Chapter 22
Developing Smart Buildings Using Blockchain, Internet of Things, and Building Information Modeling

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ABSTRACT

Building information modeling (BIM) is a revolutionary technology that provides all the necessary mechanisms to achieve end-to-end communication, data exchange and information sharing between project actors, leading to smarter outcomes for communities and more efficient projects for AEC service providers. 3D models generated in the context of engaging in the BIM process and as-delivered physical assets through building management systems (BMS) adopt Internet of Things (IoT) architectures and services. However, the orchestration of IoT devices in a highly modular environment with many moving parts and inter-dependencies between the stakeholders of this environment, lead to many security issues. This article focuses on applying novel technologies in the construction industry, such as BIM, IoT, and Blockchain, but also on examining their interconnection and interoperability on a proposed system architecture on a case of a building (museum), where efficient security, management and monitoring are considered crucial factors for the unobstructed operation of the organization that hosts.

INTRODUCTION

The expansion of Information and Communication Technologies (ICT) has been proved to transform urban life, to build powerful, intelligent and smart industrial systems and applications, enabling people to improve their quality of life within the city environment. As a direct result of the digital revolution, current urban plans are transforming the vision of sustainable cities, which must meet not only economic and environmental indicators' requirements, but also make current technological developments easy to use and accessible to their residents.

The application of Internet of Things (IoT) and Digital Technologies in Smart Cities environment has been increased, providing new challenges in the new digital ecosystem (Ahlgren, Hidell, & Ngai, 2016), aiming to provide interconnection of smart devices, collect and process data from different environments and provide products and services to end users, application groups and sectors i.e. farms, government, transportation, health, cultural management etc. (Mehmood, Ahmad, Yaqoob, Adnane, Imran, & Guizani, 2017). Smart cities have been equipped with IoT platforms and various electronic devices, applying machine learning and AI algorithms and therefore becoming smarter and more efficient than before (Arasteh et al., 2016). However, building is the key element of a city and therefore remains the key element in a smart city ecosystem.

The Architecture, Engineering and Construction (AEC) industry has not embraced digital transformation with the same enthusiasm as other industries (e.g. such as manufacture industry). In the building sector, AEC industry consists of a high number of stakeholders that have been used to operate in the same way for decades and yet have not embraced digital transformation with the same enthusiasm as other industries (e.g. such as manufacture industry, aerospace industry or financial industry) (Woodhead, Stephenson, & Morrey, 2018). In fact, AEC is one of the least digitalized sectors and for many Economic Analysts this relates to the flat or falling productivity rates (E.U.B.I.M. Taskgroup, 2017). Nevertheless, the construction sector is strategically important to economies in terms of output and job creation. The European construction sector output of €1.3tn4 (trillion) is approximately 9% of the region's GDP and it employs over 18 million people. The failure to recognize the need to transform will put eventually at risk the sustainability of the "change resistant" construction companies.

To address this problem, during the last years, the construction industry is trying to transform by emerging technologies with great potential for the development of ICT, enabling new players to adapt and to take advantage of the opportunities that are emerging. Building Information Modeling (BIM) is a revolutionary technology that is characterized as the opportunity of the Architecture -Engineering - Construction (AEC) industry to move to the new digital era, with potential to reduce cost, project delivery time and increase productivity, as it provides automation capabilities for more integrated communication, data exchange and sharing between project actors within a virtual 3D environment (Gu, N., & London, K., 2010).

Beyond the smart devices and services that has been developed in a smart city, the documentation of the characteristics of a building, through Building Information Modeling (BIM) in combination with the collected data from smart devices and the intelligent applications developed, will be the basis of the IoT platforms and the provided services in the integrated digital ecosystem. The designed virtual models (produced by a BIM – Building Information Modeling – process) and as-delivered physical assets (monitored in real-time, i.e. through BMS – Building Management Systems) (Pasini et al., 2016) could adopt an IoT framework, which consists in a data model for network of equipment, sensors (building automation), wearables.

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