Chapter 5
Usage of BIM in Smart Cities

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ABSTRACT

Rapid urbanization and overpopulation in the cities create a demand for the efficient usage of resources for the cities of the near future. Correspondingly, the need for more effective urban management strategy rises up as a current issue. The understanding behind smart cities can fulfil this need for providing a strategy model for urban management. Based on the literature review, this paper researches BIM usage throughout the lifecycle of the smart city (SC) project. This article focuses on the IoT, GIS and BIM integrated SC project model. This model aims to enhance BIM model by providing real time information from built environment to IoT sensors and geographical data to GIS in BIM model. Utilization of this SC project model can be beneficial for the industry to design and construct the smart city as well as for municipality and city government entities to manage the city.

1. INTRODUCTION

Due to the rapid urbanization and correspondingly the overpopulation in the cities, resource consumption related problems have been started to be observed in the cities. Cities are getting more and more crowded. The statistical data show that, more than half of the population on earth recently resides in the cities (Sujata et al., 2016), while this ratio is expected to exceed 70 percent in 2050 (Anthopolous, 2015). According to this expected scenario, urban environment has a growing demand for efficiency and resources, and there is a need for implementation of an urban management model to reduce usage of resources and to provide an urban life to the citizens that is comprehensive and high quality (Pasquinelli et al., 2016; Yamamura et al., 2017). Citizens have started to experience challenges (e.g. traffic problems, air pollution, etc.) reducing their life quality. Cities are becoming smarter to deal with the problems as well as to enhance their citizens' life quality and effectiveness in the resources' usage. Smart city (SC) concept has emerged as a potential tool for enhancing cities' capabilities to cope with the challenges experienced.

This concept has various definitions. Yamamura et al. (2017) summarize the aim of SC as developing a sustainable city through optimizing resource management and providing high quality life to citizens. Since smart cities (SCs) have a multi-stakeholder and technology-based complex structure, they aim to collect large amount of data about life in the city from objects and participants (Song et al., 2017), this information creates the need for an integrated framework to create an urban-data-based value provided to urban stakeholders (Lim, Kim, & Paul, 2018). For this reason, BIM is among the main constructs or enablers of SCs. BIM can provide the cities a platform that collects and contains data about buildings as well as other entities related to urban planning and urban life (Torabi et al., 2016).

Even if there are studies on BIM, studies on adoption of BIM in SCs with integration of GIS-IoT are limited. There are papers in the literature that studied either BIM and GIS integration (Akkaya & Başaraner, 2012; Ma & Ren, 2017; Al-Saggaf & Jrade, 2015) or BIM and IoT integration (Dave et al., 2018; Machado & Ruschel, 2018; Varnosfaderani & Delavar, 2017). For example, Song et al. (2017) proposed BIM-GIS integration as a model to support sustainable SC due to the model's capability in integrating data and managing the cities. Similarly, Ma and Ren (2017) reviewed application areas of the BIM-GIS integrated model and classified the literature based on the integrated model's applications at the building and urban levels. Gunduz et al. (2017) studied BIM, GIS and IoT's integrated usage to deal with challenges about complex facilities and reviewed the usage areas of BIM-GIS and GIS-IoT at building and urban levels as well as presented and tested a software for the IoT, GIS, and BIM integrated usage for the FM phase of a building. This current paper differs from the existing literature as it studies the potential of integration of both IoT and GIS into BIM for SCs projects. This literature review-based research searches for the usage areas of this integrated model. This paper examines the potential of GIS and IoT integrated BIM model usage throughout the entire lifecycle (e.g. establishment, development and management) of SC projects. Within the scope of this paper, SC projects concept covers all phases of SCs including transformation of the cities into smarter ones, enhancing smartness of SCs and their operation as well as construction project management (CPM) starting from the design phase. This study may be beneficial to the architectural and engineering companies, construction companies, municipalities and governments and entities related to ICT.

2. SMART CITY CONCEPT

SCs are the improvement of the city by integrating the city's physical infrastructure, information technologies and social infrastructure (Harrison et al., 2010). They are cities that promise economic growth and high life quality through effective management of the city's resources, stakeholder integrated governance and technology-based solutions (Caragliu et al., 2011).

SC is a city that operates as a system enabled by relevant technologies. Technologies used in the SCs can enhance efficiency in the system enabling optimization of resource usage and identification of areas which need to be improved. For this reason, technology is among the main pillars and constructs of SCs. SCs are recognized by technology used (Ismagilova et al., 2019) such as ICT, IoT and sensors, cloud and edge computing (Nitoslawski et al., 2019; Lea, 2017). Main technologies used in the SCs can be briefly described as follows:

- **ICT:** ICT is a high technology that must be used to collect and deliver information to advance the quality of daily life and urban operations in the city (Dameri, 2017). It has four different phases;

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