COMPARATIVE EFFECTIVENESS OF QUANTITY SURVEYING IN A BUILDING INFORMATION MODELLING IMPLEMENTATION

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ABSTRACT

Over the past eras, growths of innovative technological concepts are promptly increasing, in order to achieve competitive productivity and performance. Building industry identifies technology as vital. Although the building industry is broadly identified as unique and conservative, at the same time construction industry has to have varied according to these innovative technological variations. In addition to that these technological variations may have potential to influence everyone's professions in different ways. Although, the concept of Building Information Modelling (BIM) is not practiced in Sri Lankan construction industry yet, it is likely to become the project delivery standard in future. Introduce with the vision "sustainability by building smarter", BIM will improve the performance of building professionals. The current knowledge does not adequately explain how the functions of a Quantity Surveyor are affected by BIM. This paper presents a study on comparative effectiveness offered by BIM for the traditional functions of a Quantity Surveyor. The study is interesting because the new knowledge will help to develop strategies for professional development and update the education curricula to train the Quantity Surveyors to face future challenges.

Keywords: *Building Industry; Building Information Modelling; BIM; Quantity Surveying; Sri Lanka.*

1. INTRODUCTION

As the world is transforming and developing at a very express pace, rapid technological innovative practices are increasing, in order to achieve the competitive advantage. Building Information Modelling (BIM) is one of innovative practice which is becoming a better known established collaboration process in the construction industry. This study explores how the practices of Quantity Surveyors are being influenced by BIM and comparative effectiveness of BIM tools against conventional Quantity Surveying methods.

2. INTRODUCTION TO QUANTITY SURVEYING

A Quantity Surveyor is an expert in the art of costing a building at all its stages who offer expert advices on construction costs. It is inevitable that, the advices are vital for life cycle costing, cost planning, procurement and tendering, contract administration and commercial management. Moreover, a Quantity Surveyor may be involved as a specialist in one area or generalize in several over the course of a project (RICS, 2012) and he known as a Construction Economist, a Cost Manager, a team of professional advisers to the construction industry as well. As advisers they estimate and monitor construction costs, from the feasibility stage of a project through to the completion of the construction period. After construction they may be involved with tax depreciation schedules, replacement cost estimation for insurance purposes and, if necessary, mediation and arbitration (AIQS, 2011).

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2.1. HISTORY OF QUANTITY SURVEYING PROFESSION

Eventhough ancient Egyptians are believed to be amongst the first ones to have practiced a system of Quantity Surveying, it was not until the 17th century restoration of London after the Great Fire that Quantity Surveyors developed as an occupation (AIQS, 2011). In 1834 architects decided that they wished to divorce themselves from surveyors and establish the Royal Institute of British Architects (RIBA), exclusively for architects (Cartlidge, 2009). The grounds for this great schism were that architects wished to distance themselves from surveyors and their perceived ‘obnoxious commercial interest in construction'. The events of 1834 were further responsible for the birth of another UK phenomenon, the Quantity Surveyor. A study by Ashworth and Hogg (2007 as cited Shangvi, 2012) emphasized that Quantity surveyors trace their roots back to more than 2000 years ago. However, the fire that destroyed the Palace of Westminster in 1834 is considered to be partly responsible for the employment of the QS on an extensive scale. Around 1820, quantity surveying was imaged as a profession and Sir Henry Arthur Hunt is considered as one of the earliest Quantity Surveyor, who involved in the construction of House of Parliament in United Kingdom (Quantity Surveying Practices, 2012).

2.2. ROLE OF A QUANTITY SURVEYOR

Quantity surveying is an important discipline within the construction industry. Matipa (2008 as cited Gee, 2010) proved that the Quantity Surveyor is responsible for the management of costs through the whole of the project and is involved from the feasibility and design stage up to the completion of the project and can have responsibilities such as calculating replacement cost or estimation for insurance purposes after construction. Ashworth and Hogg (2007 as cited Fanous, 2012) concluded that traditionally Quantity Surveyors are expected to conduct initial cost planning, measure and quantify all elements of a project, control costs throughout construction, give procurement advice and prepare financial documents, accounts and valuations. This is known as a simple ‘measure and value' system and still remains the main, if not only, purpose of modern quantity surveyors working on smaller projects. Olatunji *et al.* (2009) discussed that the majority of the most important functions traditionally carried out by quantity surveyors are based upon the measuring and pricing of construction works. Following is the representation of the 9 most important traditional roles and responsibilities of a Quantity Surveyor identified by Fanous (2012) in his empirical study.

- Providing Approximate Cost Estimates
- Advice on Procurement
- Cost Planning
- Measuring Items on Site
- Preparing Bills of Quantities
- Preparing Schedules of Works
- Preparing Financial Statements
- Controlling Costs throughout Project
- Assessing and Negotiating Tenders

Furthermore, Olatunji *et al.* (2009) spotout that Quantity Surveyors are ubiquitous in the construction industry. Conventionally, Quantity Surveyors' services include the preparation of preliminary estimates and feasibility studies bills, Quantity surveyors draft and compile documentation for construction contracts. They further provide advice on contractor selection and financial management of all construction works and allied reporting, including auditing, planning cost and indexing. They provide construction project management services as well as value management, facilities management, management contracting, construction dispute resolution, research, and other forms of consultancy services. A recent article of AIQS (2011) indicates that preparing bill of quantities (BOQ) is one of the oldest tasks performed by the Quantity Surveyor. In fact, the Quantity Surveyors get their name from the BOQ. Furthermore Shangvi (2012) denote that, a comparison of the prices quoted in the BOQ normally forms the basis of selection of a tender, especially, on the traditional design-bid-build route. The process of measuring quantities of various items of work is termed as quantity takeoff.

Preparing preliminary estimates is one of the important traditional tasks which are performed by Quantity Surveyor. A study of Ashworth (2010) emphasized that preparing pre-tender estimates or cost estimates provides an indication of the probable construction cost which is prepared at various stages of the project like the conceptual stage and the detailed design stage. Fiserv (2012 as cited in Shangvi, 2012) show that cost reporting is again different from cost planning and cost estimating. It is an exercise whereby the QS provide regular updates on the likely out-turn cost of a project. According to Shangvi (2012) the contractor's Quantity Surveyor prepares payment applications, usually on a monthly basis, which contain a statement of monies due to the contractor by the client based on the progress of works.

Value Management and Life Cycle Costing are relatively new concepts compared to the other traditional tasks outlined above. However they have greater relevance in present times to the Quantity Surveying profession. Cartlidge (2008 as cited Shangvi, 2012) states that Value Management (VM) is concerned with enhancing the performance of a building at the same cost or achieves the same functions at a lower cost. A recent article of Isurv (2011) declared that Life Cycle Costing is a decision-making technique that takes into account both initial and future costs over the life of a building. For buildings and structures, it is inevitable that, not only capital costs, the relevant costs in use or operational costs will consider as well.

3. INTRODUCTION TO BIM

Building Information Modeling (BIM) has recently attained widespread attention in the Architectural, Engineering and Construction (AEC) industry. BIM represents the development and use of computer generated n-dimensional (n-D) models to simulate the planning, design, construction and operation a facility. It helps Architects, Engineers and Constructors to visualize what is to be built in simulated environment and to identify potential design, construction or operational problem (Azhar*et al.*, 2010). Furthermore Smith (2007) says, the concept of Building Information Modelling is to build a building virtually prior to building it physically, in order to work out problems and simulate and analyse potential impacts.

Succar (2008) defines, Building Information Modelling (BIM) as a “set of interacting policies, processes and technologies generating a methodology to manage the essential building design and project data in digital format throughout the building's life-cycle”.

3.1. THE HISTORY OF BIM

Before 1980s traditionally, Architecture, Engineering, Construction industry used to express building components in symbolic language and orthographic drawings by means of manually drafted drawings on paper using drawing boards, T-squares and pencils. With the development of the computer science, in the early 1980s, architects began using geometry-based CAD (Woo, 2007). BIM is a three letter acronym, Building, Information, Modelling coined by architect and Autodesk building industry strategist Phil Bernstein in 2002 who used the actual terms for BIM (Beck, 2008). However, according to Eastman (1999 as cited Fanous, 2006) state that BIM concept can be tracked back 30 years ago and credited to Chuck Eastman, who created it at the Georgia Tech College of Architecture and computing which he referred to as “Building product model*”.* Eastman described Building product model as “the provision of rich, integrated information from conception through design to construction and demolition of a building over its life cycle”.

BIM has brought a new era for the construction industry and there is a little disagreement that BIM is a new era and will transform almost everyone in the building and construction industry (Neeley, 2010).

3.2. CAPABILITIES OF BIM

Building Information Modelling (BIM) is the latest technology in the built environment utilising data models. It is a multi-dimensional model that acts as a communication and information resource over the lifecycle of a construction project (Gee, 2010). Olutanji *et al.* (2009) says relevant literature highlights BIM as three- or four-dimensional drafting applications that generate data-intensive plans. In contrast to two dimensional drawings where sets of lines and surface areas are rendered through soft and hard intelligent features, BIM systems store data related to each ‘object'. The implication of this on the construction process is that construction designers and constructors are able to model real life situations before moving to site. Muzvimwe (2011 as cited Shangvi, 2012) summarise that following BIM applications which are capable to provide the services on a construction project.

Table 1: BIM Applications which are Capable to Provide the Services on a Construction Project

3D BIM (Design)	They can create three dimensional (3D) models of the buildings from which the design can be visualised at any stage of the project. Moreover, 3D models are useful for design coordination and clash detection of services in a building.
4D BIM (Scheduling)	Certain BIM applications possess the capability of linking the components of the model to the construction schedule. This process of adding the parameter of time to the 3D model is termed as 4D simulation. The 4D model is used for planning and tracking construction activities.
5D BIM (Cost)	The 5D model is an integration of design (3D) and schedule (4D) with the costs associated with the components of the model. It is primarily used for cost estimation.
6D and 7D BIM	Due to the large scale research and development, the repertoire of BIM tools now covers applications related to life cycle management and sustainable design which are referred to as 6D and 7D.

4. BUILDING INFORMATION MODELLING AND QUANTITY SURVEYING PRACTICE

4.1. IMPACT OF BIM ON QUANTITY SURVEYING PROFESSION

Technology is developing rapidly by improving all its subsectors across the world and making all the real life functions easier than they were. The construction industry which identifies technology as vital, has been sensitive to these technological changes. Ashworth and Hogg (2007 as cited Gee, 2010) emphasized that 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. The history of Quantity Surveying and the way Quantity Surveying tasks were performed provides enough substantial evidence to show how Information Technology has changed the way Quantity Surveyors perform their duties and the speed and efficiency of the professional services of the Quantity Surveyor.

BIM has the potential to influence every characteristic of the construction industry together with construction professionals. BIM consists of 3-dimensional design functions (3D), programming and scheduling functions (4D) and cost estimating functions (5D). Olatunji *et al.* (2009) specified that, BIM is a major challenge to the services conventionally provided by Quantity Surveyors and other construction disciplines. The adoption of BIM may redefine traditional professional boundaries in construction not just for Quantity Surveying. BIM has the potential to automate measurement and facilitate the preparation of accurate estimates. Building Information Modeling has the capability to automate a quantity take-off, which will reduce the time and costs required to estimate a project; however, the industry is not using BIM for estimating. BIM software is compatible with estimating software, such as Innovaya Composer, which converts BIM files, making them compatible with Timberline's estimate and quantity data (Sattineni and Bradford, 2012). According to Gee (2010), 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. Hergunsel (2011) reported that two main elements of a cost estimate are quantity take-off and pricing. Quantities from a Building Information Model can be extracted to a cost database or an excel file. However, pricing cannot be attained from the model. Cost estimating requires the expertise of the cost estimator to analyse the components of a material and how they get installed. If the pricing for a certain activity is not available in the database, cost estimator may need a further breakdown of the element for more accurate pricing. Autodesk (2007) argues that as BIM tools are capable of automating the tedious task of quantifying, they allow the estimators to dedicate their valuable time on other cost sensitive tasks as pricing and factoring risks. Baldwin and Jellings (2009) emphasized that traditionally followed Quantity Takeoff and bill generation is a very time consuming process that are prone to error. Moreover, it is perceived that the following factors undermine the accuracy of the manual Quantity Takeoff.

- Errors associated with moving data between files
- Risk of double counting
- Risk of missing elements
- Multiple 2D drawings themselves are likely to contain many errors compounding the problem further

Furthermore Paul *et al.* (2011) denote that BIM software can help assist the Quantity Surveyor in various tasks rather than quantification. BIM can aid programme certainty at tender stage, contractors can link their programme to the model upon tender submission, and this should reduce the amount of variations required during the construction phase.

As a summary it can be illustrated that there is considerable impact of BIM on the profession of Quantity Surveying.

4.2. USAGE OF BIM AS A QUANTITY SURVEYING TOOL

The use of Building Information Modelling (BIM) in the construction industry is on the rise. It is widely acknowledged that adoption of BIM would cause a seismic shift in the business processes within the construction industry and related fields (Sattineni and Bradford, 2012). The manual process requires a great deal of time for revising the BOQ to accommodate design changes. Hence, the BOQ is often out-of-date. Ashworth (2010) considers that the speed of response and the ability to reduce manual errors have led to the wide spread use of software applications for performing QTO and estimating. The 5D model created by BIM has the potential to perform an automatic analysis of all materials and components and to derive their quantities directly from the model (Baldwin and Jellings, 2009). Eastman *et al*. (2008), consider that proponents of BIM are very useful for VM as the speed of response of BIM tools provides an excellent opportunity to perform VM throughout the design period.

Baldwin and Jellings (2009) reported that Consolidated ContractorsCompany used BIM to generate bulky monthly payment applications, cost reports and estimated that by utilizing BIM in the Dubai Mall project. That tasks which would possibly have required 25 full time QSs were carried out by employing 8 modellers and 2 BIM engineers. BIM suggest that a detailed building model wouldprovide a greater certainty over the quantities of material, andtherefore, BIM would produce a more reliable cost estimate comparedto the traditional process (Eastman *et al*., 2011). Monswhite (2011 as cited in Shangvi, 2012) denote that large clients who have their in-house cost database can directly derive their estimates during the early stages of the project using BIM based estimating tools such as DProfiler. Therefore, they can afford to do without the services of the QS.

According to Eastman *et al.* (2011 as cited in Shangvi, 2012), below table provides an overview of the capabilities of BIM applications pertaining to the traditional quantity surveying tasks.

Table 2: Capabilities of BIM Applications Pertaining to the Traditional Quantity Surveying Tasks

Traditional Quantity Surveying task	**BIM tools capable of performing that task**
Quantity Take-off	Autodesk QTO, BIM Measure fromCauseway
BOQ Preparation	CostOSTM, Nomitech
Cost Estimation	DProfiler, Beck Technology
Cost Planning	Vico Cost Planner
Cost Reporting	Vico Office Client
Cost Control	Vico Cost Explorer
MaterialProcurement	Quantities of material can beobtained using BIM tools for QTO
PaymentApplications	Bentley
VM	BIM tools for estimating can beused to obtain the estimated costs of various design options
Life Cycle Costing	Integrated Environmental Solutions Virtual Environment

4.3. UNCERTAINTY OF BIM AS A QUANTITY SURVEYING TOOL

Building Information Modelling "BIM" is becoming a better known established collaboration process in the construction industry (Hergunsel, 2011). However, as per the viewpoints of Ogunsemi *et al*. (2010), there is a second line of thought within the construction industry which suggests that, BIM is not completely trustworthy as a Quantity Surveying tool as nonconformity of the output data from BIM with the standard methods of measurement. Furthermore Buckley (2008 as cited in Shangvi, 2012) argued that, BIM tools are not advanced enough to be capable to substitute the experience and expertise of the QS. Furthermore Bruce Buckley does not endorse this practice of preparing a cost estimate without the involvement of an estimator and estimator's knowledge and experience are absolutely essential to adjust the estimate in accordance with the specific conditions of a project. Moreover Buckley point out that BIM tools are not programmed to perform such adjustments by themselves. Olatunji *et al*. (2010) have doubts over the reliability of QTO performed by BIM applications as BIM tools simply provide theoretical quantities based on the attributes of the model without any allowances for wastage, lapping etc.

5. CONCLUSIONS AND WAY FORWARD

Technology is developing rapidly by improving all its subsectors across the world and making all the real life functions easier than they were. The construction industry which identifies technology as vital has been sensitive to these technological changes. According to the literature, Building Information Modelling (BIM) is one of the technologies that have been creating a buzz in the construction industry over the last few years which have potential to effect of Quantity Surveying profession. However, the technology itself provide list of benefits as well as a certain degree of risk which depend on the situation its being used.

The review of current knowledge synthesized numerous benefits of BIM for QSs to offer effective service. Finding the validity of these conclusions empirically will be the next step of this study. However, in the absence of real cases of proper use of BIM in Sri Lanka, a positivists approach is not possible. Thus, the research will involve triangulation and interpretation of information from multiple sources to draw sensible conclusions.

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