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BIM-based deconstruction tool: Towards essential functionalities

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Abstract

This study discusses the future directions of effective Design for Deconstruction (DfD) using BIM-based approach to design coordination. After a review of extant literatures on existing DfD practices and tools, it became evident that none of the tools is BIM compliant and that BIM implementation has been ignored for end-of-life activities. To understand how BIM could be employed for DfD and to identify essential functionalities for a BIM-based deconstruction tool, Focus Group Interviews (FGIs) were conducted with professionals who have utilised BIM on their projects. The interview transcripts of the FGIs were analysed using descriptive interpretive analysis to identify common themes based on the experiences of the participants. The themes highlight functionalities of BIM in driving effective DfD process, which include improved collaboration among stakeholders, visualisation of deconstruction process, identification of recoverable materials, deconstruction plan development, performance analysis and simulation of end-of-life alternatives, improved building lifecycle management, and interoperability with existing BIM software. The results provide the needed technological support for developing tools for BIM compliant DfD tools.

Keywords: Building deconstruction; Building Information Modelling (BIM); Functionality framework; Focus Group Interviews; Descriptive interpretive analysis

1. Introduction

The recent wide adoption of Building Information Modelling (BIM) has revolutionised the approach to timely project delivery across the world (Eastman et al., 2011). The benefits accruable from BIM have stimulated several nations to set a deadline for its adoption. For example,

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the UK government has stipulated that from April 2016, all procurement in public sector work must adopt BIM approach. This deadline has forced most companies in the UK to integrate BIM into their activities in order to sustain their competitive advantage. Due to the rise in BIM adoption, the implementation of BIM has experienced diverse innovation especially for building design, cost estimation, 3D coordination, facility maintenance, building performance analysis, etc. In addition, there is progressive improvement on the capabilities of BIM and its integration with technologies such as RFID, GIS, big data, Internet of Things (IoT), and others (Bilal et al., 2016a). Despite the benefits accruable from the use of BIM and the steep rise in the adoption of BIM, the use of BIM for end-of-life scenarios is often neglected (Akinade et al., 2015). This is because most BIM implementations focus on the planning to the maintenance stages of the building and only few works have been done on BIM for end-of-life scenarios.

It is important to give additional attention to the end-of-life of building, especially in terms of waste generation, because evidence shows that demolition activities account for over 50% of the total Construction and Demolition Waste (CDW) output of the construction industry (Kibert, 2003). Diverting this amount of waste could lead to a cost saving of over £1.3 billion on landfill tax and haulage. Therefore, ensuring adequate management of waste at the end-of-life of building is imperative since the current rate of construction suggests that building renovation and demolition activities would grow substantially. The need to reduce waste at the end-of-life therefore requires that demolition, as the traditional method of building disposal, be replaced with building deconstruction. Deconstruction is a building end-of-life scenario that favours the recovery of building components for the purpose of building relocation, component reuse, recycling or remanufacture (Kibert, 2008). Design for Deconstruction (DfD) is not just concerned with the recovery of building components at the end-of-life but processes that make building to be easily assembled and disassembled. Despite efforts in mitigating demolition waste through deconstruction (Akinade et al., 2015; Phillips et al., 2011), there has not been a progressive increase in the level of DfD. Evidence shows that DfD is still far from reaching its waste minimisation potentials since less than 1% of existing buildings are fully demountable (Dorsthorst and Kowalczyk, 2002).

Considering the foregoing, the use of BIM for building deconstruction management would be an effort channelled in the right direction. This is because literature reveals that design decisions have high impact on waste generation and end-of-life performances of buildings (Faniran and Caban, 1998; Osmani et al., 2008). Based on the identified gap in knowledge, this study seeks to identify key BIM functionalities that could provide effective decision-making mechanisms for DfD at the design stages. Therefore, the specific objectives of the study include:

(1) To assess the effectiveness and limitations of existing DfD tools.
(2) To understand opportunities accruable from the adoption of BIM for DfD.
(3) To identify essential functionalities of a BIM-based tool for DfD.

In order to identify inefficacies of current DfD practices and tools, this study starts with a review of existing works on DfD and the discussion of the role of BIM in DfD. Afterwards, a descriptive interpretive research was conducted using multiple Focus Group Interviews. This approach allows the investigator to set aside all presuppositions about the phenomenon in the search of true meanings and to have in-depth understanding of the phenomenon as experienced by experts. This is important to understand why the use of BIM for deconstruction is not common practice in the industry and to unravel the expectations of the participants on how BIM functionalities could be leveraged for DfD.

2. Building deconstruction and BIM

Deconstruction is a building end-of-life scenario that allows efficient recovery of building components (Kibert, 2008) for the purpose of reuse, recycling or remanufacturing. The recycling and remanufacturing of building components is now common practice; however, a more beneficial and challenging task is the ability to relocate a building or reuse its components without reprocessing. This is because building relocation and components reuse require minimal energy compared to recycling and remanufacturing (Jaillon and Poon, 2014). In addition, the reuse of building components guarantees a closed material loop condition where request for new resources and the generation of CDW is minimised. Fig. 1 shows how deconstruction enables a closed material loop condition at the end-of-life of buildings. The closed material loop eliminates the linear pattern of material movement in demolition to a circular economy model, which is more sustainable.

The aim of building deconstruction is to eliminate demolition as an end-of-life building disposal option. Apart from favouring the recovery of building components and diversion of waste from landfills, deconstruction is more beneficial than demolition in other ways. First, deconstruction eliminates environmental pollution and CDW generation that is characteristics of demolition (Akbarnezhad et al., 2014). Other benefits include reduction in harmful emission (Chini and Acquaye, 2001), preservation of the embodied energy (Thormark, 2001), reduction in site disturbance (Lassandro, 2003), etc.

Kibert (2008) suggests that effective strategy for closed-loop building material usage and material recovery requires basic rules which are: (a) building must be fully deconstructible; (b) building must be disassemblable; (c) construction materials must be recyclable; (d) the production

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