How is Building Information Modeling Influenced by Project Complexity?
A Cross-Case Analysis of e-Collaboration Performance in Building Construction

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ABSTRACT

Virtual design and construction of buildings and architectural spaces require extensive collaboration among a diverse set of design professionals. The authors analyze e-collaboration performance in two construction projects of differing complexity, to gain an understanding of how collaborative design based on building information modeling (BIM) is influenced by the complexity of the building project. The findings suggest that the perceived business value of BIM depends on project complexity and that BIM-based collaboration does not yield unconditional positive implications for all types of construction projects. The authors argue that current practice would benefit from a more structured approach to building business cases for e-collaboration, comprising the following aspects: 1) a thorough assessment of BIM's potential benefits based on the complexity of the project; 2) an assessment of all designers' collaborative BIM capabilities and maturity; 3) a reliable cost estimate for full-scale BIM e-collaboration; and 4) a cost benefit analysis to identify the business value of BIM-based e-collaboration. In addition, a systematic approach to collaboration engineering would be required to develop e-collaboration environments customized for the information needs of a specific project.

Keywords: *Building Construction, Building Information Modeling, Design Practice, e-Collaboration, Project Complexity*

INTRODUCTION

Designing buildings and architectural spaces requires extensive collaboration among a diverse set of design professionals. Experts from various disciplines, such as architects, structural engineers, and landscape designers, develop design solutions in collaboration (Gal, Lyytinen, & Yoo, 2008). Using next-generation virtual design technologies such as building information modeling (BIM), the construction industry has data-sharing technology powerful

DOI: 10.4018/ijec.2014040102

enough for integrated and concurrent digital design of facilities. BIM technologies can best be described as a platform of IT tools used in designing virtual models that present all functional and physical characteristics of a building (National Institute of Building Science [NIBS], 2007). BIM is regarded by many as a core technology for aiding collaboration among the actors in the Architecture, Engineering and Construction (AEC) industry.

BIM-based collaboration may be necessary and desirable, but research indicates that this is not easy to achieve (Isikdag & Underwood, 2010; Shen et al., 2010). This is partly due to BIM applications not living up to the industry vision of their use as inter-organizational collaborative tools (Neff, Fiore-Silfvast, & Dossick, 2010), and issues related to the new ways of organizing required to create interoperable processes for information exchange and storage (Ahmad & Sein, 2008). Additionally, AEC firms exist along a spectrum from "highly computer literate firms to those that hardly use computers in their work," which leads to dissimilar expertise and knowledge in using advanced information systems (Williams, 2007). Many AEC organizations remain skeptical about changing established work practices in response to new information systems (Guha, Thakur, Konar, & Chakrabarty, 2011).

Even in leading BIM projects run by leading construction firms, seamlessly integrated practice remains elusive: "Findings from the evaluations indicated that the winning submittals continued historical success in the area of visualization, whereas opportunities for virtual analysis and other critical areas still remain relatively unexplored, even in the 'best BIMs in the world'" (McCuen, Suermann, & Krogulecki, 2012, p. 224). On the upside, several scholars report performance gains in projects where organizations succeed in using BIM technology collaboratively (Manning & Messner, 2008; Khanzode, Fischer, & Reed, 2008). Reported gains include decreasing the number of change orders, reductions in unnecessary rework, and decreased need for clarification (McGraw-Hill Construction, 2012). A recent study argued for the need to inquire further into whether collaborative BIM use is contingent upon individual project characteristics such as project size, value, and complexity (Bryde, Broquetas, & Volm, in press). In addition to the specific project characteristics, collaborative BIM performance depends upon organizational ICT maturities and capabilities (Succar, Sher, & Williams, 2012).

Following up on the call by Bryde et al. (in press) and a recent literature review suggesting further research on BIM based interorganizational collaboration practice (Merschbrock & Munkvold, 2012), we investigate how and whether collaborative BIM performance is influenced by the complexity of a construction project. Project complexity has been defined as "consisting of many varied interrelated parts" and can be operationalized in terms of differentiation and interdependency (Baccarini, 1996, p. 202). Differentiation refers to the "number of varied elements, e.g. tasks, specialists, components," and interdependency refers to the "interrelatedness of these components" in a project (Baccarini, 1996, p. 201).

We contribute to the ongoing discussion by studying the intertwined nature of project complexity and collaborative performance in digital construction design, and by suggesting how current practice can be improved. Thus, our research is guided by the following question: How does project complexity influence BIM-based collaborative performance in construction projects?

To address this question, we present the results of a comparative case study of two Norwegian construction projects that analyzed digital modeling performance based on an assessment metrics provided by Succar et al. (2012). The construction projects differ in their design complexity, taking into account if and how project participants respond to varying complexity in their collaborative efforts. The intended contribution of this article is twofold; we seek to identify how project complexity influences BIM-based collaboration in these two cases and to provide practical suggestions for addressing related challenges.

Patterns in Electronic Brainstorming

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Virtual Group Strategic Decision Making Using Structured Conflict and Consensus Approaches

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