



Mapping the managerial areas of Building Information Modeling (BIM) using scientometric analysis

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Abstract

The successful adoption of Building Information Modeling (BIM) leads to the subsequent need for improving management practices and stakeholders' relationships. Previous studies have attempted to explore solutions for non-technical issues; however, a systematic and quantitative review of the details of non-technical field, namely, the managerial areas of BIM (MA–BIM), seems to be missing. Hence, a scientometric approach is used to construct knowledge maps in MA–BIM, thereby allowing bibliometric data to provide an objective and accurate perspective in the field as a whole. Through keyword and abstract term analysis of 126 related papers published from 2007 to 2015, an integrated conceptual framework is proposed to summarize current status and structure future directions of MA–BIM based on five principal research areas. This study shows the transformation of MA–BIM from an individual approach to a wide-ranging organizational strategy. It provides new insights into managing BIM projects by referring to the accurate representation and analysis of previous research efforts.

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1. Introduction

Construction projects, particularly megaprojects, are becoming significantly complex and difficult to manage (Bryde et al., 2013). To cope with the increasing complexity and difficulty of project management, BIM has been developing at a rapid pace and becoming extensively utilized. The benefits of BIM in different types of construction projects are manifold and generally recognized by involved stakeholders (Eastman et al., 2011; Gu and London, 2010). Despite its immense technical advantages and value potential, the facts remain that the use of BIM worldwide still falls considerably short of its capabilities; many construction projects even disregard BIM (Cao et al., 2014). Barlish and Sullivan (2012) determined that returns on investment (ROI) generated by BIM may vary considerably

from project to project. Oakley (2012) revealed the minimal effects of several construction projects with the use of BIM on project performance. Although the technical side of BIM is considerably maturing in the construction industry, the managerial areas of BIM (MA–BIM) still have limitations.

For a construction project, BIM is not merely a software suite. However, obtaining the promised project benefits of BIM seems to hinge on management changes instead of technology issues. A recent example is the Shanghai Tower, in which the critical challenge of BIM implementation was not the technical aspect but the coordination among 8 BIM teams with members having diverse occupational backgrounds and different interest orientations. Among the involved parties, the Shanghai Construction Group was the general contractor and one of the owners with a 4% of the share on the project (Shanghai Tower, 2015). The IPD-ish partnership (El Asmar et al., 2013) significantly facilitated the involvement of Shanghai Tower contractor in the preplanning and design stages. In this regard, the non-technical challenge necessitates an industry-wide demand for the studies

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on MA–BIM. Volk et al. (2014) presented a comprehensive review on BIM from a “broad” sense, which comprises functional, informational, technical and organizational/legal issues throughout the entire life cycle of a project. According to Volk et al. (2014), the organizational/legal issues are what MA-BIM needs to improve for project performance.

For these reasons, MA–BIM could be proposed as:

Organizational and legal strategies for coordinating and managing overall project information, processes and aligning project policies to improve the level of BIM adoption and implementation.

Literature review is regarded as an expedient approach to gain in-depth understanding of a research area. Through a systematic examination of existing studies, state-of-the-art advancements and emergent trends can be identified with the purpose of spurring encouragement for future studies. Despite the importance of critical review, almost no such work has yet been conducted regarding MA–BIM. Therefore, the current study undertakes a scientometric analysis of MA–BIM articles published from 2007 to 2015. Different from previous studies, this study does not distinguish between sources specific to MA–BIM, which enables data to provide a highly accurate general perspective in this field.

The objectives of this study are as follows: (1) to summarize MA–BIM studies from 2007 to 2015; (2) to acquire a holistic research status for MA–BIM from the perspective of keyword co-occurrence network, as well as to identify research theme-divisions through abstract term cluster analysis; (3) to identify emergent trends from studies in this field through keyword burst detection; and (4) to develop an MA–BIM framework that illustrates a future research roadmap. The rest of this paper is structured as follows. Section 2 elaborates on the research method used in this study. Section 3 presents the results of the keyword co-occurrence analysis and burst detection, followed by Section 4 that describes the results and findings from the abstract term cluster analysis. Then Section 5 develops and presents the MA–BIM conceptual framework based on the scientometric analysis. Finally, Section 6 concludes the findings of this study.

2. Research method

2.1. Paper retrieval

To achieve the research objectives of this study, academic journals with the MA–BIM publications were identified. The list of publications was obtained using two databases, namely, Scopus and Web of Science (WoS), for a comprehensive search on the subject area. WoS database covers over 12,000 of high impact journals worldwide, including open access journals and over 150,000 conference proceedings (Thompson-Reuters, 2014). And Scopus includes over 21,500 peer-reviewed journals, 7.2 million conference papers, and over 60 million records (Elsevier, 2016). The integration of sources from these

two databases was considered sufficient to justify broad conclusions regarding the overall development of MA–BIM.

Given the difficulty of searching each related article, a delimitation of the research boundary is frequently necessary (Chen et al., 2015). The main points of each paper should be determined by its research objectives, methodologies, and major contributions. In the current study, three criteria were proposed during the delimitation process of the BIM literature in the managerial areas. Fig. 1 shows the research framework of this study.

Firstly, only papers in peer-reviewed English journals were included for the review with considering their impact positions in the BIM research in terms of SCImago Journal Rank and H-index. Book reviews, editorials, and conference papers were excluded so that all retrieved papers could be screened using an identical analytical construct in terms of research aims and methods (Mok et al., 2015).

Secondly, the topics of these papers were limited to the managerial issues in BIM adoption and implementation rather than the technical development of BIM. The topic of each paper was determined by its research aims and methods from abstract. Those papers, which aim at providing technical solutions of BIM without referring to project strategies for improved BIM adoption level or implementation process, were preliminarily excluded. Meanwhile, the topic of each paper could also be identified from the research methods. It is noteworthy that interviews and questionnaires are typically used as the principal means of investigating the managerial issues of BIM. In contrast, technologies integration and systems development are essentially employed to address the technical issues of BIM.

Thirdly, papers aimed at addressing functional issues that describe BIM functionalities and applications, informational issues that describe industry foundation classes (IFC) and model view definition (MVD), and technical issues that describe data capture, data processing, object recognition, and modeling, were excluded. After identifying the research aims and methods from abstract, there was still a need for in-depth understanding of the primary contents of each paper. For example, if the main body of a paper discussed the whole process of BIM plug-in development, but nearly had no relationship with organizational/legal issues, it was screened out. To decrease potential bias during the selection of target papers, the contents of each paper were screened by different authors to identify the ones suitable for this study.

The search rule in this study was (“BIM” OR “building information modeling” OR “building information modelling” OR “building information model” OR “virtual design and construction” OR “VDC” OR “as-built model” OR “virtual model”) AND (“management” OR “managerial” OR “managing” OR “manage”). To avoid omissions of target papers, the timespan of the publication search was set for “all years” (ended in August 18, 2015). According to the first criterion, a total of 308 journal papers were retrieved. As shown in Table 1, 16 journals were selected in this process. These journals have published at least one paper that fits the first criterion, and are highly ranked by construction management researchers. Despite the rigorous search rule, some retrieved publications appear to be less relevant. Based

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