the capability of BIM in their practice. The role of Quantity Surveyors whose building procurement is based on BIM would be revolutionized drastically from the existing role where BIM permits to analyze the building, the structure, materials and performance in real time as it is being designed. Hence, a research is conducted with broader aim of exploring the potential expansions of QS roles, changing key roles and responsibilities of future Quantity Surveyors in a sustainable BIM based project delivery which will help in training Quantity Surveyors to face future challenges. This paper contains the preliminary findings of a literature review conducted on the current key roles and responsibilities of Quantity Surveyors in local building procurement and future expectations in a BIM based project delivery.

**Keywords:** Building Information Modeling (BIM), Capability, Quantity Surveying, Construction Industry, Cost

## 1. Introduction

Building information modeling is an innovative new approach to building design, construction, and management. In the construction phase of the building lifecycle, building information modeling makes available concurrent information on building quality, schedule, and cost. Completing a construction project within these three important parameters such as time, cost and quality are criteria of success for a project. Quantity surveying is an important discipline that provides cost management services in the construction industry. The major tasks provided by quantity surveyors (Qs) include Quantification, bills of quantities preparation, estimation and pricing of construction projects. The use of traditional manual quantity surveying practice such as excel spreadsheet and 2D CAD have made quantity surveying a tedious and time consuming task, which are less efficient and are more susceptible to human errors. As a result, it has reduced the performance of Qs which subsequently affect the project cost outcomes. Besides, clients are becoming dissatisfied with the conventional ways of Qs performing their practice. With the help of BIM we can accelerate the quantification of the building for estimating purposes and for the production of updated estimates and construction planning.

Automating the process through implementing building information modeling (BIM) helps to resolve these problems. BIM removes many tedious tasks of traditional quantity surveying, such as measurement, take offs and the production of bills of quantities (BQ), by automating these tasks. There is limited research on investigations into potential and capabilities of BIM in quantity surveying practice. There are fears that adoption of BIM could threaten and challenge the existence of Quantity Surveying profession. Therefore its necessary to understand its potential expansions of QS roles in BIM based project delivery. Under this context, the work presented in this paper is a part of an on-going research which is conducted with broader aim of exploring the changing key roles and responsibilities of future Quantity Surveyors in a BIM based project delivery. While the ultimate findings of such a study will be helpful in training Quantity Surveyors to face future challenges, this paper presents literature synthesis of the same identifying the appropriate next steps to further the knowledge

## **2. Building Information Modelling**

BIM is a computable representation of all the physical and functional characteristics of a building and its related project/lifecycle information, which is intended to be a repository of information for the building owner/operator to use and maintain throughout the lifecycle of a building. As a digital representation, BIM provides a virtual view of the objects in the building with physical geometry (2D or 3D) and other functional parameters, such as materials, spatial relationship, etc. Designers compose these BIM objects together to define a building model, and this model incorporates both physical and functional information stored in the BIM objects. Once the building model is completed, all the information can be generated by users for fabricating, analyzing, construction scheduling (4D BIM) and cost estimating (5D BIM), and eventually, for facility management during operation phase of the building lifecycle. Building Information Modelling (BIM) involves generating a visual model of the building which also manages data about it, at the design stage, throughout the construction phase and during its working life. Typically BIM uses real-time, dynamic building modelling software working in 3D, 4D (workflow) and, increasingly, 5D (quantity surveying) to increase productivity and efficiency, save costs in the design and construction stages, and to reduce running costs, after construction.

## **3. Quantity Surveying using BIM**

Qs play an important role in the construction industry. According to a report published by RICS in 1971, the quantity surveyor's roll is "to ensure that the resources of the construction industry are utilized to the best advantage of society by providing the financial management for projects and a cost consultancy service to the client and designer during the whole construction process". They are responsible for the cost management throughout the entire life span of a project from the feasibility and design stages until building completion. The key roles of a Quantity Surveyor are to perform financial control, cost and contractual administration of a project at every stage. Their services can be divided into two stages, which are pre- and post-construction stages of the projects. At the pre-construction stage, quantity surveying services include the preparation of preliminary estimates and feasibility studies, cost plans and schedules, bills of quantities preparation, procurement and tendering procedures, and evaluation of tenders. On the other hand, at the post-construction stage, quantity surveying services include providing general contractual advice, assessing interim payments, evaluating variation, preparing finance statements, settling final account, and giving alternative dispute resolution (ADR).

The core services provided by the Qs are measurement and bills of quantities preparation. The cost estimating process involves performing quantity takeoff (QTO) and adding cost data to the QTO list. The process of measuring building quantities of various building elements is defined as quantity taking off (QTO). Traditional QTO process with CAD drawings involves selecting individual elements in CAD drawings, using the software to automatically determine the dimensions for the

take-off, and inputting the quantities into the QTO list. This process requires estimators to spend substantial amount of time on generating the QTO of the entire drawing. Since the selecting and measuring processes are all based on manual operations, the errors and omissions happen during the QTO process. However, BIM technology is a potential solution for the above problems by automating these tedious tasks.

BIM is a modeling technology and associated set of processes to produce, insert, share and manage the information in a centralized model to improve designs, constructions, operations and maintenance processes. BIM works on an integrated platform where information representing the entire building by incorporating all the designs and information from different design professions. It works as a simulation model which helps to model real life situation and identify potential problems in virtual environment before it comes to actual construction. Clashes and problems can be detected earlier and rectification steps can be taken to minimize the consequences.

Building Information models are also increasingly used by diverse stakeholders during the project lifecycle such as Owners, Designers, Contractors and Engineers. Designers have been using BIM widely for visualization of design to improve design outcomes. Contractors have been using BIM for planning and scheduling to monitor construction progress and performance. However, QSs are only recently beginning to be impacted. The construction industry is a unique industry that contractors need to guarantee a price to owners before they know the actual completion cost. The calculations must be conducted before the project actually starts and this will require a higher level of accuracy during the estimating process for contractors. Since BIM models are object-based within-built parametric information, it is easier to capture the quantities of the objects in BIM and the QTO with BIM drawing will be more accurate with less errors and omissions. Meanwhile, building works are getting more complex and clients are becoming dissatisfied with the conventional ways of QSs performing their practice. Hence, it is crucial for QSs to move away from inefficient methods. It is possible to quickly extract detailed quantities directly from a BIM. Applications using BIM provide capabilities for extracting counts of components, area and volume of spaces, material quantities, and to report these in various schedules. These quantities are suitable for cost estimation. It is clear that this more automated approach for quantity takeoff can greatly reduce the laborious task of manually extraction of these quantities from 2D drawings). It is also possible to automatically link this quantity takeoff to estimating software.

Quantity surveying practice is bound to 5th dimension (5D) of BIM. The 5D BIM is an integration of the 3D BIM model and the construction schedule (4D) with contract pricing (cost) for quantity surveying applications. BIM automatically generates quantities, take-offs and helps to reduce the time and costs required to prepare an estimate. It eliminates the need for tedious manual take-off, human error during estimation and it provides a faster way to analyze data and prepare cost estimates. The main benefit of BIM for cost estimation is the field of quantity takeoff. Estimators can extract quantities from the BIM for cost estimation using software applications. A BIM can support estimators in every design phase. In early project (or design) stages, the BIM can produce quantities like volume and total area. These quantities may produce accurate enough estimates (e.g. by linking total volume of the building to a cost per cubic meter). Later on, as the model is more detailed, it is possible to extract detailed quantities of each building element (beams, columns, floors etc.) of the model. These quantities may form the basis for more accurate estimates, necessary in later project stages.

BIM can offer significant benefits over traditional drawing-based manual taking-off process. When changes happen, it requires manually editing and updating for all drawing views which is tedious and error-prone. The manual process requires a great deal of time and energy to revise the quantities to accommodate the design changes. The QSs would have to constantly check what have been changed, added or omitted. This process is time-consuming and leads to serious consequences if the changes were not detected. BIM has the added advantage over CAD to deal with design change efficiently

due to parametric change technology that coordinates changes and maintains consistency when changes happen. A change made in one drawing view will be updated and represented in all other drawing views as well. It allows the QSs to easily identify drawing changes and automatically update the quantities when the design is changed.

The use of BIM has two benefits. First, it can automatically produce accurate quantities, used for cost estimation. Second, it is possible to create an 'active' link between the design and corresponding costs so when the design changes, so will the estimate costs. When estimators use BIM in cost estimation, this also influences the estimating process. Therefore, BIM has changed the way QSs perform their duties and subsequently brings impact on the speed and efficiency of the professional services. By implementing BIM, QSs can improve their performance and productivity as these tedious tasks can be automated by BIM.

#### **4. Capabilities of BIM**

BIM capability in this study is defined as the ability of BIM to perform tasks in quantity surveying practices in order to enhance their job performances through BIM adoptions.

##### **STAGE 1: Preparation stage**

At this stage, QSs undertake feasibility studies by preparing cost appraisal to determine the initial building cost. Clients need professional cost advice from QSs to determine and assess the viability and feasibility of undertaking the project.

##### **STAGE 2: Concept design**

After establishing the cost range at the feasibility stage, the design team starts to develop the design in more detail at this stage. The task of QSs is to provide a more comprehensive cost estimate based on a better developed design and scope of work. QSs begin to prepare the first structured cost plan; preliminary cost plan which aims to confirm the budget determined at the feasibility stage.

##### **STAGE 3: Developed designs**

At this stage, design progressively developed as more detailed information become available. QSs conduct further cost studies and estimates to update the cost plans that presented in an elemental cost format, stating the specific construction materials, finishes, specification with elemental unit rates and quantities. It is noted that drawings, details and specifications from designers are important in this stage for QSs to perform detailed cost estimation. Frequently changing in design and scope throughout the design process is a major cause of cost overrun as project cost correlates to the design of building. It can lead to serious impact on the project cost if design changes and revisions are undetected.

##### **STAGE 4: Technical designs**

Bills of quantities (BQ) preparation remain as an important service provided by QSs at this stage. It is noteworthy that quantity takeoff is tedious and time consuming task during BQ preparation. It takes up a lot of the QSs' time, focus and attention to count as well as measure each item in the drawing. Automatically quantity takeoff is one of the BIM capabilities that help to simplify and remove routine and drudgery that come with this task.

#### **5. Important of Implementing BIM in Quantity Surveying Practices**

The quantity surveying profession has become a rapid developing profession over the last few decades. As building work becomes more complex and employers becomes dissatisfied with the methods used for controlling and settling the cost of work, an urgent need for an independent quantity surveyor has arisen. Quantity surveying is a vital part of the construction process, from the project initiation phases to project close-out. The quantity surveyor today can be defined as professional consultants that "add value primarily to the financial and contractual management of construction projects at the pre-construction, construction and post-construction stages" Quantity

surveying is a profession that demands great knowledge and the correct and skilful use and interpretation of this knowledge. It also requires correct interpretation and understanding of designs and the numerical representation of these designs (BIM Journal, 2009). Cost estimation, feasibility studies, tendering, cost planning, value management, and dispute resolution are some of the activities employed by the quantity surveyor. Some cost management functions of Quantity Surveyors are briefly explained as follows.

**Bills of Quantities:** Bills of quantities are one of the main tools used in the cost management of construction projects. The automatic production of bills of quantities is one of the functions that BIM technology developers pride themselves on as the fifth dimension of BIM. The automation of bills of quantities is one of the functions that enhanced BIM technology to be fully collaborative and integrative. The automation of the production of bills of quantities eliminates tedious traditional take off methods and at the same time reduces human error.

**Cost Estimates:** BIM technology can extract accurate quantities and spaces that can be used for cost estimating at any period of the design of a project. It also allows estimators to identify and communicate relationships between quantities, costs and locations, and distinguish how areas and components of the building are contributing to the total cost of the project. The realisation and understanding of cost-determinants enrich the competence of cost estimators and along with the accuracy of the quantity take-off produced by the BIM enables the estimator to produce reliable and accurate cost estimates in the early stages of the design phase.

**Rapid Updating of Costs:** By integrating cost estimation with a BIM design tool it allows designers, estimators and clients to carry out value management throughout the design phase. As design changes are made to the BIM the cost estimate can be automatically updated with quantities extracted from the modified model, without the estimator needing to take-off quantities.

**Bidding Process:** Competitive tendering and bidding with BIM models can reduce the risky gap that exists between project members due to the transparency and accessibility to project information and documentation. The BIM provided substantially higher quality construction information than conventional working drawings and provide a more accurate bill-of-quantities. In addition, potential constructors can receive training in quantity extraction and measurement from the BIM. During tender, bidders can identify and correct errors in the model, further enabling more accurate bids.

## 5.1 Challenges of BIM

- Taking the model beyond the design team – The true value of BIM can only be realized when it is taken beyond the design team – to subcontractors, the owner and facility manager. Providing access to the model and allowing them to contribute and link other information are key.
  - Viewing the model (including in the field) – How can a subcontractor be given a view of a particular part of the model to resolve an issue without having to download and install software? How can people collaborate around that view quickly and easily? How can they view it on the tablet when standing on the site?
- Linking models to other data – A lot of project information, like drawings, RFIs and spec sheets, lives outside the model. How can these documents be linked for a more complete model? Owners may insist on receiving a 3D model but, for the full picture, it should be linked to all of the other data created and collated on the project.
- Tracking approvals and audit trails – Models are generated by different authoring tools and constantly changing, making it difficult to obtain and record approvals. With hundreds of decisions made around the model during its life, maintaining an audit trail of who did what and when can be almost impossible.
- Managing large file sizes – When BIM models can easily reach 50MB or more, distributing files securely and efficiently can be difficult, if not impossible. E-mail can't handle the file sizes and FTP sites don't provide the access control or audit trail you need.

## 5.2 The Influence of BIM on Quantity Surveying Profession

The quantity surveying profession is, like many other professions, an evolving profession that needs to continue to change to meet the ever changing conditions of the building industry. Cost estimation, feasibility studies, tendering, cost planning, value management, and dispute resolution are the main activities performed by quantity surveyors that makes them an essential contributor to any construction development. BIM does not only provide construction project management and scheduling facilities but it also contains various cost management functions that will come in handy to quantity surveyors. “The accurate and computable nature of building information models provides a more reliable source for owners to perform quantity take-off and estimating and provides faster cost feedback on design changes” (Eastman et al. 2008). The model automatically analyzes all materials and components and extracts quantities directly from it. It offers to simplify some of the traditional tasks performed by quantity surveyors and remove routine and drudgery that come with such tasks. BIM can therefore be used to automatically produce bills of quantities and through this also produce cost estimates at various levels of the project, rapidly update costs due to design changes and calculates maintenance costs, and evaluate space planning or renovation alternatives in the post-construction phase of a project. Through the automation of the production of bills of quantities quantity surveyors will be able to produce deliverables much more efficiently and timely, and at higher and accurate standards.

Implementing BIM into a quantity surveying firm will enable quantity surveyors to do their work more accurately and efficiently, which will give them a competitive advantage. The successful implementation of BIM will however not happen without affecting the quantity surveying profession in some way or another. The cost management functions of BIM will change the process of cost management of construction projects, which will shift the responsibilities of the professionals involved, forcing quantity surveyors to focus on different parts of the cost management process and create new responsibilities and opportunities for themselves, and rearrange the structure that they work in. Following are some of the barriers and risks identified for the QS profession with incorporation of BIM.

**Software and Computer Systems:** The computerized estimating tools and techniques have become an indispensable tool in the estimating process because of their effectiveness, consistency and accuracy in formulating estimation of deliverables and sub-deliverables. As BIM gains more and more importance in the design process of a construction project, the cost control process also has to be integrated into the collaborative model based working environment. In an ideal BIM environment the first step would be the design of a 3D model of the client’s proposal, the second will be to automatically generate resource demands, cost calculations or estimates, list of product specifications and bills of quantities. Traditional methods to sharing project information via file exchange using formats such as .dxf, .dwf, .dwg and .pdf do not transfer the appropriate levels of object intelligence from one model to another. According to Bazjanac (2010) “creating a BIM makes sense only if software is available to populate the BIM with data that can be reused by other software, and only if software exists to extract and import data from a BIM.” In an environment where all the project consultants works on an integrated system, quantity surveyors is still faced with data compatibility problems as most software runs proprietary file formats. Traditional computerized estimating and costing tools used by quantity surveyors will need to be adjusted in order to be compatible with the latest BIM software.

**Adjusting Services and Responsibilities:** Quantity takeoff and bill generation is a very time consuming process that are prone to error and although it is only a small part of the cost management process it takes up a lot of the quantity surveyor’s focus and attention. BIM contains 5D simulation which gives it the ability to automatically generate quantities from the model and data captured within the model. In other words, it is able to automate one of the essential traditional tasks of quantity surveying. This leaves the quantity surveyor to adapt some of his tasks or responsibilities.

The automation of bills of quantities unfortunately brings disadvantages to the table as well. Bill production is usually one of the most regular tasks performed by quantity surveyors. The automation of this task will enable them to get more work done with a smaller production team. This will lead to a reduction in staff needed which results in a reduction of size of quantity surveying practices. Quantity surveyors will need to overcome these obstacles by continuing to reinvent themselves and continually adding value and enhancing their professional services.

**Training and Expenses:** The lack of knowledge and skill relating to sophisticated software and techniques are usually easily overcome through training programs, seminars workshops and software tutorials. Software developers are usually prone to provide training programmes to companies implementing their software. Staff will not only need training in the use of a new software but also in the changes in responsibility, changes within the organization itself as well as the change in use of the information that is extracted from the BIM. The latest technology and keeping a competitive advantage always comes at a cost. Software is in general a large expense and is not something that is replaced without the necessary thought and budgeting. The transition to and implementation of new methods and software usually creates heavy time constraints for companies.

## 6. Conclusion

One of the most apparent and vital consequences that will result from implementing BIM into the quantity surveying profession is the effect that it will have on the traditional roles and responsibilities of the quantity surveyor and the structure of quantity surveying firms. BIM's capabilities of automating the production of bills of quantities, which is one of the quantity surveyors fundamental tasks, will have both positive and negative effects on the quantity surveying industry. The automatic production of bills of quantities will enable quantity surveyors to get involved in the early design stages of a construction project and make designers aware of cost implications and manage costs from early on. This will enable designers to design to a cost instead of quantity surveyors costing to a design, which will satisfy the employers need for cost effective construction. The time saved by BIM capabilities will give quantity surveyors the opportunity to develop and focus on other activities that might not be seen as essential in traditional practices, but that will offer major benefits to employers. New services can be rendered by quantity surveyors such as managing the vast and continuous data exchange between the different consultants of a BIM based construction project. The continuously changing and technologically evolving construction industry has forced quantity surveyors to evolve with it in order to meet these ever changing needs. The research in this report has confirmed this statement, and has shown that BIM, although a great advantage to the construction industry, will oblige quantity surveyors to keep reinventing themselves and develop the scope of their services in order to maintain their leading role as construction cost managers. In order to understand the future role of QS into further detail, a thorough study on what specific information will be made available for him from BIM at different stage of the project and what information the QS has to contribute at each stage is required. This is identified as the way forward for the current study.

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