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Advantages and Challenges of Using BIM: a Cost Consultant's Perspective

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Building Information Modeling (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 around the world, it appears that general understanding of it is relatively low. Focus of this study is to identify the advantages, challenges and usability of BIM for cost consultants, and its likely impact during cost estimating. Research was carried out through an in-depth review of existing literature, which was refined through questionnaire surveys and expert interviews within the UK to assess the potential advantages and challenges for cost consultants using BIM in their working practices. This research also identifies potential areas for expansion of cost consultancy services, through BIM implementation and shows that BIM has the capacity to influence the operations throughout the construction industry.

Key Words: BIM, interoperability, collaboration, cost consultant, cost estimating.

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 modeling tool, information tool, communication tool and facilities management tool (Popov et al., 2006). This research takes an information perspective and defines Building Information Modeling 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 non-graphical data models, which will allow for the provision of more accurate cost information (McCuen, 2008).

This paper was inspired by the current level of uncertainty as to how BIM will affect the cost consulting profession in the UK; these being consultants employed to act as client Quantity Surveyors, with primary roles of managing and controlling project costs. 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 level 2 BIM by 2016 (BIS, 2011). 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) 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 realizing benefits that BIM can offer them as owners. Therefore, it is essential that cost consultants expand their knowledge, awareness and usage of BIM, to ensure that they do not fall behind other construction professionals.

Literature Review

The introduction of BIM has been brought about due to a requirement for increased sustainability and productivity within the construction industry (BIS, 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). 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, as shown in figure 1. BIM as a tool can be used throughout the lifecycle with the intention to improve collaboration between stakeholders (Grilo and Jardim-Goncalves, 2010)

and encourage quick and easy sharing of information, by bringing together the work of various disciplines, through a centralized model. This resulting model is a three dimensional digital representation of a facility, which should allow for reliable decision making throughout its life time.

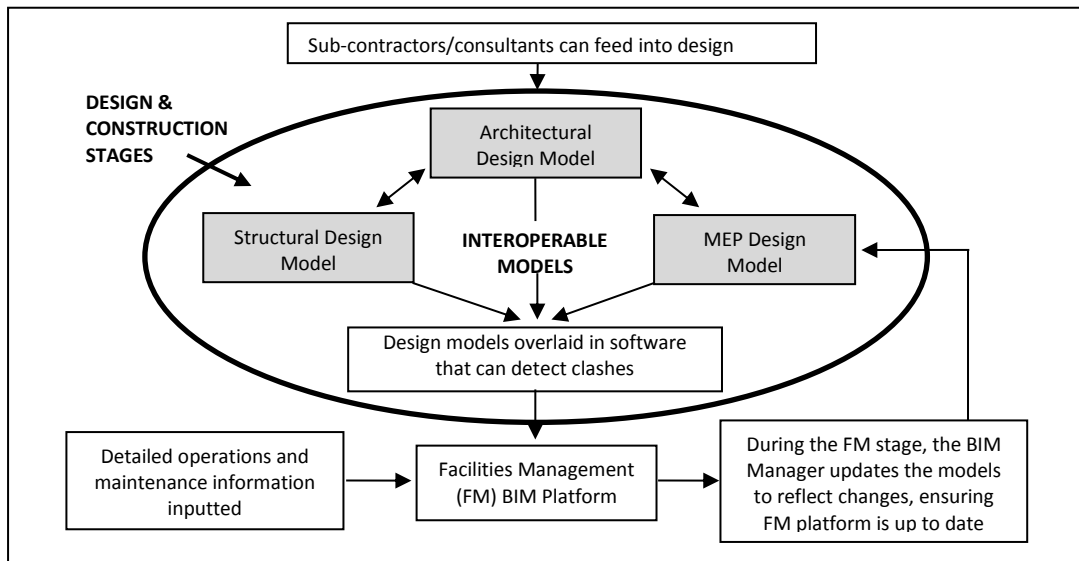


Figure 1: Interoperable BIM Process

BIM represents a move away from traditional two dimensional design practices, as models are developed through the combination of 3D graphical modeling, 4D time modeling and 5D cost modeling (Deutsch, 2011). 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 schedule, 5D cost and operation elements to be incorporated within the model (Isikdag et al., 2012). Level 3 represents a fully integrated BIM process, utilizing the models full potential, with the most complex being where clients are able to benefit from lifecycle asset management.

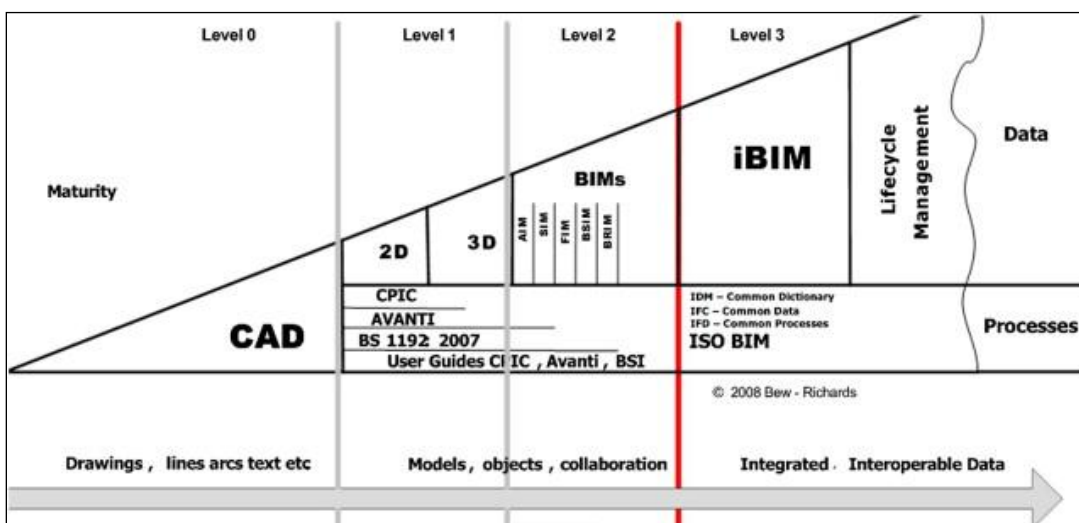


Figure 2: BIM Maturity Diagram (Cabinet Office, 2011)

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). Mena et al. (2010) 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. Certain software providers are now publicizing 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 Software, 2012). 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 and Brown, 2009). Through this, BIM enables automatic quantification (Deutsch, 2011) 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 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 (Woo, 2007) points out, it will be essential that design information is correct in the first place because information extracted from the model is only ever as good as that inputted. According to McCuen (2008) 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 (Deutsch, 2011). 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 synchronizing 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.

Integration and Interoperability

A widely publicized advantage of BIM is the increased collaboration amongst the project team, achievable through use of a centralized 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. However, issues within teams may occur as the "highly specialized skills required are currently relatively unique within the industry" (Eastman et al., 2011), 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 maximizing 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) 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 maximized. Howell and Batcheler (2012) 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 (Grilo and Jardim-Goncalves, 2010). Several information exchanges have signed up to the agreement (Laakso and Kiviniemi, 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.

Provision of Additional Information and Service Expansion

As designs develop through BIM, it will be possible to link models with a National Building Standards (NBS) application (NBS, 2012). 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 schedule 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 visualization through this should be advantageous to clients, design teams and contractors in fully understanding a project's design (Haque and Mishra, 2007). Cost consultants should therefore have to make fewer assumptions, and as clients can clearly visualize the options available, it has proven to be a beneficial decision making tool, which is hoped will result in fewer revisions to cost plan. However, as Sabol (2008) reports, it is possible that too much model detail at early stages could confuse decision making and scenario planning.

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 Modeling project, which is "a new industry project with the aim of creating an everyday design tool to facilitate carbon assessment" (NBS, 2012). This will be a valuable tool for cost consultants to provide clients with cost advice for making lifecycle management decisions. 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).

Methodology

Following the detailed literature review, an assessment framework was created to capture the relevant advantages and challenges of BIM for cost consultants, which was utilized to develop questionnaires. Two questionnaire surveys were formed in order to allow the perspective of BIM from 'general' construction professionals to be compared to that specifically of cost consultants. Likert Scale was used to collect data, where respondents ranked their levels of agreement with approximately thirty statements relating to BIM. Four 'open-ended' questions were introduced to collect additional data, which invited respondents to share opinions on particular aspects of BIM, and to give any further comments. These questionnaires were distributed amongst existing contacts across several companies to reduce specific 'company cultures' being reflected in the results, and therefore increased the likelihood of the results depicting opinions held within the UK construction industry as a whole. Total of 68 responses were obtained from 35 cost consultants and 33 general practitioners. In order to get detail answers of specific elements of the questionnaire findings, expert interviews were carried out using semi-structured interviews. At the time of interviewing, 'Interviewee A' had worked in the UK on approximately ten BIM building projects as a consultant architect; whilst 'Interviewee B' was working as an in-house client BIM Coordinator in the UK, having previously worked in an architectural practice using BIM.

Results and Discussion

Cost Consultant's Attitude

The results showed a generally low level of BIM experience amongst the respondents, with approximately 20% of cost consultants and 40% of general construction professionals surveyed having previously used it. This was reflected within the RICS '2011 Building Information Modeling Survey', which reported only 10% of Quantity Surveyors were regularly using BIM in working practices (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, 2011), Rider Levett Bucknall (2012), a large international cost consultancy firm 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. A potential reason for the level of uncertainty towards BIM implementation may be due to a lack of personal knowledge and experience. When asked whether other members of their profession were keen to embrace BIM, both surveys showed a mixed opinion towards the usage of BIM in everyday practices within the UK construction industry. Similarly, the question of whether respondents felt that BIM would fundamentally change their current role received a varied response, with the majority neither agreeing nor disagreeing. Again, this may be because of a lack of real understanding of BIM and how it can be integrated into the construction industry and within the various professional disciplines. An improved knowledge base may help individuals to form clearer attitudes towards BIM; however, as Azhar *et al.* (2008) discuss in their research, this can be a complex process, as there is no single document instructing on its application and usage.

Interviewee A revealed that a key driver for his company investing in BIM was the commercial advantage they felt it would give them over competitors, hoping that clients would see the potential benefits BIM can offer as long term facility users. Interviewee B supported this viewpoint stating that as a client who has worked with BIM, in the future they would only look to appoint consultants who can use BIM. Whilst the research has shown a generally a slow uptake of BIM amongst Quantity Surveyors (BCIS, 2011), the cost consultancy survey showed a 63% agreement that BIM will be used widely by the profession over the next five years, representing a higher level of agreement than the general construction professionals, at 47%. Therefore, as the findings show a general acceptance from cost consultants that BIM will be implemented across their profession, it would seem the most constructive attitude to take is to embrace the movement positively.

Collaborative Working Approach and Change in Current Practice

The detailed literature review shows that collaborative working is one of the most commonly reported advantages of using BIM on construction projects. From the surveys undertaken, 70 % of the respondents agreed that BIM will improve project collaboration. Interviewee B indicated that further benefits can be gained from BIM when the whole team starts to use it as the common platform to share information. As BIM usage increases, advantages through team collaboration will improve considerably in the future. Popov *et al* (2006) back this up in their research, pointing out that overall project integration will improve through BIM, as individual executors will be brought together as teams. Furthermore, 77% of the surveyed cost consultants perceive BIM as an approach for easier sharing and obtaining of information, compared to traditional practices.

There were several questions incorporated within the surveys to find out how respondents felt BIM could aid the current working practices. Results showed that 77% of cost consultants and 57% of general construction professionals agreed that automatic quantification would increase the accuracy of cost estimates. As Tulke *et al* (2008) explain in their research, automated measurement will increase speed of updating estimates and it will allow for the improved accuracy of quantities when time is not available to carry out detailed measures. There are certain reservations cost consultants have in connection with the change to an automated process. These include for the development of automatic quantification to comply with the standard method of measurement rules (Olatunji, 2011), 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). The survey results revealed an overall uncertainty for these areas, without a clear 50% agreement or disagreement for questions relating to this. However, when asked about how BIM can be used to provide additional information to help improve reliability of cost estimating, a positive response was recorded, supporting early supply chain involvement, early schedule information, quicker to predict cost impact of design changes and better understanding through improved visualization.

Additionally, possibility to detect clashes between the various designs produced is a key benefit of BIM for cost consultants. This can be done through overlaying the architectural, structural and MEP designs in software capable of detecting clashes. This should reduce errors in design, whilst leading to fewer issues on site. Results from the cost consultant survey showed a positive response for this, with over 50% of respondents agreeing that clash detection between designs would lead to fewer cost estimate revisions in early project stages. Sabol (2008) highlights in her research that a high level of model detail too early on in a project can potentially confuse design decisions. When this was tested through the survey, there was no clear consensus of opinion, with the majority of people neither agreeing nor disagreeing with the point. Standards are now in place to manage the level of detail included within models whilst ensuring that each team member is aware of the level of detail they are required to produce information to (VICO Software, 2012). As Interviewee B discussed “*everybody needs to know what it is, as it’s a bit*

of a change in the way of working and communicating". When survey respondents were asked whether the introduction of BIM into their work teams would be a complex process, 50% of the general construction professionals agreed, compared to 64% of cost consultants.

In the survey, 87% of the respondents indicated a strong training requirement associated with BIM implementation, which for many firms will represent a challenge, due to the investment costs and time involved. Respondents agreed with the high costs associated with BIM investment, with 75% of people who had any experience working with BIM disagreeing that it was an affordable option for all companies. Interviewee A explained how he sees the high associated costs as being a real barrier for cost consultant investment in BIM, especially if they are planning to use it solely for quantity take-off. Additionally, the questionnaires showed an overall disagreement that current non-government clients are presently requesting BIM to be used on their projects. Therefore, with a current lack of client demand and high investment costs, cost consultancy companies have generally been slow to spend money and time on BIM (BCIS, 2011).

Interviewee B discussed that from a client's perspective, they are anticipating consultants to build a level of their current BIM investment into fee proposals. He explains that they are 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 McCuen (2008) discusses, fees could go down in the long term as companies become more familiar with BIM, and efficiencies within the industry improve. Therefore, whilst clients may be willing to pay higher consultancy fees to use BIM on their projects at the present time, 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.

Research findings show that cost consultants are generally positive with regard to potential benefits that BIM can offer in their existing practices. However, the survey also revealed that there is a strong tendency to retain familiar ways of working, reflected by 100% of respondents seeing the possibility of exporting quantities into familiar programs, such as Microsoft Excel, to produce documents as an advantage of BIM, as well as 87% saying that they would still request 2D drawings. Therefore, it will be important that cost consultants obtain the necessary skills to fully operate with BIM (Hannon, 2007), and therefore ensuring that they do not appear behind other professions during BIM's anticipated widespread industry take up.

Conclusion

The research has shown that widespread BIM implementation is anticipated to bring about a new way of working and thinking within the construction industry. Usage of BIM is increasing, and seemingly has the capacity to impact every aspect of the surveying profession, therefore making it essential for cost consultants to adapt and embrace or risk the threat of 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 to the profession, through a solid understanding of BIM's potential advantages and challenges.

Following analysis of the findings, it can be seen that BIM has several key advantages to offer cost consultants during the cost estimating stage. These include the potential time improvements through automatic processes and the possibility to access additional information, which will be useful in improving the reliability of documentation. The research has shown that whilst cost consultants seem generally positive to use BIM as a tool for assisting with existing practices, there is an overall lack of enthusiasm to use it for expanding 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 maximize their investment in BIM through offering such skills. However, it is essential that BIM is introduced to organizations as part of a structured implementation plan, with the required levels of sensitivity.

The research has shown that whilst cost consultants are generally aware of BIM, there is an overall lack of knowledge and understanding of what it is; this was reflected in both the primary and secondary sources. The surveys showed a gap in the knowledge of cost consultants sampled in several significant areas, including the fundamental change to their role when working with BIM and understanding the potential limitations of automatic measurement. The research also showed a requirement for training in order to work 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 (BIS, 2011), as well as keeping future fee proposals competitive and not loose-out to 'early investing' companies.

Furthermore, the research findings indicate a need for detailed understanding of cost consultants' challenges during the implementation of 5D BIM in construction projects. Currently, the authors have undertaken a further empirical research using expert opinion survey and case study approach to collect detailed qualitative information regarding cost consultants' routine challenges in adopting BIM.

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