Chapter 14
4D BIM for the Management of Infrastructure Projects

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ABSTRACT

Building information modelling has become a core topic in the architectural engineering and construction (AEC) industry, and its benefits have been realised over different phases of project construction. Adoption of nD BIM in the domain of infrastructure projects has provided challenges and is yet evolving. This chapter reviews the adoption of Building information modelling in the management of infrastructure projects. The use of nD planning (4D, 5D, 6D, 7D, and 8D planning) in infrastructure planning and management is discussed through Mapping n-D BIM with different applications in infrastructure projects. 4D BIM models are developed integrating the 3D models with the schedule and they support multiple construction management tasks. The implementation of 4D planning and management in infrastructure projects is demonstrated with the help of two case studies.

BACKGROUND

The construction of infrastructure project is complex to execute and involve participation of various tradesman to perform explicit activities on challenging design constraints and on-site conditions. Infrastructure projects involve massive sets of information and huge cost implications. They often require a lot of effort to understand and communicate various sets of information among the project team to obtain desired results. This necessitates collaboration, coordination of different participants and efficient exchange media for sharing and interpretation of information. Failing causes unnecessary delays and huge cost overruns. Hence, it is necessary to manage these projects to provide efficient and profitable results.

BIM (Building Information Modelling) is one such platform, which can be utilised to achieve better performances in the projects (Kymmell, 2008; Kamardeen, 2010). Building Information Modelling (BIM) is a set of interrelating policies, processes and technologies that generate a systematic approach for managing the critical information for building design and project data in digital format throughout the life cycle of a building (Penttila 2006). BIM not only stores different sets of data but also allows to perform various applications over the available data in its repository. BIM models are generally n-dimensional computer-generated models representing the physical and operational characteristics of a facility in digital environment (Kulasekara, Jayasena, & Ranadewa, 2013; Philipp, 2013). One of the main characteristics of BIM application is the transparency in the management process. This allows effective collaboration of multiple stakeholders to actively visualise, participate and manage during different stages of a project (Fanning, Clevenger, Ozbek, & Mahmoud, 2014).

One of the main challenges in construction is generation and communication of quality information (Crotty, 2012). The use of BIM overcomes this through 3D visualisation of the physical facility enabling to understand and share realistic information among the project team. The ability of BIM to visualise the facility in 3D geometry makes it easy to perform various operations. It enables to perform feasibility study over constructability, satisfying both functional requirements and budget of the project (Liu, Guo, Li, & Li, 2014). It allows collaboration of different set of functional models to perform clash checks (Lee, Lee, Shim, & Park, 2012; Liu et al., 2014; Chong, Lopez, Wang, Wang, & Zhao, 2016). This eliminates many errors during construction. Further, the visualisation using BIM is not only limited for 3D representation, rather extends to visualisation of projects risk (Chang Su Shim, Lee, Kang, Hwang, & Kim, 2012), traffic impacts (Zanen, Hartmann, Al-Jibouri, & Heijmans, 2013), alignment checks (H. Kim et al., 2014) and visualising of difficult construction process (Fanning et al., 2014).

It is often essential to control the schedule and cost overruns in a project. The BIM models allow users to perform earned value analysis to measure and control the performance using specific user defined algorithms (Marzouk & Hisham, 2014). BIM enables n-dimensional simulation of real time events to assess and formulate solution to current problems. The simulation during construction stage visualises on site construction progress, helps analyse and assess optimal improvement in schedule performance (Liu et al., 2014). It also helps visualize the erection and operational process of facilities over time (Chiu, Hsu, Wang, & Chiu, 2011). Application of BIM also allows to use modelled information to use for asset maintenance and management of infrastructure projects.

This chapter discuss on various uses of n-d BIM on infrastructure projects. Applications and insights of various research efforts present over the decade are discussed. This is followed by the discussion on 4D planning and management of infrastructure projects through case studies of two ongoing infrastructure projects namely a bridge project and a road project.

N-DIMENSIONAL BIM

BIM allows linking of n-dimensional information associated in a project. It starts with three-dimensional data and currently extends up to 8-dimensional data namely 3D, 4D, 5D, 6D, 7D and 8D BIM. Each dimensional value represents different sets of information added and specific task functions which they can be used over the project's life cycle. Thereby, BIM becomes a more centralized model, allowing to assess any type of project information over the project lifecycle. The multidimensional BIM is basically achieved through appending different sets of information with the 3D models.

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