# SMART CITIES FOR SUSTAINABILITY

## Approaches and Solutions

**Edited by** Mohammed El Amine Abdelli, Asma Sghaier, Atilla Akbaba, Samia Chehbi Gamoura and Hamid Doost Mohammadian

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# SMART CITIES FOR SUSTAINABILITY: APPROACHES AND SOLUTIONS

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Emerald Publishing Limited
Emerald Publishing, Floor 5, Northspring, 21-23 Wellington Street, Leeds LS1 4DL

First edition 2024



**British Library Cataloguing in Publication Data**
A catalogue record for this book is available from the British Library

ISBN: 978-1-80455-903-1 (Print)
ISBN: 978-1-80455-902-4 (Online)
ISBN: 978-1-80455-904-8 (Epub)

ISSN: 1877-6361 (Series)

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# SMART CITIES AND TECHNOLOGIES

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# POST-PANDEMIC URBAN PLANNING AND USE OF INFORMATION TECHNOLOGIES IN SMART CITIES

Seher Konak

## ABSTRACT

*Today, the rapid increase in the population living in cities and new developments in information and communication technologies (ICTs) increase the demand for smart cities day by day. It is thought that limited public resources and crowded cities will be managed better by making more use of the opportunities offered by smart technologies. At this point, many countries around the world are turning to smart city applications. Especially after the Covid-19 pandemic, local governments have started to give importance to smart city projects due to the advantages of smart cities. It is thought that urban planning against epidemics will gain more importance in the coming years.*

**Keywords**: Smart city; information technologies; artificial intelligence; urban planning

## 1. INTRODUCTION

In cities, which are an important living space, it is important to include urban transformation models in this process for increasing social welfare levels and creating a more livable environment (Karayılmaz & Özker, 2020). According to 2016 United Nations World Urbanization report data, the period we are in is defined as "the most striking urban growth period in history". Accordingly, it is expected that 66% of the world population will live in urban areas by 2050.[1] The difficulty here is to provide this population with basic resources such as sufficient energy, clean water, and safe food while ensuring economic, social, and environmental sustainability (Lai et al., 2020). Also, cities which cover only 3% of the earth's surface consume 70% of energy production and produce 75% of carbon emissions.[2] Herewith, smart cities applications in the world are important.

[1] www.un.org.tr
[2] www.un.org.tr

**Smart Cities for Sustainability**
**Advanced Series in Management, Volume 32, 3–14**

**ISSN: 1877-6361/doi:10.1108/S1877-636120230000033002**

Smart cities, the changes after the Covid-19 epidemic (socioeconomic, demographic etc.), the Ukraine–Russia war, and the energy crisis that emerged in Europe are a reflection of the dramatic changes in the quality of life and are seen as a potential solution to the problems. It is necessary to develop effective solutions against globalization, urbanization, climate crisis, and epidemics in the twenty-first century. Therefore, urban planning is important against epidemics. It is possible to determine the needs of cities correctly and to meet these needs in a sustainable way with smart solutions (Örselli & Akbay, 2019). The smart cities approach will ensure the further development of cities by applying the Internet of Things (IoT) to the economy, management, and environment. It is important that safe and cost-effective services are applicable in these cities with information technology infrastructure.

Covid-19 is the disease caused by a new coronavirus called SARS-CoV-2, which first appeared in China on December 31, 2019 (WHO, 2021). According to the report published by United Nations Habitat in April 2020, a total of 1,430 cities in 210 countries were affected by the Covid-19 outbreak, with 95% of the cases occurring in urban areas (UN Habitat, 2021). Population density in cities may be higher than in rural areas due to the possibilities of people living in cities to encounter epidemics and inequalities in access to services, lack of infrastructure, migration, and urban poverty (Diez Roux, 2015). The Covid-19 epidemic has greatly affected and changed the way we behave in our living spaces (such as accommodation, work, entertainment, cultural and sports activities) (Şolt, 2021). As a result of the transmission of the disease through human-to-human contact in general, it has caused a faster spread, especially in urban areas. For this reason, urban areas are among the areas where measures should be taken to reduce the spread of epidemic crisis on a national and international scale (Budak & veSezgin, 2021). It is necessary to adopt the smart city approach in many parts of the world and to start using and adapting new technological tools in these cities with the developing technology (Allam & David, 2020). These technologies play an important role in controlling and effectively managing epidemics (Gretzel, Sigala, Xiang, & Koo, 2015).

Technological innovations with smart city thinking claim to transform urban space. Smart city applications that have reached technological maturity are highlighted with an aggressive marketing strategy. The emphasis is on energy efficiency, smart infrastructure, open data, open networks, seamless access, and transformative mobile services (Velibeyoğlu, 2019).

According to the European Union (2011), the concept of smart city supports the idea of environmental sustainability because the main purpose of smart cities is to reduce greenhouse gas emissions in urban areas through innovative technologies. The growing interest in the concept of the smart city and the need to solve the challenges of urbanization lead to various private and public investments in this area (Lee & Hancock, 2012). Today, it is seen that there are over 1,000 smart city projects around the world (Karayılmaz & Özker, 2020).

Singapore, Seoul, London, Barcelona, and Helsinki were at the top of the Top 50 Smart City Government rankings for 2020/2021 as published by the Eden Strategy Institute.[3] These smart cities offer great opportunities for businesses to collaborate with public authorities who are willing to leverage the private sector's expertise in systems design and strategic management. For instance, authorities in Moncton, Canada, announced a comprehensive green city project aimed at promoting public transport,

[3]www.smartcitygovt.com

cycling, and more recycling. LED traffic lights were installed throughout the city, and electric cars were provided for city services (Barrionuevo, Berrone, & Ricart, 2012). Following the devastating floods and landslides that hit Rio de Janeiro in 2010, a $14 million smart operations center equipped with cutting-edge disaster management technology was established in the city.

Due to this system, the city's traffic flow and public transportation systems can be controlled and power cuts can be managed. Rio de Janeiro has become one of the metropolises that uses smart resources to streamline their daily operations and improve the quality of life of their citizens (Barrionuevo et al., 2012). In this section, first of all, the definition of smart cities will be made, and the features of smart cities will be mentioned. Then, the information technologies that are the basis of smart cities will be mentioned, and examples of smart cities applications in the world will be given.

## 2. DEFINITION OF SMART CITY

The origin of the smart city idea is based on the smart growth movement at the end of the 1990s. This movement advocated creating new policies for urban planning. After the 2000s, the concept of smart city has been adopted by various technology companies (Siemens, IBM, etc.) and has been used to describe the integration of complex information systems into buildings, transportation, public safety, communication, and urban infrastructure and services such as electricity–water distribution level (Harrison & Donnelly, 2011).

The concept of smart city first emerged in 1994 (Dameri & Cocchia, 2013), and since 2010, smart city projects which have been encouraged by the European Union managed to stay on the agenda (Jucevicius, Patašienė, & Patašius, 2014). A few years later, Management Center at the University of Ottawa began to criticize the idea of smart cities for being too technical. There upon, researchers wanted to reveal the hidden aspects behind the term "smart city" (Hollands, 2008). Today, a smart city is generally defined as a city that uses information and communication technologies (ICTs), new urban infrastructure to improve service, and thus makes the life of local people (citizens) more comfortable, including improving the ecological situation (Dolinina, Pechenkin, Gubin, & Kushnikov, 2018, p. 3). In this context, smart city provides health benefits to a community with improved and educational options, greater security, social and political systems, economic prosperity, better housing, education, communication, energy, and other helpful resources (Pelton & Singh, 2019).

Similar concepts such as "intelligent city," "sustainable city," "green city," "knowledge city," "wired city," or "digital city" are used, which overlap with smart city (Albino, Berardi, & Dangelico, 2015; Camero & Alba, 2019). The concept of smart city is examined in three dimensions: technology, people, and society (Harrison et al., 2010). There is no generally accepted definition of the term of smart city. However, among the common elements frequently used in definitions, adaptation to innovative technologies, use of big data, and cooperation with urban actors are at the forefront (Köseoğlu & Demirci, 2018). The smart city is an urban development model that expresses the use of human, collective, and technological capital (Angelidou, 2014). In this context, the smart city is defined as "an ultra-modern urban area that caters to the needs of businesses, institutions, and especially citizens" (Khatoun & Zeadally, 2016). Planning a smart city, the accuracy of technology, its compatibility with changing demographics, education and health needs, employment opportunities, and adaptable infrastructure systems should be taken into consideration.

Studies such as intelligent data analysis, computer simulation, etc., allow the estimation of results (Pelton & Singh, 2019).

It is important to identify some infrastructure and superstructure factors in order to understand the projects implemented within the framework of the smart city concept. These factors can be divided into internal and external factors that have an impact on various stages within the scope of the attempt to intellectualize the urban space. Projects developed for smart cities should focus on building urban space infrastructure and organizational systems based on modern technologies that can solve emerging problems. In these projects, management and organization, technologies, policy, social communities, economy, infrastructure, and natural environment factors are taken into account (Chourabi et al., 2012).

Conceptually, while megacities research explains the reason for the growth of urban areas, the smart cities debate advocates sustainability. Considering the basis of smart cities research, namely the goal of ICT, the well-being of citizens, and sustainability, smart cities research is scalable, that is, it can cover a mega city, a regular city, or a village. For example, smart village research, which focuses on transferring the information obtained from smart city researches to rural areas, has just started (Visvizi & Lytras, 2018).

## 3. CHARACTERISTICS OF SMART CITY

In a study aiming to rank medium-sized cities in Europe according to smart city factors, six characteristics and 33 factors were identified. According to this, the features of smart cities have six: smart economy, smart people, smart governance, smart mobility, smart environment and smart living (Center of Regional Science, 2007, p. 11).

The "Smart Cities Wheel (SCW)" method of Cohen (2014), which is one of the approaches to smart cities, has been accepted by the European Union and consists of six components. These are:

(1) Smart Mobility: It includes comprehensive transport systems for passengers, drivers, and operators as well as integrated environmentally friendly and modern and sustainable transport systems, especially for disadvantaged individuals.
(2) Smart Living: It includes various aspects of the quality of life of the citizens such as culture, health, safety, and housing.
(3) Smart Governance: Political participation, services for citizens, and practices aimed at providing transparency in public administration are established.
(4) Smart Environment: It refers to attractive natural conditions such as climate, green space, pollution level, resource management, and efforts to protect the environment.
(5) Smart Economy: It includes all the elements of economic competitiveness such as innovation, entrepreneurship, trademarks, productivity and flexibility of the labor market, and integration in the international market.
(6) Smart People: This feature, together with the qualifications and educational level of the citizens, refers to the quality of social interactions related to integration and public life and openness to the "outside" world.

According to Nam and Pardo (2011), a smart city has three components: technology, people, and institutions. Based on the link between these factors, a smart city can emerge when investments in human capital and information technology infrastructure support

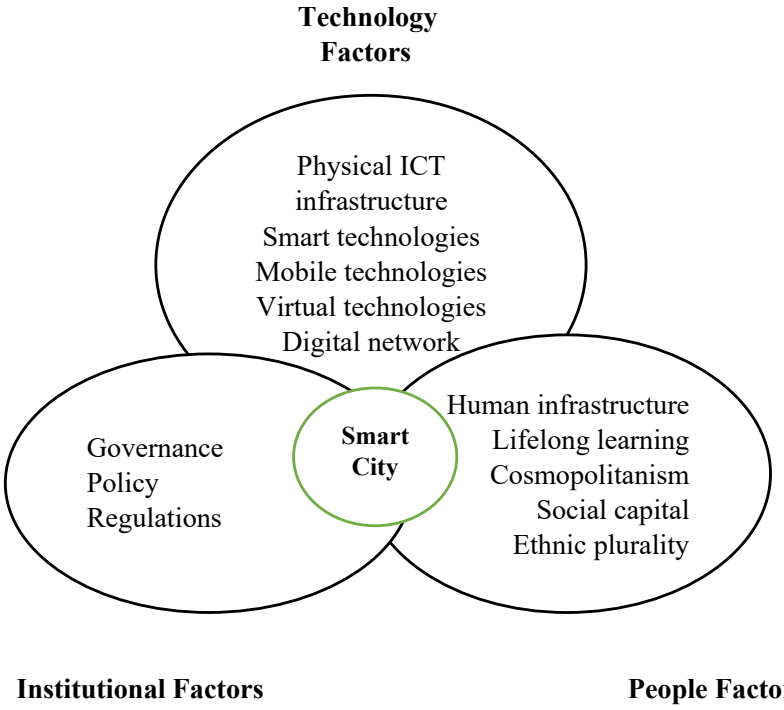


*Fig. 1.1.* Key Components of a Smart City. *Resource:* Samih (2019, p. 6).

sustainable growth and positively affect quality of life through the institutional factor. Fig. 1.1 shows the connections and subcomponents between these three components.

## 4. INFORMATION TECHNOLOGIES AT THE FOUNDATION OF SMART CITIES

Smart cities are people-oriented, have strong social services, have good governance, and have developed service areas and living standards. It is seen that these cities are not based solely on technological developments, but the concept is evaluated from a broad perspective based on the information and communication qualities of the society (Çelikyay, 2008).

Three key trends have emerged in smart city technologies: (1) the transition to wireless communication; (2) cloud computing, machine learning (ML), and smart data analytics; and (3) the development of the concept of smart technology in city security systems (Jameel, Ali, & Ali, 2019).

With the effect of digital transformation experienced today, innovative technologies that are at the core of smart cities come to the fore. Especially in recent years, big data, data mining, IoT, cloud computing, and Industry 4.0 are widely used in smart cities to solve urban problems (Köseoğlu & Demirci, 2018). Fig. 1.2 shows the relationship of smart technologies, including big data and cloud computing, with smart city applications.

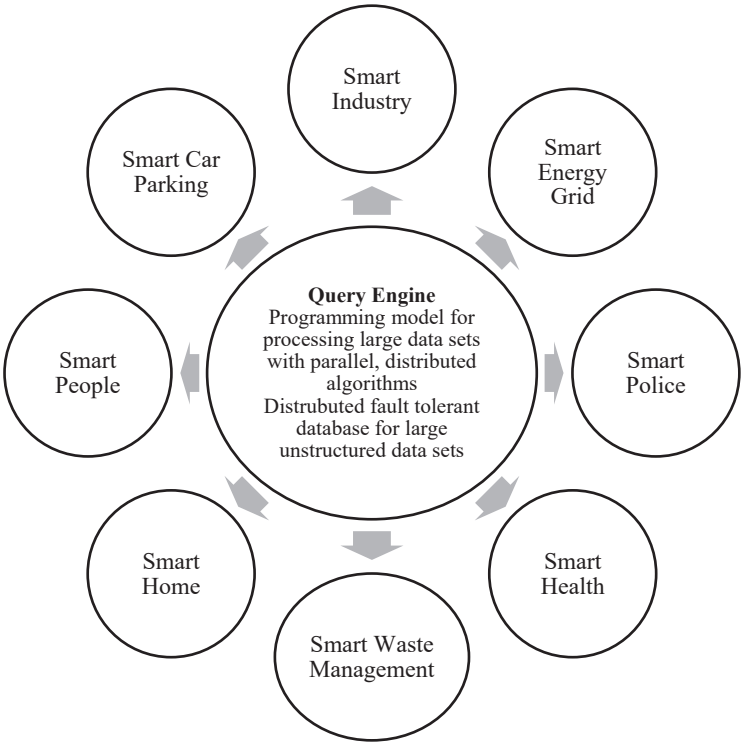


*Fig. 1.2.* Smart City Paradigms. Based upon: Hashem et al. (2016, p. 749).

According to Fig. 1.2, various smart applications share information by using sensors and other tools integrated with the cloud computing infrastructure to generate large amounts of unstructured data. This large amount of unstructured data is collected and stored in the cloud or data centers using fault tolerant databases. Thus, parallel algorithms and programming models are used to process large data sets, and data analytics are used to generate values from stored data (Hashem et al., 2016, p. 748). At this point, data mining technologies are used. In addition, due to the IoT, a variety of data is produced by many different actors such as individual users, private companies, city residents, and public institutions (Köseoğlu & Demirci, 2018). In Section 4.1, smart technologies used in smart cities will be explained.

### *4.1 Big Data and Data Mining*

E-commerce on the internet, messaging, location sharing, all kinds of interaction, and communication through e-applications digitally produce and record high volumes of data without the knowledge or awareness of users (McKinsey, 2013). Everything that is recorded by modern ICTs, such as network sensors, smart objects and devices, and web and social media, constitutes big data (Rabari & Storper, 2015).

Data mining, on the other hand, is the application of ML algorithms with the help of various software packages on a smaller data set to help decision-makers make