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A SYSTEMATIC REVIEW OF BIM REQUIREMENTS THROUGHOUT A WHOLE LIFE CYCLE OF A PROJECT

Syafizal Shahruddin*

School of Housing, Building and Planning
Universiti Sains Malaysia
Malaysia

Mohd Zairul

Department of Architecture, Faculty of Design & Architecture
Universiti Putra Malaysia
Malaysia

***Corresponding author's Email:** fizalshahruddin@gmail.com

Author's Biography

SYAFIZAL SHAHRUDDIN is currently attached to the School of Housing Building and Planning (HBP), Universiti Sains Malaysia (USM), as a fellow. He obtained his first degree in BSc. in Housing, Building, and Planning majoring in architecture (LAM Part 1) from USM in 2011. He then gained his Bachelor in Architecture (LAM Part 2) from USM in 2014 and his Master in BIM and Integrated Design from Univeristy of Salford in 2017. Currently he is continuing his doctorate study at Universiti Putra Malaysia (UPM) in the field of architecture focusing on building information modelling.

MOHD ZAIRUL is currently attached to the Department of Architecture of Faculty of Design and Architecture (FRSB), Universiti Putra Malaysia (UPM), as a senior lecturer. He is a professional technologist (Ts) and a member of Lembaga Arkitek Malaysia (LAM) and Pertubuhan Arkitek Malaysia (PAM). In 2017, he received his Ph.D from TU Delft from the Department of Management in the Built Environment in 2017. His research interests reside within flexible housing, industrialised building system (IBS), circular economy, architectural pedagogy, and qualitative data analaysis.

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Research Highlights

In this systematic review, we attempt to defend a view that the full potential of building information modelling (BIM) in enabling sustainable design and construction could transpire only through an in-depth understanding of every required component of BIM requirements across a construction project lifecycle. The findings from the study add to the body of literature by expanding the required components of BIM requirements through the amalgamation of variables that reside within the General Practitioners Information System (including IT infrastructure, process, people and environment) (Saleh and Alshawi, 2005) and the protocols for a BIM-collaborative design framework (including policy, process, and technology) (Kassem et al., 2014). The most striking result to emerge from the study is the process requirements of BIM. The fact that the accuracy and reliability of the information produced, shared, and reused across the construction project lifecycle may be affected without having a BIM process map and procedure for each of the BIM core activities being in place.

Research Objectives

Much of the discussion on BIM implementation centres on the required set of BIM requirements and specifications that should be delivered throughout a whole lifecycle of a project (Farzaneh, Monfet, & Forgues, 2019; Gao & Pishdad-Bozorgi, 2019; Ibrahim & Kingdom, 2013; Kamel & Memari, 2019; Parllaku & Underwood, 2017; Sacks, Gurevich, & Shrestha, 2016). Yet, very few studies have attempted to systematically review every aspect of BIM requirements from the perspective of policy, process, technology, environment and people-related interlocking pillars. The review by Farzaneh, Monfet, and Forgues (2019) and Kamel and Memari (2019) disregarded the legal and process aspects of BIM requirements and included only the technical requirements of BIM technology. In another review study, Sacks, Gurevich, and Shrestha (2016) drew conclusions from the review of BIM protocols, guides and standards and not from the existing emprical studies in supporting the emerging findings of BIM requirements obtained through the BIM-based documents. This gap necessitates the present study to holistically define the required components of BIM requirements by extending the base knowledge of BIM requirements as defined by Saleh and Alshawi (2005) and Kassem et al. (2014).

Methodology

The study employed PRISMA-P (Preferred Reporting Items for Systematic reviews and Meta-Analyses) (Moher et al., 2009) by first identifying related literature in the Web of Science, Scopus, and specific top-ranked journals covering BIM area of research. The following sets of keywords were used: (1) body of knowledge (including requirements, specifications and deliverables); (2) field area (including BIM, "building information modelling," "building information model," "building information modelling and management," "collaborative BIM," "integrated BIM," "level 2 BIM," and "level 3 BIM") and (3) context (including organisation, firm, SMEs, industry, "construction industry," AEC, macro, micro, and project). The initial search produced a list of 423 records, but 24 records were removed because of duplication. The remaining 399 articles were screened based on the following criteria, among others: publication types (research articles), language (English publications), and year (publication from 2005 to 2019). Finally, an eligibility screening was conducted to finalise the relevant

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literature for the qualitative thematic analysis. The total number articles finalised for analysis in ATLAS.ti 8 was 39.

Results

The review of the study uncovered five main pillars and 41 subpillars of BIM requirements throughout a whole lifecycle of a project. The six main pillars are process (P1) (16 subpillars), policy (P2) (7 subpillars), technology (P3) (6 subpillars), environment (P4) (6 subpillars), and people (P5) (6 subpillars). Process requirements of BIM have been the primary focus of previous studies (*n*=29), from which the following 16 subpillars emerged under the "process" pillar (P1): (i) benchmarking practices; (ii) BIM implementation plan; (iii) BIM model deliverables; (iv) BIM lifecycle process map; (v) BIM uses process map; (vi) BIM-information delivery manuals (IDM); (vii) COBIE; (viii) cost implementation plan; (viv) digital data management; (x) identification of project team's capability; (xi) mobilisation; (xii) pilot project; (xiii) process flow redesign; (xiv) quality assurance; (xv) scoping activities and purpose and (xvi) risk management. Furthermore, majority of of the reviewed articles (*n*=25) discuss the policy pillar (P2) of BIM requirements, which further consist of the following seven subpillars: (i) BIM based documents; (ii) BIM execution plan; (iii) collaboration requirements; (iv) contractual documents; (v) employer information requirements; (vi) intellectual property and (vii) obligation of stakeholders. Meanwhile, sub-pillars including (i) BIM object library; (ii) collaboration server; (iii) ICT infrastructure; (iv) interoperability; (v) technical support and (vi) vendor evaluation have emerged across 23 studies under the technological requirements of BIM (P3). Also, in regard to the environment pillar (P4), the following six subpillars are discussed across 13 studies: (i) BIM research and development; (ii) incentives and reward; (iii) IT vison and mission; (iv) knowledge management; (v) organisational culture and (vi) senior leadership. Finally, the following six sub-pillars emerged within the people pillar (P5) of BIM requirements: (i) BIM competence; (ii) organisation experience; (iii) qualification; (iv) roles and responsibilities; (v) staff experience and (vi) training and education.

Findings

In can be concluded from the study that striking a balance between fulfilling the required components that reside within the process, policy, technology, environment, and people pillars of BIM requirements is crucial in achieving the full benefits of BIM adoption throughout a construction project lifecycle. Despite the policy and process requirements of BIM being the focus of discussion in previous studies, very few have attended to the investigation of people-related requirements of BIM, hence providing an avenue for further study. BIM adoption can no longer be viewed as a technological challenge but rather a strategy that requires organisational, managerial, and operational changes within the traditional practices. This shift would require the existing architectural, engineering and construction (AEC) industry players to equip themselves with different skill sets in order to remain competitive in the AEC industry sector.

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