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SUITABILITY OF BIM FOR ENHANCING VALUE ON PPP PROJECTS FOR THE BENEFIT OF THE PUBLIC SECTOR

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Collaborative integrated working and stakeholder's interest have been among key drivers that underpin and encourage the use of Building Information Modelling (BIM) within the AEC industry. BIM is becoming a major means to deliver projects with better improved product, and reduced risk within the construction industry. Furthermore, using BIM in areas like buildability, quality assurance, cost and scheduling can be justified through BIM-*n*D modelling application. What is not so obvious is how the utilisation of BIM visualisation and knowledge embedment will enhance these areas to refine and achieve better value for PPP procurement projects for the long term benefit especially during post-construction phase for the public sector. As of now there is no well-defined guidance with respect to BIM usage incorporating all of the above. Do we really need to revisit the way we specify projects within the contractual framework under PPP? This paper examines the possibility of how BIM can be utilised in the realisation of augmented formal database information management system under the PPP procurement routes with respect to operation and maintenance support. The paper concludes with additional measures that BIM can offer at the post-construction phase for the public sector at learning organisations.

Keywords: Building Information Modelling, Public Private Partnership, PFI, E-procurement, *n*D Modelling.

INTRODUCTION

Integrated project delivery has been suggested as an alternative to the traditional process which will help in reducing waste streams and improve productivity of construction processes through the integration of people, systems, business structures, practices into a process that collaboratively harness the talents and insights of all the participants (AIA 2007). In the publication of numerous research papers, it has been suggested that Building Information Modelling (BIM) plays a key role in the integrated project delivery approach by facilitating full collaboration and information sharing amongst the participants of a construction project throughout its lifecycle (Laishram 2011). Furthermore, Public Private Partnership (PPP) is seen as a way of integrating the various practitioners as well as working collaboratively on projects.

Public Private Partnership (PPP) in construction concerns "a long-term contractual arrangement between a public sector agency and a private sector concern, whereby resources and risk are shared for the purpose of developing or refurbishing a public facility" (Li *et al.* 2001:16). At the moment, PPP is prominently used in public projects procurement in many countries. In the UK, for example, the number of PFI projects has increased steadily since 1997 when the Labour Government came into power (HM 2000; Li *et al.* 2000).

Typical PPP project risks have been highlighted in PFI guidelines (HM 1995). The various risks in PF projects vary with the development process, i.e. from the planning stage through the design, construct

and operation stages. The objective of risk analysis is to capture all feasible options and to analyse the various outcomes of any decision concerning their treatment (Flanagan and Norman 1993). The UK Government guideline on PPP/PFI procurement recommended the assignment of risks to the party best able to manage them (HM 2000). To facilitate this process contractual change in the building industry requires a more integrated approach (Hannele 2012). Thus, a model which will help PPP parties to allocate risks between themselves more quickly is worthwhile. BIM is envisaged as a good candidate in this area.

With the increase in the utilisation of BIM in the construction industry, it has become clear that there is some legal uncertainty in dealing with this technology (Douglas *et al.* 2012). In order to achieve a Level 2 BIM standard in the UK, which is a BIM file based collaboration and library management, there is little change required to the fundamental building blocks of copyright law, contracts or insurance (McAuley 2012).

BIM effectively requires significant changes in the way construction businesses work at almost every level within the building process and requires not only learning new software applications, but also how to reinvent the workflow, but also how to train staff and assign responsibilities (Arayici *et al.* 2011). The subject of this paper is the value BIM will create in its utilisation on PPP contract during the post construction phase.

The rest of the paper is divided into the following sections: the nature of the construction industry, the nature of the public organisations, the organisational changes encountered in a dynamic environment, the nature and role of BIM in public sector projects; towards a better integration of BIM and PPP and finally discussion and conclusion.

THE NATURE OF THE CONSTRUCTION ORGANISATIONS

Construction embraces buildings, civil engineering and plant erection. Any individual product of the construction industry could be as small as a few hundred pounds in value in the case of small domestic structures, or as large as the multi-million-pound installations for the power generation or oil-production. In addition to covering a broad range of size of product unit, it is a feature of the construction industry that it also covers a wide range of skills – architect, engineer, surveyor and much different type of contractor and materials supplier. Most of these skills are organised in separate companies or units, which means that in any one project there may be a large number of organisations involved. This fragmentation is a feature of the construction industry influencing the way in which it operates. Another specific feature which is typical of the construction industry is the uniqueness of its product and most projects are of the one-off type. These characteristics of variability and uniqueness of product together with fragmentation is not a good prerequisite for collaborative working without the aid of visualisation and information technology.

Since projects are becoming ever more expensive, complex and interactive, the rational approach offered by the methods of Building Information Management through modelling can provide benefits to all. Those who are prepared to make the effort to find solutions to their problems in the digital age that will be reliable, persistent and retrievable will be the benefactor of the utilisation of the power of BIM for such life cycle solutions. One such organisation that may benefit from this approach will be the public sector utilising PPP as a delivery vehicle of projects.

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THE NATURE OF PUBLIC SECTOR ORGANISATIONS

According to the OECD Glossary of Statistical Terms (OECD 2006) the public sector comprises the general government sector plus all public corporations including the Central Bank. Similarly put, a public sector organisation is one who's ownership funding and cooperation is by the government or one of its agencies (Broadbent and Guthrie 2008; OECD 2006). Broadbent and Guthrie (2008) identify four key domains of the public sector (Grant *et al.* 2010):

- Central government;
- Local government
- Public institutional systems, which although funded through taxation may be separate from local government and central government (e.g. the national Health Service – NHS)

Hagen and Liddle (2007) argue that the public sector comprises a network infrastructure that comprises of, and relates to, a number of layers, which interact with each other as well as the wider context of, for example, the private and voluntary sectors.

Drawing on the work of Boyne (2002) and Guy (2000, cited in Dufner *et al*. 2002: 415) it is argued that what distinguishes public sector organisations from the private sector relates to the nature and interactions of:

- Their goals particularly in the absence of the '*profit motive*' and competitive pressures;
- The greater variety of stakeholders and their goals;
- The role of the public scrutiny;
- The political dimension.

In public sector organisation the absence of '*profit motive*' and the imperative to be successful in the market place, is a key difference from the private sector. The profit motive gives the private sector organisations a simple and unfailing compass with which to navigate towards, and judge their success. In contrast, the public sector organisations face a variety of stakeholders, each with what may be differing, or even conflicting goals. As individuals, we require efficient and effective provision from our public services – but at the same time as we would like to have our tax burden (which pays for the services) minimised. For public sector organisations, value (i.e. best value) rather than 'profit' is the guiding concept. The Scottish Government describes the '*duty of best value in public services*' as having two principles (Scottish Government 2006):

- Securing continuous improvement in performance whilst maintaining an appropriate balance between quality and cost; and
- Having regarded to economy, efficiency, effectiveness, the equal opportunities requirements, and to contribute to the achievements of sustainable development.

As such these organisations engaging in PPP contracts with private consortium need some amount of persistent data that are retrievable and reliable, even with all the negativity shown by their status in the partnership. Most of these public sector organisations have realised that they do not have certain capabilities to be competitive in such a changing

environment. As such a platform can be offered through the BIM capabilities, for them to realise such a change.

ORGANISATIONAL CHANGE

Each organisation is built on a particular business model and differentiates itself through its strategy; it has both a state and a direction (Miles and Snow 1978; Mintzerg and Westley 1992). An organisational state is determined by its culture, structure, management systems and people. The organisation's direction is determined by its strategic vision, market position, business processes and assets (i.e. buildings, equipment, facilities and information). Organisations can change their state and direction but it is not always necessary for change in one dimension to be accompanied by one in the other (Mintzberg and Westley 1992; Magretta 2002). For example, it is possible to change individuals in a particular job without requiring any changes elsewhere. A change asset, however, can require a change in people. For example, if an organisation replaces its legacy IT system (i.e. CAD to BIM) with similar but newer system, it may require fewer personnel with more advanced skills. Such changes, however, will typically have little or no effect on the organisation culture or strategic vision.

Change begins with perception. Neither an individual nor an organisation can begin to change unless something of interest is seen in the operating environment that deviates from an important and relevant expectation (De Geus 1999; Day and Schoemaker 2005; Roberto *et al.* 2006; Grant *et al.* 2010). That is why succeeding in complex and rapidly evolving operating environments requires managers to be sensitive to signals of change, to observe trends and make sense of emerging patterns. What managers can see depends on their knowledge and what is important in their view of the future (De Geus 1999; Grant *et al.* 2010). The reason is that when something of interest has been observed, it creates a curiosity gap. That is, when our curiosity is pricked, we will feel a gap in our knowledge and the need to fill it (Loewenstein 1994). To guard against this, it is important that different people from different disciplines collaborate effectively, because what one may miss, another may pick up, allowing the organisation to respond sooner and with a greater sense of urgency (Kotter 1995).

Managing strategic change is about effecting fundamental change in how the organisation creates value for its customers and how it differentiates itself from competitors. Regardless whether the need to do so originates inside or outside the organisation, change begins with perception. To bridge this gap the government recognises the importance of PPP and BIM procurement routes such driving the adoption of this method.

THE NATURE OF PPP-PFI PROJECTS

The UK Private Finance Initiative (PFI) is a holistic and integrative conceptual model that integrates a hierarchy of four levels of concepts: government ideology, principles, practices, and tools. The PFI life cycle process, value chain, and value-delivery network are discussed here. PFI is as a novel way to do business, and requires the establishment of a long-term relationship. PFI is an innovative concession as it relates the revenues for the private partner solely to the provision of a service, which in turn is performance related. It is too early to assess PFI success or failure because of the long life cycle of PFI projects, 20 to 30 years, and most projects have not yet been in operation for 10 years. In addition, based on the empirical data from the research and recurring to business information sources and academic studies on PFI (still very limited), the article addresses two

important issues that emerged from the introduction of PFI: first the change in organisational culture brought about by a move into the services sector, coupled with the need to deal with long-term issues, followed by the financing structure, that is, the balancing of debt and equity and the hypothesis of considering bond issues to finance senior debt (de Lamos *et al.* 2003).

During recent years, a wide spectrum of research has questioned whether public services/infrastructure procurement through private finance, as exemplified by the UK Private Finance Initiative (PFI), meets minimum standards of democratic accountability. While broadly agreeing with some of these arguments, the debate or discourse is flawed on two grounds. Firstly, PFI is not about effective procurement, or even about a pragmatic choice of procurement mechanisms which can potentially compromise public involvement and input; rather it is about a process where the state creates new profit opportunities at a time when the international financial system is increasingly lacking in safe investment opportunities. Secondly, because of its primary function as investment opportunity, PFI, by its very nature, priorities the risk-return criteria of private finance over the needs of the public sector client and its stakeholders (Asenova and Beck 2010). This requires a good understanding of decision-making under uncertainty in the post construction period in which the information and support is required.

Decision making is a process that involves a variety of activities, most of which deal with handling information. From an IT-supported decision perspective, the issue here is to figure out what and how IT can be used to help the decision maker get the information he needs, better formulate the problem, clarify his preferences, process complex reasoning, and better appreciate the impacts of the decision before it is made.

THE ROLE OF BUILDING INFORMATION MODELLING

Modelling is the process of constructing a model of reality based on a situation that we know the answer, and try to apply to another situation that we have yet to find the solution. The model component stores a family of analytical models in a model base that a user can choose, and possibly integrate them together, to solve his decision. For example, the user can request a simulation to a forecasting model from the model base to weigh different market forces, and transfer that result of the simulation to a forecasting model that calls regression algorithms/appraisal algorithms to predict costs. Models need to fit with the data, they need to be kept up to date; users need to understand and trust them; and if several models are used, they need to work together (i.e. interoperability) (McNurlin *et al.* 2009).

'Building Information Modelling' and 'Building Information Model' are terms that are often used interchangeably, reflecting the term’s growth to manage the expanding needs of the constituency. There are several definitions of BIM and no universally accepted one. However, many researchers seem to accept the definition advanced jointly by the RIBA, Construction Project Information Committee and Building Smart Alliance. That definition states that BIM is "a digital representation of physical and functional characteristics of a facility creating a shared knowledge resource for information about it forming a reliable basis for decisions during its life cycle, from earliest conception to demolition" (RIBA 2012:3; BSA 2012; CPIC 2011). Thus, BIM is a digital model of a building in which information about a project is structured in such a way that the data can be shared. This

information can be in 3D (visualisation and coordination of project), 4D (integrating time) 5D, (including cost estimating), 6D (procurement and thermal properties analysis), 7D (operational applications lifecycle), 8D (integrated project delivery)- right up to '*n*D' (a term that covers any other information needed for construction and running of a facility). BIM is a new technology that brings with it a new method of working which is aiming to revolutionise and make the construction process more responsive to of the end-user's needs (Edwards and Maguire 2013).

The accurate cost of the lack of interoperability in the UK has not – and probably could not – be precisely calculated but estimates suggest that the scale of waste due to a lack of shared structured information for owner operators in the UK amounts to £100 million a year(AIA 2010). Two-thirds is incurred directly by owners and one-third through the facilities management industry. There is, in any event, wide agreement that process and technology change could be harnessed to deliver improvements in cost and quality. Collaborative working, using a central BIM, offers a practical way forward.

Construction industry has established the basis of object-oriented building product modelling in 1990s. Initially, certain market sectors such as structural steel utilised the parametric 3D modelling. Building Information Modelling (BIM), therefore, as a technology is not new to the construction industry. This technology under different names such as product model, virtual building, and intelligent object model has been in use for over twenty years. The term building information modelling came into popular use after Jerry the publication of Laiserin's article in LaiserinLetter in December 2002 (Smith and Tardiff 2009).

BIM MATURITY LEVELS

A maturity framework has been developed to ensure clear delivery of the levels of competence expected and the supporting standards and guidelines their relationship to each other and how they can be applied to projects and contracts in the construction industry.

In the UK, the government requires fully collaborative level BIM Level 2 (with all project information, documentation and data in an electronic format) as minimum by 2016 on all public projects (Cabinet Office 2011). Level 2 comes third in a four-tiered system as listed below (BIMTG 2011):

Level 0: Unmanaged fragmented (none standardised/ none exchangeable data format) CAD.

Level 1: Managed CAD in 2D and/or 3D format using BS1192:2007 (fragmented production/analysis programmes, file based collaboration).

Level 2: Managed 3D environment with data attached but fragmented (discipline based collaboration and library management).

Level 3: Single, online (integrated/interoperable data), project nD model including but not limited to visualisation and coordination, construction sequencing, cost estimating, procurement, thermal properties analysis, operational applications lifecycle, integrated project delivery, and lifecycle management information.

As discussed above, BIM has not reach full maturity level yet and continues to develop. It is obvious that the adoption of systems and technologies by businesses will not be at the same rate. However, just like organisations in the retail sector before them, BIM adopters will need to go through a managed process of change which encompasses not only their internal organisation but also the way they interface with their external supply-base and clients. The majority of the UK market is still working with Level 1 processes, and the best in class are experiencing significant benefits by moving to Level 2. It is clear that organisations adopting BIM now will be those most likely to capitalise on this advantage as the market improves.

As discussed above, BIM continues to develop. Clearly, not all businesses will adopt systems and technologies at the same rate. However, just like organisations in the retail sector before them, BIM adopters will need to go through a managed process of change which encompasses not only their internal organisation but also the way they interface with their external supply-base and clients. The majority of the UK market is still working with Level 1 processes, and the best in class are experiencing significant benefits by moving to Level 2. It is clear that organisations adopting BIM now will be those most likely to capitalise on this advantage as the market improves.

NEW WAY OF DELIVERY: PPP AND BIM

BIM offers the opportunity to achieve accuracy and inevitability in delivering products and services. It improves efficiency and allows design processes to be smoothly repeated. But how and why does BIM deliver this outcome? To understand what BIM does and the benefits it brings, we need to look at traditional procurement approaches in the construction industry and their drawbacks.

The concept of procurement aims generally to supports a delivery-relationship between sellers and buyers. Other than "purchasing" scope, procurement includes strategic activities such as, negotiating with suppliers, sourcing, and coordination with R&D (Grilo and Jardim-Goncalves 2011).

The principal barrier to reduced cost and increased growth is the lack of integration in the industry, combined with a lack of standardisation and repetition in the product; and by relative protection from international competition. In parallel, a procurement process has been shaped that has reinforced those barriers. These issues necessitate both reform of the procurement process and greater efficiency in the operation of that process (Cabinet Office 2011:6).

E-procurement (electronic procurement) began from the early use of the Internet in business. Early e-procurement was linked to the surge of inter-organisational systems, communities, electronic platforms, meeting places, virtual locations, and infrastructures, often designated as electronic marketplaces (Grilo and Jardim-Goncalves 2011).

Structures including buildings are not just 2 Dimensional, nor built, or used an element at a time. In fact, they are multi-dimensional, integrated endeavours that require collaboration from inception to demolition and recycling. Consequently, it is vital that the tools used to facilitate the design, construction, operation and demolishing of a structure should reflect this.

BIM is not just a single 3D modelling software package such as Revit or ArchiCAD but it is a suite of technologies and processes that integrate to form the system at the heart of which is a component-based 3D representation of each building element. This replaces traditional design tools currently in use in the architecture, engineering and construction industry. Each component is generated from a product library with all information about that element. As the design progresses, more information can be added and the integrated information becomes more valuable. BIM is not a simple design tool but it is the way the system generates interfaces to and uses information from other systems which is fundamental to the delivery success of a facility and its management after completion. These benefits can be gained by the whole stakeholders through the collaborative and integrated use of BIM. There are parallels between BIM and the EPOS (electronic point of sale) and ERP (enterprise resource planning) systems ubiquitously found in the retail sector (BIMTG 2012). There is a clear interface between BIM and organisational corporate systems – including those dealing with procurement, finance and supply chain performance.

DISCUSSION AND CONCLUSIONS

Decision making is a process that involves a variety of activities, most of which deal with handling information. From an IT-supported decision perspective, the issue here is to figure out what and how IT can be used to help the decision maker get the information he needs, better formulate the problem, clarify his preferences, process complex reasoning, and better appreciate the impacts of the decision before it is made. The public sector is the decision maker and the client in this case.

The client which is the public sector in this paper is not the one that controls the BIM utilisation capabilities for the long term. Although there may be clause or some contractual arrangement, however, this area is still a grey area and requires some more investigation. This is due to the fact that the public sector will be involved in this contract for the next 25/30 years after the completing the construction of a facility. If the public sector can state having ownership (i.e. knowledge and understanding of the facility) of the BIM during the operations and maintenance period by the practitioners (i.e. private sector), the public sector body will be able to be knowledgeable about what are the key areas that requires support after the facility has been handed over by the private investor to the public sector, till the design-life of the building is reached. As BIM is also repository for knowledge and information that is retrievable and persistent, the public sector as a learning organisation (Soliman 2011) during the operation and maintenance phase of the PPP project will enable them to better their understanding for future PPP projects.

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