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International Journal of Project Management 31 (2013) 971 – 980

International Journal of Project Management

www.elsevier.com/locate/ijproman

The project benefits of Building Information Modelling (BIM)

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Received 7 February 2012; received in revised form 22 November 2012; accepted 11 December 2012

Abstract

Theoretical developments in Building Information Modelling (BIM) suggest that not only is it useful for geometric modelling of a building's performance but also that it can assist in the management of construction projects. The purpose of this paper is to explore the extent to which the use of BIM has resulted in reported benefits on a cross-section of construction projects. This exploration is done by collecting secondary data from 35 construction projects that utilised BIM. A set of project success criteria were generated and content analysis was used to establish the extent to which each individual project met a criterion. The most frequently reported benefit related to the cost reduction and control through the project life cycle. Significant time savings were also reported. Negative benefits were mainly focused on the use of BIM software. Cost/benefit analysis, awareness raising and education and training are important activities to address the challenges of BIM usage.

Keywords: Business Information Modelling (BIM); Project benefits; Secondary data; Case studies

1. Introduction

Construction projects are becoming much more complex and difficult to manage (Alshawi and Ingirige, 2003; Chan et al., 2004; Williams, 2002). One complexity is the reciprocal interdependencies between different stakeholders, such as financing bodies, authorities, architects, engineers, lawyers, contractors, suppliers and trades (Clough et al., 2008). As a response to the increasing complexity of projects, information and communication technology [ICT] has been developing at a very fast pace (Taxén and Lilliesköld, 2008). During the last decade, a major shift in ICT for the construction industry has been the proliferation of Building Information Modelling [BIM] in industrial and academic circles as the new Computer Aided Design (CAD) paradigm (Succar, 2009). BIM is currently the most common denomination for a new way of approaching the design, construction and maintenance of buildings. It has been defined as "a set of interacting policies, processes and technologies generating a methodology to manage the essential building design and project data in digital format throughout the building's life-cycle" (Succar, 2009: 357). BIM has been utilised on high profile large-scale projects, such as the recently constructed London 2012 Olympic 6,000 seating Velodrome cycle track and the 48 floor Leadenhall Building "The Cheesegrater," which, at 225 m, will be one of the tallest buildings in the City of London on completion in 2014. In addition to such large scale projects BIM is also used on individual components of projects of a smaller scale. For example, the modular stairs in the new bus station at Slough, UK, that was officially opened in June 2011 was designed and fitted using BIM (Buildoffsite, 2011). Anticipating benefits from the use of BIM in respect of reduced transaction costs and less opportunity for errors to be made, the UK Government has stated that from 2014 onwards all contracts awarded will require the supply chain members to work collaboratively through the use of

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http://dx.doi.org/10.1016/j.ijproman.2012.12.001

" fully collaborative 3D" BIM (CabinetOffice, 2011: 14). 3D BIM means all project and asset information, data and documentation must be in electronic form. Furthermore, the public and private sectors in the USA are collaborating to promote BIM's use (Underwood and Isikdag, 2011). However there is a view that the case for BIM is not totally proven, with the overall effectiveness of BIM utilisation still not completely justified (Jung and Joo, 2010).

Succar's definition of BIM above highlights its holistic nature, which includes not only software that allows the geometrical modelling and the input of information but also project management (PM)-related tools and processes. As such, taking a holistic perspective of BIM places it firmly in the construction PM domain. It has a potential use for construction project managers in improving collaboration between stakeholders, reducing the time needed for documentation of the project and, hence, producing beneficial project outcomes.

One strand of the BIM literature is to document in detail the use of BIM on specific project cases, such as Heathrow Terminal 5 (BSI, 2010) and Walt Disney Concert Hall (Haymaker and Fischer, 2001). What is lacking, though, is any cross-case synthesis to ascertain the extent to which the use of BIM leads to enhanced benefits to projects beyond the individual case under consideration. To address this gap in the literature this paper reports analysis of secondary data from 35 case studies relating to the use of BIM that have been documented in the academic literature or otherwise placed in the public domain; with the purpose of answering the question, has the use of BIM resulted in benefits to construction projects?

2. Literature review

Complex construction projects require inter-organizational associations (Maurer, 2010). To ensure success in inter-organizational project ventures, trust between the different project partners is acknowledged as a key success factor (Kadefors, 2004; Maurer, 2010). Because of the nature of work in these inter-organizational ventures there is a well recognized need for better integration, cooperation, and coordination of construction project teams (Cicmil and Marshall, 2005, cited in Maunula, 2008). Inter-organizational information systems [IOIS] are one possible way to cope with the integration, cooperation, and coordination challenges faced in construction (Maunula, 2008). IOIS are sometimes referred to as Web-based PM Systems [WPMS] (Forcada et al., 2007; Nitithamyong and Skibniewski, 2004), Web-Collaborative Extranets [WCEs] or Document Management Systems [DMS] (Ajam et al., 2010). Whatever the nomenclature used, such systems facilitate the sharing of diverse types of information in an accurate and timely way, which is a key to achieving successful project outcomes (Anumba et al., 2008). A document based way of working means that through the project life cycle there is an "unstructured stream of text or graphic entities" (BSI, 2010: 2). This unstructured stream is a challenge for better integrated practices, with the information exchanged at the document level generally "fuzzy, unformatted or difficult to interpret" (Ajam et al., 2010: 763). Ajam et al. (2010) argue that the proper use of an IOIS is that of going from document sharing practices to sharing information at the object or element level. Hence, BIM could be the key approach to adopt to ensure this integration and shift from the document paradigm to the Integrated Database paradigm happens.

Whilst the topic of BIM has been studied by academics (see, Aouad et al., 2006; Lee, 2008; Maunula, 2008; Succar, 2009); by professional groups (BSI, 2010; McGraw-Hill, 2008, 2009, 2010a, 2010b); and, naturally, by software vendors (Autodesk, 2007; Bentley, 2003) very little of the PM literature focuses on BIM from the PM point of view. An exception is Allison (2010), who addresses the BIM potential as a PM tool more directly. Allison describes 10 reasons why project manager should champion 5D BIM. Aouad et al. (2006) defined this multidimensional capacity of BIM as "nD" modelling, for it allows adding an almost infinite number of dimensions to the Building Model. 5D BIM is traditionally understood as BIM that includes, besides the 3D model – see introduction section for a definition of 3D, scheduling information (the 4th D) and information for estimating the project from the model (the 5th D). Although the work of Allison is from an employee of a BIM software vendor, and the potential of BIM for PM might be slightly exaggerated, the list of advantages for PM practitioners is a useful starting point. These advantages are compiled in Table 1, and are potential ways in which BIM can benefit Project Managers.

The rising interest in BIM can be seen in conjunction with new PM frameworks, such as Integrated Project Delivery (IPD), which increases the need for closer collaboration and more effective communication (Eastman et al., 2011). When people collaborate on a project, communicating specific characteristics of the project amongst the different parties involved requires documentation of these characteristics (Lee, 2008). Traditionally, this documentation was done on a paper or document basis (BSI, 2010). BIM takes the traditional paper-based tools of construction projects, puts them on a virtual environment and allows a level of efficiency, communication and collaboration that exceeds those of traditional construction processes (Lee, 2008). Hence "the coordination of complex project systems is perhaps the most popular application of BIM at this time. It is an ideal process to develop collaboration techniques and a commitment protocol among the team members…" (Grilo and Jardim-Goncalves, 2010: 524). BIM has also been linked to the development of lean approaches to the management of projects, as the enhanced collaboration and information sharing can contribute to the lean management's goal of reducing non-value-adding waste (Olatunji, 2011).

BIM has a potential use at all stages of the project life-cycle: it can be used by the owner to understand project needs, by the design team to analyze, design and develop the project, by the contractor to manage the construction of the project and by the facility manager during operation and decommissioning phases (Grilo and Jardim-Goncalves, 2010). Looking to the future leads to speculation that BIM will eventually lead to a virtual project design and construction approach, with a project being completely simulated before being undertaken for real (Froese, 2010). As such BIM will provide potential beneficial