



# The future of cities

## How Digital Twins are transforming Smart Cities

**Cities are the beating heart of society. Over the years, they have developed into complex systems, which is why improving their sustainability is a challenging task. The use of Digital Twins can help and promote quality of life and sustainability in urban areas. Fraunhofer IESE has the necessary expertise to support cities on their way to becoming Smart Cities.**

### The concept of the Smart City

Cities should not just be seen as a collection of physical units. Rather, they are a system of interlocking building blocks that can respond to the needs of their inhabitants and the dynamics of their environment and communicate with each other. With advances in information technology and digitalization, the concept of the Smart City has been introduced to cleverly connect these units and create added value. Smart Cities use digital technologies, communication technologies and data analytics to build and expand an efficient and effective service environment that improves urban quality of life and promotes sustainability. These technologies can be used in various areas such as healthcare, mobility, education and administration.

### The heart of the Smart City

An urban Digital Twin is a digital model of a planned or actual physical product, system or process. This model uses live data from sensors distributed throughout the city to visualize and simulate the behavior of various components of the city. For example, data on the traffic volume or the parking situation at certain times of the day. Urban Digital Twins have a remarkable impact on improving the sustainability of cities. With the help of the data they collect and the analyses they perform, it is possible to gain a deep understanding of the conditions on the ground and recognize how the various entities interact with each other and with the environment currently and in different scenarios.

All of this helps to maintain the three pillars of sustainability – social, environmental and economic sustainability – and promote lasting urban development.

### The three pillars of sustainability

#### **1. Social sustainability**

Social sustainability revolves around the preservation and development of social capital. The use of Digital Twins in digital city administration applications can facilitate citizen participation and support a collaborative decision-making process. A good example of this is a Digital Twin for urban planning, which is used to plan facilities such as clinics, markets and cafés. If the city planner can merge the requests and wishes of citizens directly with the knowledge of the condition and requirements of local facilities through the Digital Twin, they can find the best location that meets the needs of the population.

#### **2. Environmental sustainability**

Protecting the environment and preserving the ecosystem are the main objectives of environmental sustainability. Digital Twins can help mitigate the effects of some climate change-related disasters, such as floods or heat waves, and protect the environment. For example, by placing sensors in the soil of green spaces, it is possible to continuously measure vital indicators such as soil moisture, air quality and temperature. These indicators play an important role in the preservation of the vegetation ecosystem, in which planning for the future is based on the measurement data collected and the scenarios developed from it.

#### **3. Economic sustainability**

Continuous monitoring of energy consumption data and information on people's needs and the state of the environment lead to more efficient use of resources. As a result, energy consumption can be minimized and economic and cost-effective units can be created in the city. This also has an impact on the attractiveness of the city as a place to live and do business.



A good example of how a city can significantly reduce energy consumption is the control of street lighting – depending on sunlight, time of day and traffic. The street lighting is dimmed on sunny days or even at night when the streets are empty and there is no traffic. This is done by installing optical sensors that calculate the desired lighting level via a central management system and then control the street lighting accordingly. In the village of Urdorf in Switzerland, for example, energy consumption has been reduced by 70 %.

### Turning sustainable cities into reality

The transformation to Smart Cities through the use of urban Digital Twins promises a lasting and livable future for urban areas: By taking social, ecological, and economic aspects into account, cities can be designed more efficiently and in a way that preserves resources. The Smart City experts at Fraunhofer IESE provide support in this regard by opening up a seamless transition between the analog and digital world and turning sustainable urban development into reality.

## Reading tip

### Study: Digital Twins – potential in urban development

An urban Digital Twin is a digital model of a city or district. For example, municipalities can use it to simulate traffic or the consequences of heavy rainfall and create other scenarios for urban development. A publication issued by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) entitled "Digital Twins – Potentials in urban development" shows how Digital Twins can be set up successfully.

The publication is the result of the accompanying research of the Coordination and Transfer Office Smart Cities (KTS). The Fraunhofer Institute for Experimental Software Engineering IESE and the Fraunhofer Institute for Industrial Engineering IAO jointly developed the study.

**Note:** Interested parties can access the German publication online or order a printed copy free of charge by email at: [publikationen.bbsr@bbr.bund.de](mailto:publikationen.bbsr@bbr.bund.de)

