

## FACTORS IMPACTING BUILDING INFORMATION MODELLING (BIM) IMPLEMENTATION IN COST MONITORING AND CONTROL

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**Abstract:** A vast majority of the construction projects suffer from cost and budget overruns and construction organisations continue to incur losses, reduction in profit and many of them often become heavily debt ridden and eventually go out of business. Therefore, drastic improvements are required in the current practice. BIM integration can bring the much needed improvement in the area of cost monitoring and control practice. There have been progressive developments in terms of BIM-enabled tools, costing techniques and standards that are becoming mature, but there has not been considerable change in the actual practice. Therefore, it is crucial to identify the most important factors affecting the BIM implementation cost monitoring and control in organisations in the UK in order to develop a practically feasible BIM implementation strategy. For this purpose the study uses the existing literature and empirical qualitative data collected through interviews from carefully selected practitioners from a large construction organisation in the UK and quantitative data collected through survey. This paper is focused on the identifying the key issues affecting BIM implementation in cost monitoring and control practice. Research findings indicate that there are a number of factors related to people, process, information and technology that influence their decision to implement BIM. These factors have been segregated as drivers and barriers for BIM implementation.

**Keywords:** BIM, cost control, cost management, cost monitoring, quantity surveying.

### 1. INTRODUCTION

The UK construction industry and the practitioners have failed to learn lessons from the past mistakes and wasted improvement opportunities. The prominent industry reports such as Simon's Report 1944, Latham's Report 1994, Egan's Reports 1998 and 2002 and Wolstenholme's 2009 have highlighted the problematic issues in construction industry practices and emphasised on the significant need for improvements (Egan, 1998, 2002; Hillebrandt, 2003; Latham, 1994; Wolstenholme et al., 2009). One of the most important project processes; the cost management is also significantly ineffective (Hanid, Siriwardena, & Koskela, 2011). Majority of construction projects suffer from cost and budget overruns and as a result the contractors and construction organisations continue to incur losses and going out of business (Cheng, 2014; Mahamid, 2012; Schleifer, Sullivan, & Murdough, 2014). Although there has been an increased use of computing and information technology but the overall improvement in the process and its effectiveness has been insufficient (Olatunji, 2011; Yusuf, Mohamed, Yusof, & Misnan, 2012).

Despite the improved awareness of BIM and software developments it has not yet been taken up in practice. Cost management professionals in particular have been considerably reluctant and slow to adopt BIM (NBS, 2014; Wu, Wood, Ginige, & Jong, 2014a, 2014b). Most of the developments have taken place the pre-construction phase and only a few of the research studies have been found to be focused on the construction phase. Their scope include

technology and process integration with planning and construction through BIM such as Elbeltagi et al. (2014), Willems & Vanhoucke (2015) and Zhao & Wang (2014). Dodge Data & Analytics (2015) has reported that there hasn't been significant development in this area in relation with implementing BIM. Considering the poor state of BIM implementation in cost monitoring and control there is a crucial need for identification of key factor responsible for this resistance or reluctance in order to overcome the barriers and challenge for improving the performance of the cost monitoring and control practice and its smooth transformation into a BIM-based process.

This paper is focused on the highlighting the key factors and issues impacting the BIM implementation in area of cost monitoring and control in construction phase through review of literature and preliminary findings from the thematic content analysis of the empirical data collected through in-depth interviews from the practitioners in a large construction organisation in the UK. This exercise will help in identification of most important factors due to which the sample contracting organisation "ORG-1" is struggling to adopt BIM. This will provide an insight of the practical challenges due to which BIM has not been adopted in practice and what are the most important drivers for cost managers. The first part comprises a brief literature review, the adopted research methodology for the research is discussed in the second part and the third part focuses on the analysis and presentation of data followed by a discussion on the findings and conclusion.

## **2. COST MONITORING AND CONTROL IN CONSTRUCTION**

Cost monitoring and control during construction phase is a critical process for keeping the project cost within the predefined budget (Ashworth, 2010; Hanid et al., 2011). It involves regular conduct cost analysis, progress monitoring, reporting, interim estimating and valuations (Ashworth, 2010; Elbeltagi et al., 2014; Kern & Formoso, 2004; Pilcher, 1994). These operations enable cost managers to overcome budgetary/ cost shortfalls by making recommendations for adjustments in design, programme, construction methods, materials costs, payments, finances, stakeholder relationships, cost variances and changes in design or construction etc. It is a highly complicated mechanism involving management of a high number of work packages and costs accounts resulting from material, labour, plant, consultancies and other expenditures and also claiming payments from client and maintaining a reconciled record (Ashworth, 2010; Hanid et al., 2011). The cost managers have to maintain a critical balance during the whole process to ensure fulfilling the demands of both parties; the client and the contractor and the stakeholders (Al-Jibouri, 2003; Ashworth, 2010; Hanid, Koskela, & Siriwardena, 2010; Hanid et al., 2011; Jackson, 2002; Potts, 2008). The best possible value delivered for the money spent by the client and securing a decent profit for the contractor accordingly.

## **3. ISSUES AND CHALLENGES IN COST MONITORING AND CONTROL**

A number issues and challenges exist in the practice related to knowledge, costing techniques being used, collaboration and coordination, quality of available data, communication and the technology being used (Cândido, Heineck, & Neto, 2014; Jaya, Pathirage, & Sutrisna, 2010; Sunil, Pathirage, & Underwood, 2015; Willems & Vanhoucke, 2015). There have been efforts for improving the costing practice from the RICS and academia such as introduction of new rules of measurement (NRM), partnering and collaborative working and advanced

costing techniques etc. But the practice has inefficient and ineffective and involves substantial amount of manual working and isolated processing (Olatunji, 2011; Smith, 2014; Yusuf et al., 2012). The project information and data are manually processed through paper-based documentation, spreadsheets and estimating software (Cho, Russell, & Choi, 2013; Zhao & Wang, 2014). Ideally the cost managers should monitor costs as they take shape, but in reality it is a retrospective process as cost managers assess and report the costs incurred in the past month (Ollmann, 2015). Therefore they are unable to take the control action in time to prevent any loss. It can be said they that in true sense they do not monitor the cost to control it, instead they manage it by keeping the overall cost within the budget. Also, the widespread culture of working to approximate cost also impacts the practice in addition to the other constraints which allows the cost managers not to be precise. All of these issues contribute in shaping the practice and determining the acceptable results.

The need for an integrated cost management system/ process has been recognized in order to improve the practice (Ballard, 2010; Isidore & Back, 2002; Jaya et al., 2010; Kulmala, Paranko, & Uusi-Rauva, 2002; Rasdorf & Abudayyeh, 1991; Turkan, Bosché, Haas, & Haas, 2012). They have highlighted the need for integration of cost management with other project processes for improved cost control along the project progress through collaborative working, inclusive decision making, and using advance costing techniques, IT system and streamlined project information flow.

#### **4. BIM IMPLEMENTATION IN COST MONITORING AND CONTROL**

BIM holds significant potential for resolving issues affecting the cost management such as non-collaborative and isolated operations, system incompatibilities, poor communication, low-tech and overwhelmingly manual documentation and processing etc. (Olatunji, Sher, & Gu, 2010; Popov, Juocevicius, Migilinskas, Ustinovichius, & Mikalauskas, 2010). Thurairajah & Goucher (2013) further state that cost managers can coordinate with project team and benefit from the readily available data and detailed information in the BIM model and from its technological, processing and information support.

Most of the BIM related developments are in the pre-construction area of cost management such as BIM enabled estimating and measurement tools etc. (Raphael & Priyanka, 2014; Thurairajah & Goucher, 2013; Wu et al., 2014a, 2014b). Only few research studies have been focused on the role of BIM in cost management during construction phase such as Elbeltagi et al. (2014), Willems & Vanhoucke (2015) and Zhao & Wang (2014). These studies are focused on highlighting the areas for improvement, development of software tool and integration of cost management with planning and construction processes respectively. BIM enabled QS tools are available in the UK market for cost monitoring, control and reporting such as Vico Office. But Dodge Data & Analytics (2015) has reported that it is fairly new area for BIM implementation and there has not been significant development in in this area. NBS BIM Survey 2016 has indicated that a high number of organisations have attained BIM maturity Level-2 (NBS, 2016). But the majority of the respondents of the survey were from the architectural background. Only 3% of the respondents were Quantity Surveyors. Therefore this proposition does not effectively imply to the QS firms or departments. Also the government mandate does not require using 5D cost management (Thurairajah & Goucher, 2013). Therefore, it is crucial to identify the key factors that impact the BIM implementation in cost monitoring and control practice/ cost management/ quantity surveying departments of the contracting organisations as they are the main players during construction.

## **5. RESEARCH METHODOLOGY**

This research paper is part of the PhD research study that has adopted mixed methods research strategy involving multiple case study methodology and survey research methodology. Multiple case study method is aimed at conducting cross case analysis of multiple cases to identify the critical factors affecting BIM implementation. Multiple cases study also improves the validity and generalisability of the research findings as the data is collected from multiple sources (Saunders, Lewis, & Thornhill, 2012; Yin, 2014). Purposive sampling has been used to select three case study organisations which are large contracting organisations from the UK, depending upon the extent of BIM deployment in quantity surveying/ cost monitoring and control. Semi-structured interviews have been used to collect qualitative data from people in the cases study organisations. In-depth interviews allow the participants to express their views in depth (Saunders et al., 2012). The interview format has been designed to capture participant's opinion about the BIM implementation in the cost monitoring and control and the associated factors. The qualitative data has been analysed through thematic content analysis. It is "a set of procedures for collecting and organizing non-structured information into a standardized format, which facilitates making inferences about the characteristics and meanings of written or recorded material" (Kulatunga, Amaratunga, & Haigh, 2007, p. 501). For categorisation pre-defined themes; people, process, information and technology that have been identified from the literature are used but there is flexibility in the approach to add any further emergent theme. The survey collects quantitative data from the practitioners across the country to investigate wider trend of the critical factors the using descriptive analysis and factors will be ranked using factor analysis. The survey results are intended to improve the validity and generalisation of the qualitative research findings.

As the research is currently in progress, the preliminary findings from the first case study are presented in this paper highlighting the most important factors affecting the BIM implementation in the cost monitoring and control. A large contracting organisation "ORG-1" from UK has been selected for collecting the empirical data. ORG-1 does not use BIM for the project cost management which makes it ideal for investigating the actual facts due to which they have not adopted BIM. Five people from this organisation have been interviewed; two from the strategic level and three from the operational level in the cost management process for investigating both strategic and operational constraints.

## **6. FACTORS AFFECTING BIM ADOPTION**

Research studies conducted during past 5 to 6 years have highlighted a number of potential factors that impact BIM implementation such as Ibrahim, Kado, & Bala (2014), Balfour Beatty (2015), Eastman et al. (2011), Hosseini, Azari, Tivendale, & Chileshe (2015), Kehily (2016), Shang & Shen (2014), Smith (2014), Stanley & Thurnell (2014) and Turner, Edwards, Curran, & Guillemet (2015). These factors include; drivers, barriers, challenges and other issues that are associated to people, process, information and technology in the practice. The designers and constructors have embraced and made progress in implementation but cost management/ quantity surveying discipline is lagging behind (Dodge Data & Analytics, 2015; Wu et al., 2014a). Therefore, it is essential to investigate this area to determine the most important factors responsible for this. The interviewees were asked to express their opinion about these factors such as the relevance of the factor, how it impacts, underlying causes and the practical implications. These factors are divided into two groups for analysis act as 'Drivers' that organisations and professionals find most attractive in terms of BIM's

impact in improving the practice and ‘Barriers’ that prevent/ make BIM implementation difficult. The case study findings are presented in the following sections.

### **6.1. Drivers Associated with People**

Cost managers form the people component of the cost monitoring and control practice as they perform core QS tasks in cost monitoring and control practice. BIM implementation in this area will directly impact the people. Following are the most important drivers associated with people that have been identified from the analysis of ORG-1 organisation.

#### ***Role of Cost Manager***

All of the respondents agree that BIM implementation will considerably enhance the traditional role of the QS through highly advanced technology and integrated process. It has been found that QSs role is confined to commercial management and mostly operate in isolation. They work in a constrained environment because of poor information availability, manual nature of processing and basic technology etc. and do not actively seek opportunities for cost savings and do not monitor the cost performance. It has been found that although the QSs and the management are satisfied with their current role, they expect that with BIM their role will be enhanced and can become more effective. The QSs are mostly busy and do not have time to look at other aspects of the project where greater benefits can be achieved. The QSs and management both feel that BIM would be beneficial if it can improve the cost control and ability to monitor leading to better performance and profit. Moreover, QS can actively participate with project team and through BIM support they can give faster cost feedback on alternative design, programme and materials. This enhancement in the QS role is seen as an important driver for BIM adoption.

#### ***Decision Making Support***

Decision making is the main task of cost managers as they always have to assess the cost performance and make judgements and adjustments. Cost manager’s decisions directly impact the commercial performance of the project and organisation’s profitability. It has been found that the experience is considered to be the major competency factor for better decision making. But the BIM co-ordinator is confident that BIM significantly help cost managers’ decision making. Although the QSs lack the detailed BIM knowledge but the model visualisation feature due to the multiple angle 3D viewing and model fly through is seen as a major factor that can play vital role in improving their decision making such as specific requirements and buildability issues leading to better cost certainty. It can also help in easing the time, labour and cost pressure. Other, important contributing factors are availability of right detail of detailed information and ability to integrate cost managers in the project team for inclusive and collaborative. BIM support for better informed decisions is a driver that is considered vital by the management and the surveyors..

### ***Collaborative Working***

It has been found that the QSs mostly work in isolation as they are not actively involved with the project team for example with designers, site management and planners etc. But they acknowledge the fact that cost monitoring and control is not solely the responsibility of the QS but in fact it is a team process. It has been found that QSs believe that site managers are also responsible for controlling cost because they oversee the works on site but QSs don't collaborate with them. As a result they are mostly unaware of the project development/ progress and are unable to provide immediate cost feedback. Moreover, they do not take control action unless there is a considerable problem and they have to conduct meetings and site visits to assess the situation and obtain information. However, the QSs emphasised on the need for improving collaborative working with other disciplines to provide quicker cost feedback and proactive identification of design and planning issues and variations can be better planned.

Although the QSs lacked in-depth BIM knowledge, the management however has been found keen about the BIM's capability to connect the project team members through its centralised platform as it can improve the required collaboration for improving the cost monitoring and control. Through BIM, QSs can closely work with subcontractors, suppliers and the client's team such as clients QS. BIM allows sharing information, communication and model/ project updates across the project team. It enables team to collectively deal with problems such as construction and cost issues and assess alternatives in more efficient and effective manner. It has been found that BIM can help in changing the traditional professional and cultural barriers in the construction industry including the QS professionals.

### ***Support for QS Tasks***

Although the QSs and the management emphasised that the current methodologies of cost management and the QS tasks and activities are satisfactory. They have been found to be confident about the accuracy of the CVRs, cost data, reporting and processing. It has been found that QSs in ORG-1 are responsible for a number of tasks during construction phase such as cost control, cost and value reconciliation, measurements and take offs, variations management, procurement, subcontractor and supplier accounts and corrective action for financial adjustments. Most of these tasks and processes are manual and time consuming. Moreover, at peak times the QS can be involved in up to three live projects and mostly work under time and work overload pressure. As a result they do not regularly monitor the costs or seek availing cost saving or value enhancing opportunities.

Through analysis it has been found that the QSs are keen about the automated features of BIM and the BIM enabled QS tools. They specifically emphasised on visualisation and clash detection as they have witnessed their benefits. They repeatedly mentioned that BIM can be useful if it can help them saving time and speed up their routine tasks such as quantification and updated information provision. They named some of the important benefits; detection of design, construction and programme issues and check and the manage subcontractor's work. From QSs perspective, the support for QS tasks and duties is an important factor for them to consider using BIM.

## **6.2. Drivers Associated with Process**

BIM implementation will affect the process of cost monitoring and control. The most important process related drivers that have been found through analysing the ORG-1 are presented below.

### ***Integration and Coordination***

The QSs emphasised that cost management has to coordinate with the on-site construction progress in order to be able to monitor project cost performance and this coordination can be reached by integration of cost management and construction schedule. Lack of integrated processes and coordination has been highlighted by the QS professionals in ORG-1. It has been found that the quantity surveying, design, and construction processes operate in isolation. QSs are often not aware of the extent of development of design or construction on site and variation instructions. They cannot attend all meetings to coordinate with team. As a result they cannot properly conduct cost management. They rely mainly on the monthly CVR for analysing the performance of past month and that takes over a week. The QSs have to manually enter and process data into Excel and then produce cost reports from it manually. Due to the practical inability they don't monitor the project cost performance.

There is acceptance that the integration of cost, schedule and on-site construction progress is important for enabling cost monitoring. In their opinion BIM can play an important role in linking design, cost and schedule data. The QSs believe that through BIM the project team can be linked together and the process can be integrated with each other that can enable them to coordinate with the design and construction teams and the cost management can potentially become in-line with the development on site. Also the changes in in design or programme can be captured and cost data can be updated accordingly. They believe that the combined processing will ultimately help in improving the cost monitoring and control practice. Without BIM support they do not have enough resources to monitor project cost regularly. Therefore, the capability of BIM to integrated processed and improve coordination is seen as an important driver to improve the process.

### ***Standardisation and streamlining***

Another important factor that can act as a driver for BIM implementation in ORG-1 is standardization and streamlining the cost monitoring and control process. It has been found through the analysis that in ORG-1 organisation and project the non-standardised processes, methods and documentation are important issues. Due to using different methods and formats QSs often fail to understand the data and information and they have to spend extra time and effort to work with it. Also it creates cost uncertainty because people use different formulas and techniques and present information in various structures. Also, it has been found that in most cases the required level of detail is not provided which leads to queries, delays and uncertainty. Due to these issues the process cannot be streamlined.

It has been found that in the management and the QSs opinion BIM can definitely help in improving the standardisation and streamlining the process through the information standards and protocols. They emphasised that use of standardised medium, structure and file format is a very important aspect of working in BIM environment. From cost management perspective, as they use input from internal and external project team members it a key driver. The QSs

can avoid delays due to duplications and repetitions, direct access to the model and required data and use of dedicated QS software tools.

### **6.3. Drivers Associated with Information**

Information is the core component of the BIM projects, the drivers associated with the information that have emerged from the analysis of the in-depth interviews with the practitioners are presented below.

#### ***Information Availability and Sharing***

All of the participants concur that BIM has a significant potential in eradicating the chronic issue of lack of data and information availability for cost monitoring and control purpose. It has been found that most errors and delays occur due to the missing or incomplete information. The QSs emphasised that with BIM they will be able to obtain majority of the information with right level of detail at all relevant projects stages that can improve the speed and quality of their work. During construction phase if all people enter the correct information into the BIM model, QSs will be in better position than today in monitoring the cost expenditure. Also in case of a variation or problem they will be able to quickly assess the cost impact and produce proposals for the client's approval. They will be able to share the material specifications with the suppliers in quick manner to check and cross-check prices and generate subcontract packages with greater accuracy. Similarly, information sharing is also an important aspect as the QSs can easily send and receive information through centralised platform.

#### ***Quality of Data***

It has been found that the QSs have serious concerns about the quality of information and data in the current practice. The problems are often caused due to use of verbal and hand written notes. Also the structure and vocabulary used by various people in the project are not uniform which creates problems for QSs and they have to chase people for right interpretation. This creates additional work and leads to delay and errors.

The improvement in quality of data is seen as an important factor by the QSs in relation with BIM adaptation. Some of the benefits they want to achieve through this decreasing the workload, delay and accuracy. It has been found that it is due the fast paced nature of the project construction and involvement of high number of people and activities in construction phase.

#### ***Information Format***

It has emerged from the analysis that people in the UK construction always prefer their own preferred manner in which the structure the information and documentation. Also various isolated software system are in use that have file format and compatibility issues. Due to these issues often time and resources are wasted along with valuable data and sometimes QSs prefer printed information that they can manually enter into their spreadsheets.



Ability of BIM to standardise the information structure and support for a wide range of file formats has been mentioned as an important aspect that can improve the cost management process. It has been found that improved system compatibility can support the cost managers to conduct cost monitoring and control activities.

#### **6.4. Drivers Associated with Technology**

From the analysis it has emerged that Qs and the management of ORG-1 possess limited BIM knowledge in relation with cost management. The main source of their BIM technology knowledge has been acquired from introductory demonstrations. The important drivers associated with BIM technology from their perspective are presented below.

##### ***Visualisation***

The Qs and management concur that the detailed 3D model visualisation feature of BIM can be very useful for the cost managers and the key benefits they aspire are better understanding of the design and features of the building and visual clash detection analysis. The Qs consider the ability to compare the physically built assets to the model during construction phase as very important development as they can verify the construction and identify issues easily. Moreover, they also highlighted the importance of embedded cost data for checking and verification. From cost monitoring and control perspective it has been stated that 5D BIM can enable the QS to assess the project cost performance during construction which was previously not feasible in the traditional settings. Also the visualisation can significantly support the valuation process from completed and pending works.

##### ***Automation***

The management have been found to be keen about the automation of the time consuming tasks such as measurements, quantity take offs, clash detection etc. Whereas, the Qs are more interested in documentation, checks and reviews, report generation and access to data. The Qs repeatedly mentioned that due the work overload and fast paced nature of the construction projects, they often leave the crucial checks and analysis. They desire if the BIM can support them in measurements, quantity take offs and data collection, they can use that valuable time in detailed assessments to improve project cost certainty and performance.

Although the Qs seek speeding up their working through BIM, they emphasised on the importance of QS's role in supervising and controlling the process for accuracy and right detail because they assert that all cost items cannot be modelled. However, the automated features are seen as major technological developments that can improve the cost management during construction phase.

#### **6.5. Barriers for BIM Implementation**

Although there are a number of drivers highlighted by the practitioners in ORG-1 but still the BIM has not been taken in the QS department of the organisation. Therefore the thematic

analysis was conducted to identify the barriers that have prevented the BIM implementation. The main barriers that have been identified from the data analysis are presented below.

### ***Resistance to Change***

It has emerged from the analysis that there is resistance to BIM implementation in the QS department in the ORG-1. The senior management indicated that they are satisfied with current cost monitoring and control practice in the organisation and do not view BIM to add significant value. It has been attributed to the lack of BIM knowledge and advanced stage of career as the older people in the company are suspicious about the achievable benefits. The more experienced people prefer their existing methods and tend to resist the BIM implementation. Moreover, it has been found that Qs use different methods and tools and there is a strong culture in the industry to defend your preferences and challenge others. As a result there is certain level of resistance to change from their preferred methodology as each of them used different method for his calculation but remained assertive about its accuracy.

### ***Fear***

It has been found that there is a significant element of fear and uncertainty in relation with BIM adoption which is rooted in the low level of BIM knowledge. Although people tend to project lack of confidence in the accuracy and effectiveness of BIM based cost management but the actually there are other factor involved such as job security, uncertainty, decrease in wages etc. Also people in construction industry have low level of trust and they do not feel comfortability in sharing information due to reservation about security of their commercial interests. It has also emerged the people are unaware of the BIM standards that define the roles and responsibilities such as PAS 1192-5:2015 and BS 1192-4:2014 etc. As their BIM knowledge is at low/ basic level in the QS department, people have a lot concerns about the legal and contractual implication related to BIM implementation in a project. For instance one of the primary concerns is about the ownership of the data, and responsibility in case of issues in the model. One of the Qs raised concern that BIM model is open to human errors because people can make changes.

### ***Knowledge and Competency***

Lack of BIM knowledge and competency is one of the major barriers for BIM adoption in the cost monitoring and control practice. It has been found that QS professionals use generic tools and techniques for cost management. The QS department as a whole suffers from severe lack of advance digital IT skills vital for BIM adoption. In addition, it has been found that the senior management expect people to develop these skills at the university but the reality they lack core QS competencies which put the organisation under pressure to train the Qs first for quantity surveying first. Moreover, the organisation has already once failed to implement a popular BIM enabled cost management software package due to the lack of competency.

### ***Cost Manager's Workload***

From analysis it has been found that the cost managers are extremely busy as they are over occupied with a high number of important tasks and duties as discussed earlier under high time pressure. Upon investigation it has emerged that due to the high volume of workload, tight deadlines in the fast paced construction business it is not feasible for the QSs to dedicate time for learning and developing BIM competency. It has been found that the QSs prefer to get on with the jobs first so that the organisation can continue its business.

### ***Leadership***

ORG-1 is capable of delivering Level-2 BIM projects as the design department is BIM enable. The design department adopted BIM because of a strong leader who had previous knowledge and experience but had dedication and ability to withstand management and staff pressure. Whereas the QS department suffers from leadership crisis and as a result has not made progress with BIM adoption. However, there is expectation that recent change in the management can provide support and add a new member of team who can lead and mentor the QS department to become BIM capable.

### ***Organisational Structure***

The organisational structure plays a vital role in implementing new technology in the ORG-1. Head office governs the regional offices and the new technology is first trialled at the head office and then passed on to the regional offices. If something is being trialed at the head office, the regional offices cannot run its trail. It has emerged this policy has proven counterproductive in relation with implementing BIM in cost management department. Upon direction from the head office, the regional office started the implementation of BIM capable software demonstrations and training sessions to the QSs. But the head office postponed it for another year. As a result many people have lost interest and a lot of time, planning, and money has gone wasted. It has been found that people feel that as teams have different strengths and level of understanding, if something suits them they should be able to use it and then they can share the knowledge across the organisation.

### ***Training & Learning***

It has been found that the staff training and skill development in ORG-1 acts as a barrier for BIM implementation. The trainings programmes are focused on attaining professional accreditations and health and safety. There is no emphasis of developing new skills such as BIM competency. It has also emerged that most of the trainings are funded by the industry grants and are focused on Health & Safety and similar areas which do not contribute to improving the business, making it lean and more profitable. The QSs also revealed that the previous BIM trainings were not adequate and the knowledge was being force fed in short time. It is unrealistic to expect the professionals to be able to adopt new techniques and technologies after few hours of trainings.

### ***Strategy & Investment***

From the analysis it has emerged that ORG-1 does not have a robust BIM implementation strategy. At the regional office level there is no active programme for implementing BIM in the QS department. The head office allocates the budget for these purposes but due to the past experience of failed implementation now the people in regional office are reluctant to make such commitment. Also, in tight economic situation it is difficult for the organisation to take the QS off the project and get them trained up for BIM.

In addition to this the IT strategy and investment are not aligned. The organisation sometimes arranges training sessions but that is not backed up by providing the software to the QSs and gradually they forget everything learnt. Also the upgrading of the hardware is not satisfactory as QS have systems which are not capable of opening BIM model which puts them off and they cannot get involved in BIM project. The company has to adjust its BIM strategy if it is to succeed with BIM implementation.

### ***Quality of data & information***

One of the main barriers for implementing BIM in cost monitoring and control practice is the inadequate quality of data and information. It has been found that the management and QSs are concerned about the reliability of the BIM model information. Although it is a collaborative exercise and users can highlight the issues and notify the author but QSs feel that it increases their workload significantly if they have to verify the whole model. Similarly if extracted information has an issue, they have to re-check all of it and they suggest it is easier for them to create it by themselves. This uncertainty and lack of trust is an important barrier to overcome because otherwise it is difficult to convince them to use BIM.

### ***Interoperability & Compatibility***

The major technological barrier that has been found for the analysis is the issue of interoperability and compatibility. The senior management suggest that with rapid development in the area of BIM, new tools are emerging and it is becoming increasingly difficult for them to choose a specific one. As a large contractor in the UK they are struggling to find appropriate BIM capable cost management software package. Because there is a considerable investment required for acquisition of software and hardware, implementation and training.

Senior management has been particularly found concerned about the file format issues. It has been suggested that as there are various BIM software packages in the market; it is difficult for them to assess what type of file formats they may be working with in the future projects, what software the client's architect will be using and will there be any file compatibility issues.

## **7. CONCLUSION**

Due to inadequate cost monitoring and control, construction projects exceed the budgeted costs and the main contractors continue to incur losses. There have been attempts to improve

the cost monitoring and control but those attempts have not been successful. It is suggested that BIM implementation can resolve the issues in the practice. The BIM enable QS software tools are available in the UK market but still in practice BIM has not been taken up by the practitioners. It is suggested that the QS professionals resist the change due to uncertainty, insecurity and lack of BIM competency. Also the construction companies are not adopting BIM due to the high cost of acquisition and implementation. A case study organization “ORG-1” has been investigated with aim of identifying the most important factors impacting BIM implementation in its cost monitoring and control. A number of factors have been identified and have been categorised as drivers and barriers.

The management and QSs identified that the most important drivers associated with people are enhanced role of cost manager, decision making support, collaborative working, and support for QS tasks. The most important drivers related to cost monitoring and control process include integration and coordination, standardisation and streamlining of the process. Information availability, sharing, quality of data and information format are considered most prominent information associated drivers. In relation with BIM technology QSs it has been found that visualisation and automation are most important drivers. Moreover, the most important factors acting as barrier for BIM implementation are resistance to change, fear of unknown and uncertainty, lack of BIM knowledge and competency, extensive workload, lack of leadership, organisational structure, training, organisational strategy and investment, inadequate quality of data and information, interoperability and software compatibility issues. From their perspective BIM has to provide the above mentioned benefits and identified barriers have to be alleviated in order to implement BIM in ORG-1 QS department.

Although the literature suggests a large number of drivers and barriers but this research has revealed that people in each organisation have their own opinion about BIM based on their specific needs, organisational structure, BIM knowledge, competency and experience. In ORG-1 the people lacked in-depth BIM knowledge and understanding and the senior management using inadequate training methods for developing BIM competency. There is also impression that the top management is not keen to implement BIM in the QS department and there is serious lack of BIM enthusiast leadership capable of leading and mentoring the team. As the research is currently in progress the next step is to investigate another organisation for further identification of factors impacting BIM implementation.

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