

## Chapter 2

# Smart City and Digital Twins: Definitions, Methodologies, and Applications

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### **ABSTRACT**

*The chapter proposed aims at facing the various implications underlying the smart city concept based on digital twins. The structure of the text is articulated in three main themes: the use of the term “smart city” and the role that technologies had in its definition; the “3D city model” meaning and the integration procedures between BIM (building information modeling) and GIS (geographic information system); the classification of 3D city models by use cases. The chapter can provide researchers with a detailed dissertation aimed at clarifying both the theoretical and technical features belonging to smart city and its related innovative technologies.*

### **INTRODUCTION**

The “Smart City” definition was coined in the last decades due to the necessity to incorporate into the urban design discipline the issues related to sustainability, social inclusion and new internet technologies. Smart City is, in fact, a relevant new concept that has been adopted not only in developed countries but also in developing countries. The concept aimed at fostering a sustainable city development through the optimal management of the resources, offering a comprehensive, high-quality life for the citizen (Vasileva et al., 2016). The governance of the contemporary city has to deal with social, economic, political and technical dynamics that are strictly related and profoundly influence each other. Understanding the complexity of this phenomenon requires an indispensable connection between scientific disciplines and humanities (Ferraris, 2018) then today, more than ever, the design should incorporate a wave of relational and technical knowledge, and it should be described in its complexity as a product of negotiation between actors, rules, laws and collective will (Armando & Durbiano, 2017). City governance can not be intended anymore as a deterministic matter based on standards and index for its regulation. However, the city has

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to be considered as the place where life, relationship and communication develop. Communication plays a crucial role in the city discourse has been improved in the recent years by growing digital products and their power in influencing our daily working habits, teamwork relationships, creative process and a wide range of human products (Floridi, 2011). Information and Communications Technology (ICT) and its power in transmission, reception and processing of data and information are increasingly influencing the method to transform the industry of architecture, engineering and construction (AEC). Therefore, it must be deepened the discourse concerning the methodologies through which is it possible to manage the architectural and the environmental entities belonging to the city. In this field, Building information modelling (BIM) and geographical information systems (GIS) are gaining importance due to the fact that by the integration of the micro-level buildings themselves and the macro-level representation of the external environments of buildings is it possible to establish a comprehensive view of the built environment based on data integrated. This chapter, therefore, presents a broad reflection focused on the description of definitions, methodologies and applications that can be considered to achieve the Smart City goals. In particular, the Smart City issues will be deepened by the following three levels: the social and the environmental dynamics underlying the contemporary city, the technical innovations in design practice that led to the creation of urban digital twins, the applications of digital city models for urban governance.

## **Background**

The chapter seeks to describe the state of the art regarding the definition, the methodologies and the applications to achieve the Smart City goals. To address this challenge it has been collected several critical and technical publications belonging to the sector of Smart City, in particular by following these topics: the contemporary city governance, the Digital Twin concept, the technical integration between BIM and GIS and digital applications for urban transformations. Following this framework, the first objective of the chapter is to clarify the meaning of the Smart City concept (Mohanty et al., 2016), the historical evolution of it (Hénard, 1910; Eremia, 2017; Aurigi, 2005; Brockwell & Horrocks, 2020) and the role of the smart technologies in it (Mohanty et al., 2016; Kolarevic, 2003). The second objective is to clarify the role of BIM and GIS in terms of city management. The discourse is addressed considering both the single methodology (Bolton, 2018; Hao et al., 2019) and the integration of their data-driven models by facing the issues related to a different scale, datasets, detail of information and visualization (AIA, 2008; Gröger et al., 2019). The last objective of the chapter is providing a review of the increasing types of applications of 3D city models, focused on visualization and spatial planning (Batty, 2000; Biljecki et al., 2015; Ross, 2000; Saran et al., 2018). Moreover, the chapter provides a taxonomy of virtual models use cases (Biljecki et al., 2015) to show thematic simulations over the city (Bahu et al., 2013; Kurakula, 2007; Chen, 2011; Kaden & Kolbe, 2014).

## **The Smart City Concept and the Role of the Internet Technologies**

The first objective is to clarify the meaning of smart city and to highlight the social dynamics that led to its definition. In a simplistic explanation, a Smart City is a place where traditional networks and services are made more usable, efficient, and sustainable with the use of information, digital and telecommunication technologies, to improve its operations for the benefit of its inhabitants. The different components

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