Usability and Impact of BIM on Early Estimation Practices: Cost Consultant's Perspective

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Abstract

Building Information Modelling (BIM) represents the formation of digital models for use during the planning, design, construction and operation stages of a facility's life. Whilst BIM is currently receiving high volumes of attention within the UK, it appears that general understanding of it is relatively low. The research has shown that BIM has the capacity to influence the way that the construction industry operates, with the focus of this study being to identify the usability of BIM for cost consultants, and it's likely impact during cost estimating. Research was carried out through an in-depth review of existing literature, to develop a conceptual framework, which was used to assess the potential advantages and challenges for cost consultants using BIM in their working practices. This research has the potential to help practitioners understand BIM in detail and how it can be embraced into current ways of working, as well as identifying potential areas for expansion of cost consultancy services, through BIM implementation.

Keywords: Building Information Modelling (BIM), Cost Consultant, Collaboration, Cost Estimating

1. Introduction

BIM is beginning to change the way buildings look, the way they function, and the ways in which they are designed and built (Eastman, et al., 2011). There is a wealth of research material available on the topic of BIM, providing details on how BIM can be used for purposes such as a modelling tool, information tool, communication tool and facilities management tool (Popov et al., 2006). For this research, Building Information Modelling is defined as the innovative production of a single building model, which works to integrate information supplied from all disciplines involved, for use by the whole project team (Succar, 2009). This is due to the fact that, for cost consultants, it is BIM's capability of combining graphical and data models, which will allow for the provision of more accurate cost information (McCuen, 2008a).

Building Information Models are digital representations of the physical and functional characteristics of a facility (National BIM Standard, 2011). The models intend to supply usable information throughout a projects lifecycle, by providing all details on the design, construction and operation of the building (BIS, 2011; GIM International, 2011). BIM also seeks to improve project collaboration and coordination within teams, as parties involved are able to add, share and view information in the same digital area (Autodesk, 2011).

2. Rationale

This paper was inspired by a current level of uncertainty as to how BIM will affect the cost consulting profession (Olatunji et al., 2009); these being consultants employed to act as client quantity surveyors, with primary roles of managing and controlling project costs (RICS, 2011b). It is important for cost consultants to fully understand how they can work effectively with BIM, as the UK 'Government Construction Strategy 2011' outlines that it will be mandatory for all public projects of £5 million and over, to be working collaboratively with 3D BIM by 2016 (Cabinet Office, 2011). Therefore, it is crucial that BIM is understood and embraced by this date, if companies wish to be considered for public projects.

With this in mind, this research aims to investigate the usability and impact of BIM implementation on cost consultants, with particular reference to the cost estimating stage. This was due to the fact that whilst recent studies have shown that 80% of quantity surveying firms are using elemental cost estimates in their working practices, the Royal Institution of Chartered Surveyors (RICS) reports a lack of BIM knowledge amongst its members (BCIS, 2011). Ku and Taiebot (2011, p.175) have found that BIM is "being rapidly embraced by the construction industry to reduce cost, time and enhance quality", with Eastman et al (2011) supporting this by explaining that clients are now realising benefits that BIM can offer them as owners. Therefore, it would appear essential that cost consultants increase their knowledge, awareness and usage of BIM, to ensure that they do not fall behind other construction professionals.

3. Methodology

A systematic literature review method was adopted for this paper in order to draw findings and form conclusions. Secondary information consists of sources of data that has been collected and recorded by others (Stewart and Kamins, 1993), which was derived for this research through a detailed literature review, to explore information already known on the topic of BIM (Robson, 2011). From this, tables were created to list the associated advantages and challenges for cost consultants using BIM, which was utilised to assess the usability and impact of BIM on cost consultants.

4. Literature Review

4.1 What is BIM?

BIM is a tool that can be used throughout the lifecycle of a facility by the whole project team (Azhar et al., 2007). This intends to improve collaboration between stakeholders (Grilo and Jardim-Goncalves, 2010) and encourage the quick and easy sharing of information, by bringing together the work of various disciplines, through a centralised model (Meadati, 2010). The resulting model is a three dimensional digital representation of a facility, which should allow for reliable decision making throughout its life time (National BIM Standard, 2011; Shen et al., 2012).

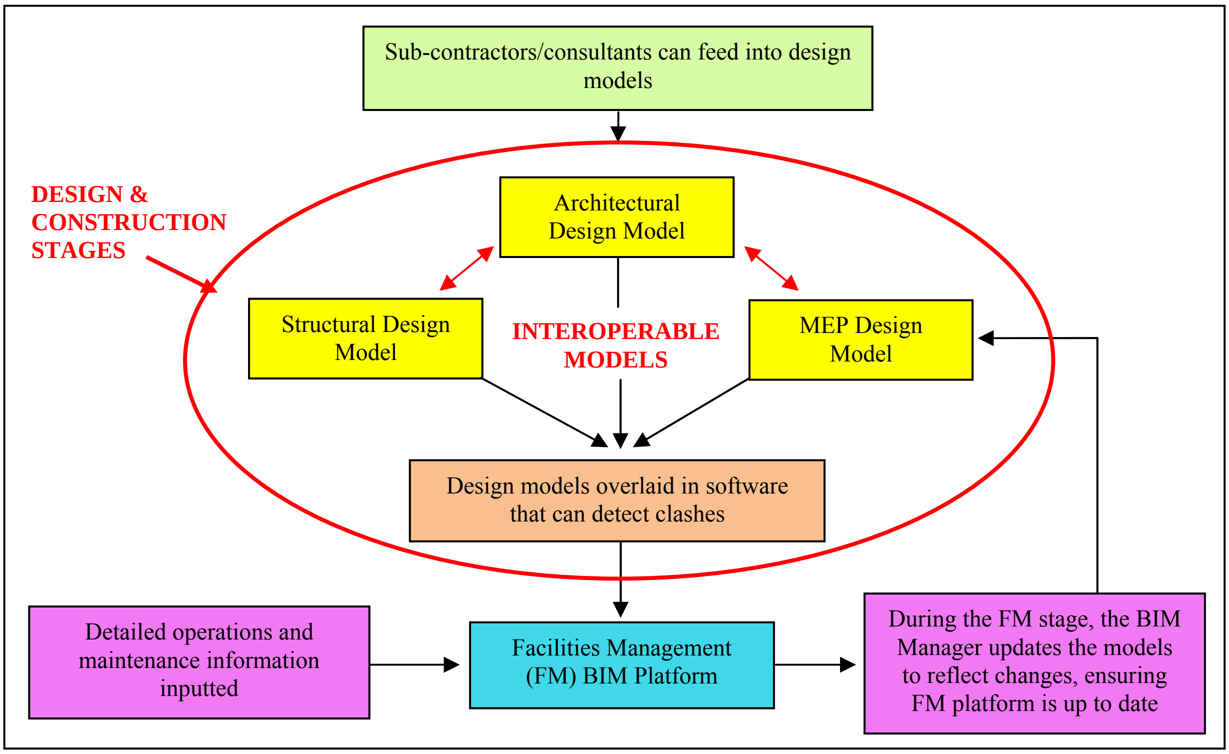

Figure 1: Interoperable BIM Process

The introduction of BIM has been brought about due to a requirement for increased sustainability and productivity within the construction industry (Cabinet Office, 2011). BIM is considered as a means of providing this through an interoperable model, serving as "an integrated and coherent information management strategy" (Meadati, 2009, p.6). It is hoped that this will work to reduce industry fragmentation and provide a smooth flow of information throughout the planning, design, construction and operation phases (McCuen, 2008b), as shown in figure 1.

4.2 BIM Maturity

BIM represents a move away from traditional two dimensional design practices (Sabongi, 2009), as models are developed through the combination of "3D graphical modeling, 4D time modeling and 5D cost modeling" (McCuen, 2009, p.2). Currently, the UK government is targeting all public projects to be delivered to a BIM 'maturity' level 2 by 2016 (BIS; 2011); the various levels achievable are shown within figure 2. Level 2 essentially requires teams to be working collaboratively with 3D BIM, however with no obligation for the 4D programme, 5D cost and operation elements to be incorporated within the model (Construction Manager, 2011). Level 3 represents a fully integrated BIM process, utilising the models full potential (Constructing Excellence, 2011), with the most complex being where clients are able to benefit from lifecycle asset management.

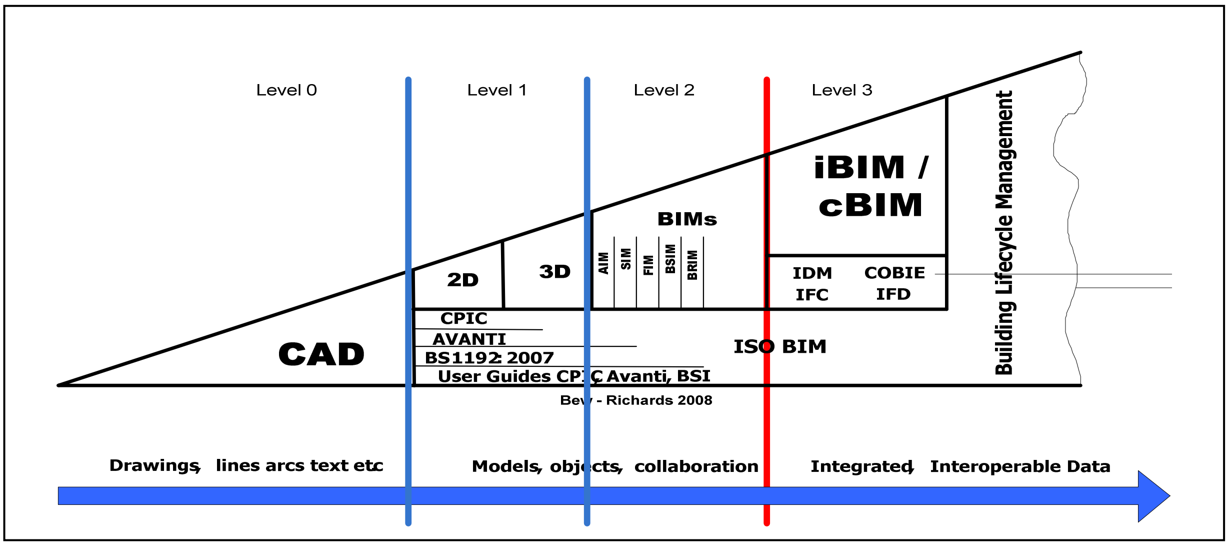

Figure 2: BIM Maturity Diagram (Cabinet Office, 2011)

4.3 5D Cost Estimating and Automatic Quantification

Through level 3 BIM, cost estimating can be carried out through the 5D function, by linking the model to an estimating database (Haque and Mishra, 2007). Hamil (2012b) discusses that this can be done through sources such as Building Cost Information Service (BCIS), to provide high level cost information, which will be useful in the early project stages (BIM Products, 2012). Certain software providers are now publicising that it is possible to develop detailed cost plans through linking a '5D Cost Library' to BIM, which performs the function of an estimating database. A 'master' library can be formed, in addition to several project specific variation libraries, making the process highly productive and easily repeatable (VICO, 2012a). This will allow varying levels of detail to be applied to estimates, depending on the project stage.

Building Information Models are formed of intelligent and multi-dimensional objects; these being objects containing information about the element they are representing, such as quantity and specification details (Azhar et al., 2009). Through this, BIM enables automatic quantification (Greven, 2011, cited in Deutsch, 2011, p.53) and the production of schedules (Woo, 2007), which will largely eliminate the need for manual take-off of buildings during estimating. In addition, design data is interrelated, and therefore an alteration of one element instantly updates anything affected by the change (Sylvester and Dietrich, 2010).

Through automatic quantification, Rundell (2006), reports that human error and inaccurate drawing interpretation during measurement will be eliminated. Hannon (2007) discusses that this will increase efficiency as it will avoid the time consuming and duplicate process of estimators quantifying what designers have already produced, reporting that manual quantification can take 50 – 80% of time during cost estimation. However, as Woo (2007) points out, it will be essential that design information is correct in the first place; an aspect agreed by Patchell (2012), who from his experience working with BIM, states that information extracted from the model is only ever as good as that inputted.

According to McCuen (2008a) estimators with an adequate BIM understanding can benefit from the 5D BIM function and automatic quantification, by creating quicker estimates. This should lead to increased client satisfaction as they are receiving earlier economic feedback on the alternatives available (Pennanen et al., 2011), whilst having a greater understanding of the likely cost influences of design decisions (Greven, 2011, cited in Deutsch, 2011, p.53). However, as pointed out by Kraus et al (2007), without industry standards showing how BIM objects can directly relate to items on estimating databases, problems synchronising the two systems are likely to occur, making it difficult to produce accurate reports. This would result in cost consultants spending time working out differences between models and databases, and rely on the required levels of detail being included within the design.

4.4 Integration and Interoperability

A widely publicised advantage of BIM is the increased collaboration amongst the project team, achievable through use of a centralised model (Sabol, 2008; Sebastian, 2011). It is hoped that communication and information access will be improved through this, therefore reducing the level of work carried out in isolation (Thomson and Miner, 2007 cited in Sabongi, 2009). However, issues within teams may occur as the "highly specialised skills required are currently relatively unique within the industry" (Eastman et al., 2011, p.414), which can cause problems, as different members often possess different BIM capabilities. Eisenmann and Park (2012) found in their research that the team experience level was very important in maximising benefits from BIM, and with little experience, it is possible to see negative results from its implementation. Therefore, they recommend that team ‘experts’ are assigned, as well as a general requirement for sound levels of BIM understanding for those using it.

In addition, Olatunji (2011, p.3) found that interoperability between different software providers is a “major issue that BIM adoption has got to deal with”. Interoperability is the smooth sharing of information across all BIM applications and disciplines involved, which is required for business benefits to be maximised (Arayici, 2008). Howell and Batcheler (2003) agree with this, and state that collaboration can be difficult to achieve due to expectations for the team to adopt one BIM system, which is rare due to the number of companies involved. However, this has reportedly been improved through the establishment of Industry Foundation Classes (IFC), which ensure the effective exchange of information between BIM platforms is achieved through a neutral file format (Iqbal, 2012). Approximately one hundred information exchanges have signed up to the agreement (Solibri, 2012), which will be essential for cost consultants, as without complete interoperability, items will be missed from the model as they are combined and therefore excluded from estimates.

4.5 Provision of Additional Information

As designs develop through BIM, it will be possible to link models with a National Building Standards (NBS) application (NBS, 2012b). This can be used to provide early and reliable specification data, which can be a useful cost management tool (Rider Levett Bucknall, 2012). The 4D function of BIM can also add additional information, in the form of early construction programme details (Meadati, 2009), which may not otherwise have been available. Additional information such as this should help in creating estimates that more accurately reflect the scope of work involved and improve the reliability of cost advice.

Through BIM’s 3D viewer function, the facility can be viewed in an infinite number of ways, from any angle through the model (Sylvester and Dietrich, 2010). Improved visualisation through this should be advantageous to clients, design teams (Haque and Mishra, 2007) and contractors in fully understanding a project’s design (Goldberg, 2007). Cost consultants should therefore have to make fewer assumptions, and as clients can clearly visualise the options available, it has proven to be a beneficial decision making tool (Shennan, 2012), which is hoped will result in fewer cost plan revisions. However, as Sabol (2008) reports, it is possible that too much model detail at early stages could confuse decision making and scenario planning.

4.6 Service Expansion and BIM

Through implementation of BIM, research has shown that it will be possible for cost consultants to offer several additional services. The NBS Group has recently undertaken the Interoperable Carbon Information Modelling project, which is “a new industry project with the aim of creating an everyday design tool to facilitate carbon assessment” (BIM Academy, 2012). NBS believe that this will be a valuable tool for cost consultants to provide clients with cost advice for making lifecycle management decisions (NBS, 2012a). In addition, cost consultancy firms have reported several alternative service provisions that are possible through use of BIM, as part of the cost estimating stage; these include value management, capital allowances and risk analysis (Meadati, 2009).

5. Discussion

Following the detailed literature review, a conceptual framework was formed to record a comprehensive list of advantages and challenges cited for cost consultants using BIM in their working practices; summarised versions of these have been included within Tables 1 and 2. The findings have been grouped into five broad headings, as detailed below.

5.1 Collaborative Working Approach

It can be seen from the conceptual framework created that collaborative working is one of the most commonly reported advantages of using BIM on construction projects. In particular, it has been pointed out that this will be achieved through a centralised model that working through BIM will introduce, with Kraus et al (2007) outlining that collaboration improvements amongst the stakeholders involved will be a key advantage of BIM. Similarly, Popov et al (2006) point out that a lot more is to be gained from BIM as more of the parties involved use it, explaining that overall project integration will improve through BIM, as individual executors will be brought together as teams (Hamil, 2012a), which should maximise the benefits of a centralised model.

5.2 Cost Consultancy Attitudes

The research has shown a fairly low usage of BIM within the UK, with the RICS '2011 Building Information Modelling Survey', reporting only 10% of quantity surveyors as regularly using BIM in working practices, as well as a general level of uncertainty towards it (BCIS, 2011). Whilst there have been fears within the industry that BIM could threaten the viability of the quantity surveying profession through automatic quantification (Olatunji, 2009), cost consultancy firms such as Rider Levett Bucknall (2012), who are currently using BIM, promote a positive attitude and state that it has enhanced their service delivery, including the provision of up to date cost planning. Therefore, a potential reason for the level of uncertainty towards BIM implementation may be due to a lack of personal knowledge and experience. Whilst an improved knowledge base may help individuals to form clearer attitudes towards BIM, as Azhar et al (2007) discuss in their research, this can be a complex process, as there is no single document instructing on its application and usage.

Table 1: Potential advantages for cost consultants using BIM

Potential ADVANTAGES for cost consultants using BIM	Asite, 2012a	Azhar *et al*, 2007	BCIS, 2011	Boon, 2009	Department for BIS, 2011	Goldberg, 2007	Grilo and Jardim-Goncalves, 2010	Hannon, 2007	Haque and Mishra, 2007	Ibrahim *et al*, 2004	Jung and Joo, 2011	Kraus *et al*, 2007	McCuen, 2008a	McCuen, 2009	Moazami, 2011	Olatunji *et al*, 2009	Popov *et al*, 2006	RICS, 2011a	Sabol, 2008	Sebastian, 2011	Shen and Issa, 2010	Tulke *et al*, 2005
DOCUMENTATION																						
Based on current design information													√	√								
Clear audit trail	√																		√			
Quicker documentation preparation																	√					
TEAM COLLABORATION																						
Improve collaboration and communication	√			√	√	√	√	√	√		√	√	√	√	√		√	√	√	√		√
Quick information sharing		√		√			√							√			√		√			√
Good decision making tool				√			√					√	√	√	√		√		√			
Early programme information		√		√					√													
Reduced errors through integrated model	√																					
Earlier supply chain involvement				√	√		√			√	√											
QUANTIFICATION																						
Automatic quantification	√	√		√		√	√	√	√		√	√	√	√	√	√	√	√	√		√	√
Increased consistency and accuracy												√						√	√			√
Export quantities into familiar programmes						√																
Quantities automatically reflect design changes		√					√															
Increase industry productivity				√							√			√				√				
PROJECT UNDERSTANDING																						
Improved visualisation	√	√		√		√	√	√	√		√	√	√	√	√		√		√	√	√	√
DESIGN FACTORS																						
Clash detection	√	√		√			√	√	√			√			√					√		
Develop solutions to design issues							√								√							
Quicker understanding of design change impact							√	√	√		√	√					√			√		
Rigorous option analysis		√		√			√	√	√		√	√			√		√					
Generate 2D drawings				√																		
COST CONSIDERATIONS																						
Greater understanding and confidence in lifecycle costing		√	√	√	√		√		√		√	√			√		√	√	√	√		
Integrating design with cost estimating databases		√				√	√													√		
Possibility to edit BIM estimates						√											√					
More time available for alternative services				√				√								√	√		√			

Table 2: Potential challenges for cost consultants using BIM

Potential CHALLENGES for cost consultants using BIM	Azhar *et al*, 2007	BCIS, 2011	Boon, 2009	Cabinet Office, 2011	Grilo and Jardim-Goncalves, 2010	Hannon, 2007	Haque and Mishra, 2007	Ibrahim *et al*, 2004	Jung and Joo, 2011	Kraus *et al*, 2007	McCuen, 2008a	McCuen, 2009	Olatunji *et al*, 2009	Richards, 2012	RICS, 2011a	Sabol, 2008	Sebastian, 2011	Shen and Issa, 2010
EXPERIENCE																		
Lack of confidence with automation											√							
Varying levels of team knowledge		√	√							√	√				√			
Lack of knowledge held by Quantity Surveyors	√	√					√		√								√	√
Lack of client demand		√																
Lack of training		√																
INTEGRATION																		
Integrating BIM with current practices									√							√		
Investment expense			√		√	√	√			√								
No single set of implementation guidelines	√																	
CHANGE OF PRACTICE																		
Fundamental change														√	√		√	
Uncertainty over data entry control	√																	
Resistance to change			√			√				√					√			
Lifecycle costing putting individuals out of 'comfort zone'			√															
Embrace BIM by 2016				√														
Threaten viability of profession through automatic measurement													√		√			
Detailed models may confuse decisions																√		
SOFTWARE ISSUES																		
Lack of hardware support		√															√	
Different project and company requirements								√									√	√
Interoperability challenges			√		√		√			√		√						
Incorporating unique items										√								
MEASUREMENT AND COST ESTIMATING																		
Detailed model objects required for reliable estimating																√		
Difficulties mapping objects into estimating databases			√			√				√						√		
5D cost function not optimised	√								√								√	
Objects required to reflect RIBA stage																√		
Reduce manual interpretation																		√
Compliance with standard methods of measurement													√					

5.3 Change in Current Practice

The research has shown that many authors, including Tulke et al (2007), have reported that automated measurement should work to increase the speed of updating estimates. In addition, through the potential to overlay designs in software that detects clashes, this should lead to fewer design issues, and in turn the need for fewer cost plan revisions. However, it is important to note that there are certain reservations cost consultants appear to have in connection with the change to an automated process, reflected in an overall slow uptake of BIM amongst quantity surveyors to date (Construction Index, 2012). These include for the development of automatic quantification to comply with the standard method of measurement rules (Olatunji et al., 2009), a lack of confidence in automatically producing something that was previously controlled manually (McCuen, 2008) and through this, the loss of manual interpretation during measurement (Shen and Issa, 2010).

Boon (2009) explains that BIM will allow for the provision of additional information for costing purposes, such as through early supply chain involvement, early programme information and a better understanding of the scheme through improved visualisation. Nonetheless, as Sabol (2008) found in her research, a high level of model detail through such information too early on in a project can potentially confuse design decisions. Whilst this may be true, it appears that standards are now in place to manage the amount of detail included within models, through the Model Progression Specification (MPS). This is a procedure of bringing information together, whilst ensuring that team members are aware of the level of detail they are required to produce information to (VICO, 2012b).

5.4 Additional Service Offerings

Sabol (2008) and Hannon (2007) point out in their research that it will be possible to provide alternative professional services in practice. A key UK government driver for promoting BIM is the opportunity to "derive significant improvements in cost, value and carbon performance through the use of open sharable asset information" (BIM Industry Working Group, 2011, p.15), which lifecycle costing can assist with. Whilst it has been found that additional services such as lifecycle costing exercises are likely to put certain individuals out of their comfort zones (Boon, 2009), it is essential that cost consultants innovate to provide this, as the research has shown that clients are demanding it, whilst other construction professionals perceive it as being a value adding service.

5.5 Additional Challenges

Widespread BIM implementation is likely to present challenges for some people in adapting to changes in traditional practices (Kraus et al., 2007). Several sources show a strong training requirement associated with BIM implementation, which for many firms will represent a challenge, due to the investment costs and time involved (Grilo and Jardim-Goncalves, 2010). As many firms have reported a current lack of client demand, and due to the high investment costs, cost consultancy companies have generally been slow to spend money and time on BIM (BCIS, 2011). Whilst this is understandable, it appears that cost consultants should be aware of BIM's increasing popularity, and consider its influence on their practices in the future, as to ensure that they do not appear behind other professions during BIM's anticipated widespread industry take up (Cabinet Office, 2011; RICS, 2011a).

Hamil (2012a) explains that from his experience, clients appear to be willing to pay higher professional fees for their projects to incorporate BIM, due to the anticipated future benefits to them as long-term facility users, through lifecycle management improvements. However, as Wise (2012) discusses, fees could go down in the long term as companies become more familiar with BIM, and efficiencies within the industry improve (Boon, 2009; McCuen, 2009). Therefore, whilst clients may be willing to pay higher consultancy fees to use BIM on their projects at the present time, as the 'early-investing' firms become more experienced with BIM and are potentially able to decrease future fee proposals, higher costs charged by consultancies making later investment are unlikely to be tolerated. Therefore, companies who adapt later are more likely to have to cover a higher proportion of their BIM investment themselves, or suffer fewer new client commissions.

6. Conclusion and Further Research

The research carried out has generally shown that widespread BIM implementation is anticipated to bring about a new way of working and thinking within the construction industry, in comparison to traditional practices. As supported by the RICS (2011a), it has been found that the usage of BIM is increasing within the UK and seemingly has the capacity of impacting every aspect of the surveying profession, therefore making it essential for cost consultants to adapt and embrace BIM, as to not risk losing ground to others. It is not only BIM's capability of performing automatic and accurate quantification that cost consultants need to be aware of, but also the opportunities that it can offer them, through a solid understanding of BIM's potential advantages and challenges.

Several authors have commented that whilst cost consultants are generally aware of BIM, there is an overall lack of knowledge and understanding of what it is. There was also a requirement shown for training in order to have the capacity of working with BIM in its entirety, and gain the full advantages from it. It will be essential for firms to act promptly, in order to meet the government's 2016 target, as well as to keep future fee proposals competitive and not loose out to 'early investing' companies.

Analysis has shown that BIM has several key advantages to offer cost consultants during the cost estimating stage. As commented by various authors (Azhar et al., 2007; McCuen, 2008a), these are expected to include the time benefits associated with automatic processes and the possibility of accessing additional information, which will be useful in improving the reliability of documentation. The research has displayed potential reservations for using BIM to expand service offerings, such as lifecycle cost estimates and carbon assessments. It appears however, that these are services desired amongst clients and project teams, and therefore the most successful cost consultancy companies in the future are likely to be those who maximise their investment in BIM through offering such skills. However, it is essential that BIM is introduced to organisations as part of a structured implementation plan, with the required levels of sensitivity and potential allocation of 'champions' to help with the process.

Following on from this paper, further research has been undertaken to collect and analyse standpoints of cost consultants and other construction professionals towards the usability and impact of BIM on estimation practices. In addition, it will be critical to explore the change in the cost consultant role during the post contract project stage, as well as the contractual changes that will be brought about.

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