Chapter 4
The DIM Approach for Digital Twin

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ABSTRACT

In the era of connections and information and communication technologies, the building industry is facing the challenge of digitization at the building and urban scale. Several researches have been carried out to generate virtual city models to manage and represent a variety of data to reach the smart city concept. Therefore, the development of building/urban digital twins is directly linked to the definition of innovative methods and tools that are able to collect, organize, query heterogeneous data to make it available for the various involved actors. This chapter aims at presenting the district information modelling methodology that is strictly related to the digital twin concept, starting with data domains, arriving at the various tools developed to reach the users' needs.

INTRODUCTION

Nowadays, Architecture Engineering Construction, and Operations (AECO) industry is crossing a transition period driven by digitalization. The building industry community is investing a considerable effort together with researchers who are investigating in depth the issue of using digital technologies and digitized data to impact how to work and its products get improved. The driving impulse of the construction sector digitization is due to several factors linked to climate change and current economic conditions. The growing demand for energy from existing buildings and the consequent increase of pollution in cities have led the various states and the European Commission to call for new standards to improve the liveability of urban spaces by optimizing the management of available resources. In these terms, the fourth industrial revolution (Industry 4.0) has introduced digital technologies, sensor systems, intelligent machines, and smart materials to the construction industry to increase knowledge of the existing architectural heritage and to improve it with strategies oriented towards structural reliability and energy efficiency. Recently, an amendment of the directive on the Energy Performance of Buildings (EPBD)

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encourages each EU Member State at accelerating the cost-effective renovation of existing buildings, both public and private, into a highly energy-efficient and decarbonized building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings (2018/844/EU). In this area, several researchers are studying the best processes and tools to transform existing cities into smart cities that European Commission defines as places where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business. Besides, the achievement of a smart city implies the active involvement of private and public administrations and citizens with their habits. What said before highlights the need to develop systems capable of linking data stored in various databases and providing it to various users. So, it is clear that data management is gaining an essential role in the smart city field to optimize energy saving at building and urban level.

Several projects have been recently developed in order to face the lack of systems where all-district and building-related data is collected in a common digital repository able to be enriched and queried to define new policies towards smart cities framework. Within this context, the European 7th Framework Programme (EU FP7) District Information Modelling and Management for Energy Reduction (DIMMER) project aims at managing all district-related data through the DIMMER platform, available to all the stakeholders involved at the district level. The interoperable process makes the data exchange possible.

BACKGROUND

The city has always been considered as a meeting place where a series of complex dynamics linked to human beings' habits take place. From this point of view, it can be considered a living organism that transforms itself into the function of the society that inhabits it (Pagani & Chiesa, 2017). Vice versa, the population adapts itself to the city in which it lives, assuming behaviors that could change in another city according to its characteristics. The urban transformations that have taken place over the centuries have been driven both by the growing needs of citizens and by the technological innovation that has developed throughout history.

Over the centuries, the management of the city has been subjected to the needs of the population, which in different forms modified the urban ecosystem to improve the usability of space and optimize human activities, finding answers to the need for transformation and urban renewal according to the lifestyle of citizens and the adopted technologies.

These transformations have been often influenced by the demographic, industrial, and economic growth of countries, ignoring the aspects related to the sustainability of interventions, thus developing not very resilient cities to climate change and exceptional events caused by land degradation.

However, in recent years, more attention has been paid to the capacity of cities and buildings to adapt to climate and socio-economic change by setting several constraints to be respected on environmental sustainability.

In this sense, the EPBD directive refers to Smart Ready Technologies (SRT) which should be disseminated in the existing building stock to achieve significant energy savings with a consequent economic gain, while helping to improve indoor thermal comfort so that the building can adapt its energy behavior considering the user's needs.

Currently, the EPBD requires the development of a voluntary European rating scheme to assess the intelligent readiness of buildings, called Smart Readiness Indicator(SRI). It aims at making the added