

# Chapter 8

## The Role of Digital Twin in Accelerating the Digital Transformation of Smart Cities: Case Studies in China

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### **ABSTRACT**

*Cities are crucial carriers of economic prosperity and social development. With the approaching Society 5.0, the digital twin city has become the mainstream model for the construction of new smart cities. Digital twins, along with the internet of things, fifth-generation wireless systems, and artificial intelligence technologies, offer great potential in the transformation of the current urban governance paradigm toward smart cities. This chapter will explore the imperative role of digital twin in accelerating digital transformation of smart cities. From the perspective of the overall policy, the industry, and application of the said technology, this chapter gives insight into the development trend of digital twin cities. Additionally, through case studies of the two most outstanding digital pilot regions in China, the chapter investigates the role of digital twin in accelerating digital transformation of smart cities such as the technical approaches on city information modeling (CIM) and building information modeling (BIM).*

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## INTRODUCTION

The world is at an unprecedented level of urbanization. The United Nations (2018) estimates that 68 percent of the world's population will live in urban areas by 2050. As a result of the rapid growth in the rate of urbanization, cities face huge challenges in meeting the housing, infrastructure, transport, and energy needs of their urban populations, and urgently require new ideas and methods to solve these issues (World Economic Forum, 2022).

Digital transformation is an inevitable choice for urban governance. Each major technological breakthrough has redefined the world landscape. Mergel et al. (2019) interviewed governments in several countries and the majority of the respondents noted that digital transformation is driven by the external environment (83%) rather than by internal pressures. Modern information and communication processes become an important force for social evolution (Mergel et al., 2019). The revolution has greatly increased the productivity of cities. The efficiency of these cities attracted labor, and the concentration of labor in turn increased the productivity of the cities.

Over the past 20 years, the concept of smart cities has become almost globally known and people have started to think about innovative ways of developing smart cities. Zheng et al. (2020) reviewed 7,840 studies on smart cities between 1990 and 2019. The authors noted that sustainability and sustainable development have become popular topics not only among scholars, especially in the fields of environmental economics, technology and science, urban planning, development, and management, but also among urban policy makers and professional practitioners. Caragliu and Del Bo (2019) consider smart cities as complex systems that involve symbiotic connections between people, institutions, technologies, organizations, the built environment, and physical infrastructure. Smart cities use data and technology to improve efficiency and sustainability, and to enhance the quality of life and the experience of working in a city (Albino et al., 2015). With information and communications technology (ICT), smart cities can be applied more effectively to support economies and societies. Bifulco et al. (2016) see ICT as a set of tools for the governance and management of cities and metropolitan areas.

The digital twin is the inevitable goal of digital transformation. The concept of the digital twin was introduced by Professor Grieves in 2003 during a product lifecycle management course at the University of Michigan. The digital twin consists of three key components: 1) the physical product, 2) the virtual product and 3) the connections that link them. Digital twins fully describe potential or actual physical manufactured products from the micro-atomic level to the macro-geometric level (Grieves & Vickers, 2017). Digital twin technologies deeply integrate hardware, software and Internet of Things (IoT) technologies to enrich and refine virtual entities.

Digital twin technology has been developed over nearly two decades and is used not only in manufacturing but also in many other industries and public life. Digital Twin Cities (DTCs) is a new mode of urban development and management based on DTCs technology, and its concept is gradually becoming clear.

Table 1 summarizes the development process of DTCs in recent years. From the early stages of conceptualization and experimentation to the emergence of large-scale pilot projects and the establishment of standards and frameworks, DTCs have become an increasingly important aspect of urban planning and management. The evolution of DTCs has been marked by a focus on data integration, citizen engagement, and sustainability.

China's DTC construction market has great vitality. According to statistics, the total investment scale of China's new smart cities in 2020 was about RMB 2.4 trillion (or 0.38 trillion USD). China's City Information Modelling (CIM) construction projects have shown a trend of rapid growth year on year, with

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