International Journal of Digital Innovation in the Built Environment
Volume 11 • Issue 1

BIM and Asset Management (AM) Interoperability Towards the Adoption of Digital Twins:
Current Status and Research Directions

Karim Farghaly, Imperial College London, UK*
Ahmed Nasr Hagras, University of the West of England, Bristol, UK

ABSTRACT

Digital twin (DT) is seen as the new shift paradigm for digital transformation in the post-pandemic-built environment sector. Learning from the implementation of building information modelling (BIM) for asset management (AM), there are recurring themes that the interoperability challenge is the key barrier to firstly overcome. The absence of a critical overview of issues and research related to BIM-AM interoperability is hindering the achievement of sustainable and effective integration between the two systems. Therefore, the aim of this paper is to review and analyse the trends and overview of the BIM-AM interoperability publications, identify and classify the major research topics on BIM-AM interoperability, and finally, propose future research interoperability directions for DT initiative adoption. To achieve the research aim, a systematic review of the work done to achieve interoperability using a wide range of digital technologies published between 2010 and 2020 related to the interoperability challenges between BIM and AM and real-time data sources was conducted.

KEYWORDS

Assets Management, BIM, Building Information Modelling, Digital Twin, Facilities Management, Interoperability

1. INTRODUCTION

While every industry is thinking about reshaping their business to thrive in the post-COVID-19 era, the architecture, engineering, construction, and operation (AECO) industry is emerging the Digital Twin (DT) initiative to build a new more intelligent, more productive, and safer built environment. This initiative is aligned with Industry 4.0 to advance new practices and tools to overcome the legacy associated with saying “BIM” for almost a decade. A DT refers to a digital replica of physical assets, processes, and systems (Lu et al., 2020a). This twin would enable the AECO sector to collaborate virtually, present sensor data, simulate conditions quickly, realise outputs of the what-if scenarios undoubtedly, predict results more accurately, and provide instructions to manage the physical world more effectively. Grieves and Vickers (2017) argued that DT’s rationality definition is to have just the efficient data without intensively using resources, in other words, an integration between dynamic modelling with real-time optimisation through the whole lifecycle. Building information modelling

DOI: 10.4018/IJDIBE.294445
*Corresponding Author

Copyright © 2022, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

(BIM), according to the ISO 19650 series, "*is about getting benefit through better specification and delivery of just the right amount of information concerning the design, construction, operation, and maintenance of buildings and infrastructure, using appropriate technologies*". BIM is, to an extent, seen as an analogue to DT in the AECO sector. For this paper's argument, the authors identify BIM as an environment where processes, technologies, and resources are integrated for better delivery. In contrast, DT is an advanced deliverable of this integrated environment. In this analogy, both BIM nowadays deliveries for AM and DT have one main challenge hindering their adoption: data interoperability (Matarneh et al., 2019b). That challenge is the critical barrier to overcome, as the entire theoretical framework of any information management technology is predicated on the assumption that data can be exchanged simultaneously between software programs (Farghaly et al., 2018).

Data interoperability is the ability that all other parties can correctly interpret data generated by any one party. Also, it enhances the data exchange between two or more diverse systems to facilitate automation and avoidance of data re-entry (Shen et al., 2010). To achieve effective data exchange between applications, the proposed solution should achieve both semantic and syntactic interoperability (Farghaly et al., 2019). Syntactic interoperability solutions identify an agreed exchange format to transfer data, and semantic interoperability solutions identify a set of terms and data requirements to enable interoperation using the agreed exchange format defined by syntactic interoperability. Several works were conducted to achieve both semantic and syntactic interoperability between BIM and AM platforms, with more concentration on syntactic interoperability (Cavka et al., 2017). Despite all the efforts and contributions, the construction industry's available solutions for interoperability are still insufficient to leverage DT's potential (Sacks et al., 2020). A comprehensive review of previous research can provide significant benefits in identifying areas where additional research work is required, and in the process, discerning future directions for the development of the effective interoperability environment of the DT initiative.

Despite that, there are several reviews regarding implementing BIM for Facilities Management (FM) in general and AM in particular (Matarneh et al., 2019b, Gao and Pishdad-Bozorgi, 2019), the authors argue that the state-of-the-art of BIM-FM interoperability approaches has received limited attention. There are some reviews focused on BIM integration with a particular technology only for operation and maintenance stage such as the Internet of Things (IoT) (Tang et al., 2019) and other focused on digitalisation in general in FM (Wong et al., 2018). Even in Ozturk (2020), which concentrates only on the interoperability in BIM for AECO industry, has not unveiled detailed results about the BIM-FM interoperability approaches and just concentrated on a bibliometric search, and a scientometric mapping and analysis of interoperability in BIM research. Evidently, the literature lacks a concrete systematic review of the current semantic and syntactic interoperability approaches for BIM-FM integration, a limitation which was the crucial driver for conducting this research. In particular, the authors try to address this by answering the following:

1. What semantic and syntactic aspects must be addressed to achieve effective interoperability between BIM and AM?
2. What are the different approaches to achieve these aspects? Which are the limitations of these approaches?
3. How can these approaches utilise for effective DT adoption?

This research contributes as a fundamental early step in formulating how the digitalisation of the built environment assets can be considered, and how integration approaches can be identified and achieved to achieve the DT initiative's benefits. At the crux, this research is not providing a glistening answer for DT adoption in AECO industry, and it is a piece of enlightenment towards what should be learned from the previous work in the BIM area to demystify some of the main challenges and opportunities related to interoperability in the emerging DT initiative. It is worth noting that this review cannot be considered by any means as exhaustive since DT technology is continuously growing at a

26 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/article/bim-and-asset-management-am-interoperability-towards-the-adoption-of-digital-twins/294445

Related Content

Geospatial Analysis of Land Loss, Land Cover Change, and Landuse Patterns of Kutubdia Island, Bangladesh

Munshi K. Rahman, Thomas W. Schmidlin, Mandy J. Munro-Stasiukand Andrew Curtis (2017). *International Journal of Applied Geospatial Research (pp. 45-60).*

www.irma-international.org/article/geospatial-analysis-of-land-loss-land-cover-change-and-landuse-patterns-of-kutubdia-island-bangladesh/175837

Security and Privacy in Next Generation Networks and Services

Panayiotis Kotzanikolaou (2016). *Geospatial Research: Concepts, Methodologies, Tools, and Applications (pp. 1777-1795).*

www.irma-international.org/chapter/security-and-privacy-in-next-generation-networks-and-services/149576

Map Matching Algorithms for Intelligent Transport Systems

Mohammed A. Quddus (2013). *Geographic Information Systems: Concepts, Methodologies, Tools, and Applications (pp. 658-665).*

www.irma-international.org/chapter/map-matching-algorithms-intelligent-transport/70468

Critical Incident Management and Geographically–Based Systems

David W. Webband David R. Hoffpauir (2010). *International Journal of Applied Geospatial Research (pp. 69-75).*

www.irma-international.org/article/critical-incident-management-geographically-based/45131

BIM Education for Engineers via Self-Directed, Creative Design

Oliver Kinnaneand Roger West (2013). *International Journal of 3-D Information Modeling (pp. 65-76).*

www.irma-international.org/article/bim-education-for-engineers-via-self-directed-creative-design/105907