ARTIFICIAL INTELLIGENCE PERSPECTIVE FOR SMART CITIES

Edited by
Vahap Tecim
Sezer Bozkus Kahyaoglu

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Artificial Intelligence Perspective for Smart Cities

The concept of a "smart city" is used widely in general; however, it is hard to explain because of the complexity and multidimensionality of this notion. However, the essential qualification for being a smart city is to achieve "sustainable social, environmental, and economic development" and boost the living standards of society based on Information and Communication Technology (ICT) and Artificial intelligence (AI). AI in smart cities has become an important aspect for cities that face great challenges to make smart decisions for social well-being, particularly cybersecurity and corporate sustainability. In this context, we aim to contribute literature with a value-added approach where various AI applications of smart cities are discussed from a different perspective. First, we start by discussing the conceptual design, modeling, and determination of components for the sustainability of a smart city structure. Since smart cities operate on spatial-based data, it is important to design, operate, and manage smart city elements using Geographical Information Systems (GIS) technologies. Second, we define the structure, type, unit, and functionality of the layers to be placed on the GIS to achieve best practices based on Industry 4.0 components. Transportation is one of the key indicators of smart cities, so it is critical to make transportation in smart cities accessible for different disabled groups by using AI technologies. Third, we demonstrate what kinds of technologies should be used for which disabled groups in different transportation vehicles with specific examples. Finally, we create a discussion platform for processes and sub-processes such as waste management, emergency management, risk management, and data management for establishing smart cities including the financial and ethical aspects.

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Contents

Abbreviations

ABIS	Disaster Information System
AFAD	The Disaster and Emergency Management Presidency
AI	Artificial Intelligence
AIDR	Australian Institute Disaster Resilience
AKOMAS	Akom Disaster Information System
ANN	Artificial Neural Network
AYDES	Disaster Management and Resolution Support System
BMC	Building Information System
BSI	The British Standards Institute
CAD	Computer-Aided Design
CBA	Cost-Benefit Analysis
CDD	Canadian Disaster Database
CDEMA	Caribbean Disaster Emergency Management Agency
CE-DAT	Complex Emergency Database
CEO	Chief Executive Officer
CIA	Confidentiality, Integrity, and Availability
CNN	Convolutional Neural Network
CO_2	Carbon Dioxide
CPS	Cyber-Physical Systems
CRED	Centre for Research on the Epidemiology of Disasters
DDoS	Distributed Denial-Of-Service Attack
DEMs	Digital Elevation Models
DIKW	Data, Information, Knowledge, Wisdom
DKS	Disorder Control Assistant
DL	Deep Learning
DOD	Department of Defense
DoS	Denial of Service
DPIA	Data Protection Impact Assessment
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSS	Decision Support Systems
EM	Emergency Management
EM-DAT	Emergency Events Database

ENA	Energy Networks Association
EP	European Parliament
EU	European Union
GDPR	General Data Protection Regulation
GeoAI	Geospatial Artificial Intelligence
GIS	Geographical Information Systems
GLA	Greater London Authority
GLIDE	Global IDEntifier Number
GO bond	General obligation bond
GPS	Global Positioning System
IBM	International Business Machines
ICT	Information and Communication Technologies
IEEE	Institute of Electrical and Electronics Engineers
IJGPPA	International Journal of Governance and Public Policy Analysis
IKAS	Integrated Contraction Alarm System
IoS	Internet of Services
IoT	Internet of Things
IRB	Industrial Revenue Bond
IS	Information Systems
IT	Information Technology
LVC	Land-Value Capture
M2M	Machine-to-machine
MiTM	Man-in-The-Middle
ML	Machine Learning
NLP	Natural Language Processing
OECD	Organization for Economic Co-operation and Development
OHCHR	Office of the United Nations High Commissioner for Human Rights
OWASP	The Open Web Application Security Project
PPP	Public–Private Partnership
RFID	Radio Frequency Identification
SAP HANA	SAP High-Performance Analytic Appliance
SC	Smart City
SCADA	Supervisory Control and Data Acquisition
SCW	Smart Cities Wheel
SDKs	Software Development Kit
SIB	Social Impact Bond
SNS	Social Networking Services
SQL	Structured Query Language
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TIF	Tax-increment financing
TISN	Trusted Information Sharing Network
TMS	Traffic Management System
UK	United Kingdom

UNDG	United Nations Development Group
UNDRR	United Nations Office for Disaster Risk Reduction
UNESCO	United Nations Educational, Scientific and Cultural Organization
US	United States of America
WM	Waste management
WSN	Wireless Sensor Networks
WSNs	Wireless Sensor Networks
XSS	Cross-Site Scripting

Foreword

As the first quarter of the twenty-first century draws to a close, many governments' urban strategy agendas necessarily include discussion of and planning for the "smart city" phenomenon. This is particularly the case in developed countries, where rapid growth in urban areas requires contending with complex infrastructural, environmental, and social problems. Smart cities are being piloted as citizens around the world demand that local governments design urban spaces that improve their quality of life.

Creating smart cities is a complex challenge, one that demands contending with many discrete areas of focus, from the physical capital of the city to its intellectual and social capital. Urban planning is not only a matter of urban design but also incorporates social science, political science, and economics. Importantly, smart city creation is supported by technology driven by advances and innovation in computer science and engineering that stimulate sustainable socio-economic development. The capacity to innovate itself is shaped by a host of factors, such as the development and adoption of information and communication technologies (ICT), living standards, residents' readiness, and willingness to invest. Higher rates of urbanization and large "mega-cities" with 10 million or more residents make the task of creating sustainable and affordable environments with a high quality of life a pressing need, but one with even more difficulties.

Smart cities and the use of artificial intelligence (AI) have been among the key topics centered in urban policy discussions. Yet, attempts to use AI to increase efficiency in cities have foundered, failing to succeed in producing smart cities. This is mostly attributable to largely myopic, reductionist, technologically deterministic AI approaches applied to complex urbanization problems that belie simplistic solutions. Thus, while the use of smart city technologies has the promise of revolutionizing urban life, private sector actors that supply and develop these systems for public sector need to consider these unique factors.

This book provides readers with the conceptual and practical knowledge base to grasp and apply the fundamental principles required in the planning, design, and operations of smart cities. Each chapter of the book examines an interesting topic in terms of promoting smart city networks of the future.

The special feature of this book is that it serves as an open platform of expression for all its authors to present their views, understandings, and conclusions on this complex but fascinating subject.

We would like to express our special thanks to all the authors who contributed to all chapters in this book, and to all the authors who participated in this collective effort.

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Chapter 1

AI perspective for smart cities

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CONTENTS

1.1 INTRODUCTION

The areas that are most affected and focused by the rapid change and digital transformation in the world are the cities that affect the living conditions of societies with high levels of welfare. For this reason, it is possible to obtain information about the level of development depending on how cities are managed and structured. Being aware of this situation, technology-producing companies make important projects and investments to implement innovations and technological products in cities and connected urban living spaces.

In this study, our aim is to reveal the innovative projects and investments made within the scope of smart cities and urbanization in the world and especially the studies on the AI application areas where these are made functional. Thus, by providing technical information about the current situation of smart cities and urbanization, it will be possible to present predictions and policy recommendations for the future. In this way, it is our main goal to contribute to humanity and science.

It is a fact that there are many works in the literature on smart cities. The distinguishing aspect of this study is to reflect the artificial intelligence (AI) point of view and to reveal the necessary elements in smart city design as a whole. Therefore, this book has been prepared by working with an interdisciplinary team to which the chapter authors of the book contribute based on their areas of expertise.

In this work, the content has been prepared with a modular and interdisciplinary structure that evaluates the concept of smart city from different perspectives based on AI applications. Hence, the study is designed with the aim of presenting the big picture based on the complementary content and

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the theme of smart cities in the axis of different usage areas of AI in each chapter. Accordingly, the book is organized as follows.

In Chapter 1, we made an introduction of all chapters and summarized the aim of this book. The introduction part contains brief and concise information, especially for the purpose of clearly stating the aims of our study and providing a correct orientation to the readers.

In Chapter 2, a general introduction to the topic of smart cities is given. In this context, conceptual design information for a typical smart city is presented. It also explains the key components of smart cities. According to Batty et al. (2012), the idea of "smart city" is defined based on the key concepts such as quality, ability, intelligence level, and social adaptation. European Parliament (EP) (2014) states that smart cities are the cities with undertakings that relate at least to one or more of the following concepts such as "smart management", "smart people", "smart life", "smart transportation", "smart economy", and "smart environment". In this respect, smart cities are commonly defined by information communication technologies, resource optimization, governance capability, economic development, urban infrastructure, and interconnectedness. In addition, smart city design alternatives are discussed.

In Chapter 3, why smart cities are transforming from digital to sustainable urban systems is discussed. In this context, future expectations are revealed by establishing a connection between the concept of smart city and the concept of sustainability. Thus, the "Eco-Urban Approach" is achieved. The essential way to achieve this is to create a smart city strategy. From this point of view, in this section, the strategy that smart cities should have is explained in detail. The positive and negative aspects of different approaches are also briefly discussed. The most important finding from this chapter is that to become a smart city, it is important to give priority to the field of sustainability and prepare the smart city strategy accordingly.

In Chapter 4, Geographic Information System (GIS)-based management of smart cities is discussed in detail. AI approaches that are frequently preferred in GIS applications used in the management of smart cities are explained. The use of AI methods together with advanced technologies for the benefit of society in the spatial modeling, analysis and visualization of phenomena is also explained. In this respect, the depths of space and the cyber world can be defined as "spatial intelligence" or "geospatial intelligence" which is essential for smart city applications (Dangermond and Goodchild, 2020).

In Chapter 5, the main topic defined as the connection between Industry 4.0 and smart city concepts is explained and application areas are emphasized. In this respect after explaining the basic issues related to industry 4.0, these topics are linked with smart cities. Examples of how smart cities can be developed with industry 4.0 applications are given in detail based on relevant literature. The factors affecting this situation are explained and their importance is emphasized. In order to reach this stage, it is stated that

some technical, managerial, economic, and social problems must be solved (Becic, 2020). The creation of the smart cities of the future can be put forward based on a governance approach based on the cooperation of many actors, primarily the informatics sector, the state, local governments, and the city's stakeholders. Therefore, this situation requires the correct definition of cooperation areas. In addition, while developing smart city policies, it is recommended to consider many factors such as technological problems, data security, confidentiality of private data, high costs, qualified manpower, and the level of technology adoption by service users and stakeholders (Batty et al., 2012).

In Chapter 6, one of the important features of smart cities is what kind of opportunities and facilitating environments they provide to the disabled. In this chapter, information about the services that can be provided for the disabled in transportation applications in smart cities is presented. First of all, traditional transportation activities and advanced transportation activities are explained, and the differences are revealed. In the framework of intelligent transportation techniques, it is stated in which areas AI can be used. Suggestions for the establishment of smart transportation systems and the transition process are presented. In addition, examples are given of places where disabled people need the most and try to reach in the city.

In Chapter 7, the conceptual framework for smart waste management (SWM) models is presented. In this context, it is explained how smart cities should established SWM systems. Research has been conducted on important studies in the literature on SWM via web of science. Waste management models based on AI applications and various techniques are introduced. The purpose of the systematic literature review is to identify the main problems and solutions in the literature while reviewing the research on waste management in smart cities. Thus, it is aimed to research and visualize the issues discussed in SWM and to guide future research in this field. This research is aimed to contribute to the literature both by identifying the gaps in the literature that are expected to guide future SWM studies and by revealing the current situation. The methodology covers the systematic review of the literature used, including research questions, search criteria, inclusion and exclusion criteria, and information extraction strategy. While introducing the technology necessary for SWM, the issues about which awareness should be raised are also discussed.

In Chapter 8, intelligent emergency management in smart cities is expressed as a basic requirement. The conceptual framework and importance of smart emergency service activities are explained. Recommendations are presented for the establishment of smart emergency service systems based on AI in smart cities. In this context, technological elements, infrastructure, and modeling approaches are explained from the perspective of AI. The basic problems encountered during the installation process of smart emergency service systems and what needs to be done are explained. Prospects and recent developments based on the literature are highlighted.

In Chapter 9, financing models that are needed to provide the necessary funding for the formation of smart cities are described. Determining and applying the right financing models can be expressed as a basic need for sustainable smart city investments. In this chapter, traditional and advanced financing models, and the advantages of applying advanced financing models are explained. The latest developments and new approaches in the world are revealed and suggestions are presented. Data monetizing, an IoT and AI-based financing method, is discussed which supports the financing of the investments by the income obtained from the sale of data to third parties. In addition, crowdfunding is defined as an instrument based on public funding through online platforms. Online crowdfunding platforms can receive support from AI technologies in the processes of launching campaigns, predicting donor behavior, displaying targeted ads, creating content, and verifying the identities of the campaigners. In addition, the use of blockchain technology and cryptocurrencies on these platforms is presented as making funding processes safer and more transparent. A striking case of the use of AI in finance is asset tokenization, that is, the process of digitizing assets on the blockchain. Tokenized securities, which are blockchain-embedded representations of real-world securities, can be effectively used to finance smart city infrastructure projects.

In Chapter 10, it is aimed to emphasize the importance of the usage of AI for reducing and/or eliminating possible disaster losses associated with disaster risk management (DRM) processes. In addition, this chapter focuses on the role of disaster risk reduction (DRR) as an important tool in the decision-making support system. This chapter extends the horizon in terms of the role of risk management in AI applications, the advantages, and disadvantages of the usage of AI in the DRR process, the use of Information and Communication Technologies (ICT) for reducing disaster risk in sustainable urban systems and also application examples. The effectiveness of public stakeholders in DRR process is discussed based on relevant literature. DRR policy recommendations are made for regional, national, and international needs and expectations.

In Chapter 11, a conceptual framework is presented for the correct understanding of the concept of data ethics and AI and the evolution process of AI standards in the process from the past to the present. It highlights the opportunities and threats that arise by explaining the main ethical issues in the application of AI, especially in the design of smart cities. There are many different parties and stakeholders involved in the management of smart cities. In this context, the importance of developing common approaches to emerging ethical problems is explained. The importance of determining the role and applications of AI in smart cities according to ethical standards is explained and how future expectations will develop is expressed based on the literature. Information on the accuracy of the data required for AI applications and the legal regulations regarding the level of compliance with ethical standards are presented. In addition, various examples are given by

presenting detailed information about social and ethical problems. Algorithms, which are an important element of AI applications, and the risks and ethical problems for algorithms are evaluated. In this context, by specifying the responsibilities of individuals and states, solutions to the main problems that may arise in the future are recommended.

In Chapter 12, the scope of data and information security in smart cities is defined and the key terms, definitions, and concepts that stand out in this context are explained. The issue of security in smart cities is discussed from the perspective of the generally accepted IoT (Internet of Things). The security needs of smart cities and what needs to be done in their design are stated in detail. Data security is emphasized as a basic requirement for the sustainability of smart city applications. Based on the literature, security measures in the face of problems that may arise in smart cities are discussed and policy recommendations are made.

REFERENCES

Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., … and Portugali, Y. (2012). Smart cities of the future. *The European Physical Journal Special Topics*, 214(1), 481–518.

Becic, A. (2020). Industry 4.0 and smart cities: State-of-the-art. *Defense and Security Studies*, 1, 34–43.

Dangermond, J. and Goodchild, M.F. (2020). Building geospatial infrastructure. *Geospatial Information Science*, 23(1), 1–9. DOI: 10.1080/10095020.2019.1698274

European Parliament (EP) (2014). Mapping Smart Cities in the EU. IP/A/ITRE/ST/2013-02. European Parliament E-studies (europa.eu).

Chapter 2

Conceptual design

Components of smart cities

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CONTENTS

In the conclusion of this chapter, the reader will understand

- Smart city conceptual design process
- Components of smart city
- Smart city design alternatives

2.1 INTRODUCTION

Smart city is a possible concept that can be hypothetically put forward as a target for all cities. However, in order to define a city as a smart city, a specific vision for that city should be revealed and a determined road map in line with this vision should be progressed. In this direction, it is necessary to define first what the concept of smart city means for that city. Many professionals make various definitions on the concept of smart city. It is important that cities agree to use a proper description, as this arranges the coverage and focus of a complex transformation journey. For instance, according to one definition, smart cities are systems that use information and communication technologies (ICT) to be smarter and more efficient in the use of

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sources, thereby providing energy savings, enhanced service encounter and standard of living, logrolling innovation and a low carbon economy.

In another definition, the concept of "Smart City" means opening new horizons in science, industry and commerce by using ICT, leading the transformation in the public sector, using information technologies effectively in the fields of management, trade and communication, and multi-participation oriented "e-governance" concept. It can also be defined as a system that provides smart physical spaces and infrastructures (Odendaal, 2003). The concept of "smart" in a smart city usually emphasizes quality, ability, intelligence level and social adaptation (Batty et al., 2012). The Smart Cities Council defines the community lands that use ICT to procure the livability and sustainability of the city as smart cities. Su et al. (2011) define smart cities as comprehensive digital cities and state that they relate to visual and measurable urban management and operations. Giffinger et al. (2007) emphasize on raising intelligent combinations of assets and activities of independent and conscious citizens who perform well in the economy, people, governance, mobility, environment and life.

Another study defines smart cities as secure settlements that monitor and combine all the conditions of the city's critical infrastructures such as interconnected and efficient city management, education, health, public security, real estate, transportation and public services, and better organize their resources (Washburn and Sindhu, 2010). The British Standards Institute (BSI) defines smart cities as settlements consisting of digital and human systems that are effectively integrated to offer their citizens a sustainable, prosperous and participatory future. Smart cities are emphasized as settlements that bring together areas that impress the development of cities such as economy, people, governance, mobility, environment and quality of life and try to be more livable and competitive with the use of new technologies, the development of innovations and management knowledge (UCLG, 2018).

According to the European Parliament (EP), smart cities are defined as cities with initiatives that address at least one or more of the following topics: smart management, smart people, smart life, smart transportation, smart economy and smart environment. Smart cities are mostly defined by information communication technologies, resource optimization, governance capability, economic development, urban infrastructure and interconnectedness. On the other hand, Cohen's "Smart Cities Wheel (SCW)" approach comes to the forefront in studies on smart cities. Smart mobility is explained by six components: governance, life, environment, economy, mobility, and people. Although the EP defines cities with initiatives that address one or more of the components coming from its own definition, as smart cities, the components complete the city system when they follow and integrate each other.

In a nutshell, smart cities, which integrate the city's infrastructures such as education, health, public security, transportation and public services with ICT and effectively use-manage them, use limited resources efficiently, are

environmentally friendly and sustainable, and contribute to economic and social welfare. It can be defined as cities with active governance and public participation (Erdoğan, 2019). When we take a brief look at these definitions, it can be said that the concept of smart city does not only consist of technological infrastructure, but also ecological principles should be taken into account, that is, the concepts of technology and ecology should be combined. In the eco-tech city approach, which is the basis of more sustainable urban designs, we act together with technology that increases ecological awareness with a nature-first design approach and takes into account the local climate and green space structure. Only in this way can the smart and sustainable city concept be developed together.

As an example, survey activities were carried out with the "Talk London Initiative" to ensure that the citizens are included in the planning process. The "Croydon Technology Center" was established for innovative studies. With the London infrastructure application, the urban development process is controlled and monitored. With the "London Data Store", it is aimed to quickly identify the needs of the city with the maximum efficiency of big data. In Singapore, with the green building initiative, all buildings in the country will be developed using smart system technologies by 2030. Thanks to the open data platform, the efficiency of big data in cloud computing will be increased. With the application to be used in public transportation, the occupancy-emptiness ratios and terminal times of public transportation can be obtained instantly. Likewise, the wireless discharge system in public transportation provides time-saving in urban transportation. Thanks to the autonomous vehicle initiative in the energy category, energy efficiency will be achieved by using intelligently equipped road systems.

Unconscious use will be prevented by monitoring the water consumption with smart meter trials. It has been integrated into simulation programs using the large-scale city model with the Virtual Singapore application. In order to increase the quality of life, assistive robot technologies have been started to be used in health services. In San Francisco, 52% of carbon emissions come from buildings. In order to reduce carbon emissions and reduce costs, the project processes energy use and greenhouse gas emissions data into a dynamic, interactive 3D model of downtown San Francisco. This platform, which leverages 5D data visualization technology, serves as a collaboration tool for the city's major government agencies, private commercial building owners, academic institutions, energy management solutions providers, standards bodies, network and telecommunications companies, and energy renewal finance firms.

After the definition of the smart city is made correctly, a stakeholder group meeting should be held to generate a specific smart city foresight. It is necessary to bring together political leaders, community leaders, big companies, public-service corporation, entrepreneurs and SMEs, and universities, in order for a city to concur on a joint vision of a "Smart City". The aim of these stakeholders is to guide the design of a roadmap of individual projects

to develop the city and to agree on an inclusive and specific vision. Crafting a more in-depth vision is a task that cities must undertake, whereas their unique character, strengths and weaknesses.

A holistic approach to smart cities needs to recognize and understand the highly complicated context a city represents the rich terrestrial environment, the economy, transportation, public services and personal activities. For the conceptual design of smart cities, it is significant to create a consensus-based view of the future of a city, underlining the requirement to concentrate on the conversations, and relationships between people, communities, businesses and societies. This process often requires a creative ability jointly by city stakeholders. Thus, it would be appropriate to create a blueprint that can present the determined vision. To realize the vision of a smart city requires a roadmap of specific projects and interventions, within both short-term and long-term strategic programs.

Although these projects and interventions come in different forms, those whose priority can be completed in the easiest and fastest way, that is, within the scope of a single organization; or it may be helpful to concentrate on these, as they build on inter-organizational initiatives already underway within cities. For example, optimizing infrastructures such as energy, water and transportation with implementing "Smart techniques" which environments such as industrial park, transport network, educational sites or entertainment complexes. These taking advantages of the technology platforms conceive by the transition from cost-oriented transition to shared services in the government sector.

After a roadmap that can offer a vision for being a smart city has been put forward, the most important issue is to evaluate the feasibility of these activities and then to find the necessary financing for them. There are many ways to do this and a few of them are listed below:

- Apply for research grants to support new smart city ideas;
- Leveraging the knowledge-sharing potential of shared service platforms;
- Finding and supporting hidden local innovations;
- Exploring the cost-saving potential of smart technologies;
- Finding sponsors for some smart city initiatives;
- Taking initiatives to obtain loans from mutual funds to value-oriented banks;
- Using legitimate state aid;
- Promote open data; and
- Creating new markets.

Smart cities are cities that provide infrastructures that can be used in a perpetual process of reinvention and creativity. New technology platforms created to support smart city initiatives must be made available to communities and entrepreneurs to continually innovate in their local context. A

smart city provides the perpetual creation of new products and services that allow habitants and visitants to make choices that enrich local values and togetherness.

2.2 COMPONENTS OF SMART CITIES

It is also possible to discuss the innovations related to the concept under three headings. These are technological innovations (innovations) to improve techniques and create conditions for better use of tools; managerial and organizational innovations that need to be introduced to ensure effective use of technological tools and conditions. It can be categorized as innovations that address institutional and non-technical urban problems and introduce policies that create the conditions for a smart city. These innovations and innovative perspectives should of course be considered within the context of the changing context according to the characteristics of the cities. Otherwise, practices that are incompatible with the structure of the city and unsustainable may emerge (Nam and Pardo, 2011).

Regarding the concept of "smart city", it is possible to construct it in the axis of six main components within the framework of the fields of activity defined in the literature. The smart city is a forward-performing city within the framework of these six characteristics, built on the "intelligent" combination of assets and activities of distinctive, independent and self-aware citizens. To define the smart city and its six components, it is necessary to develop a transparent and easy hierarchical structure in which the definitions of each stage are defined by the results of another stage. In the smart city pyramid created within this systematic, there are six basic components (Figure 2.1) and 27 factors (Figure 2.2) obtained as a result of their elaboration in the field of application (Giffinger et al., 2007).

Contribution of new smart cities to smart city vision: In addition to its advantages such as designing new forms of urban strategy using cutting-edge technology, modern facilities and without being subject to the constraints that limit smart strategies in existing cities (Ratti and Townsend, 2011), it requires serious investments and a suitable governance model, and

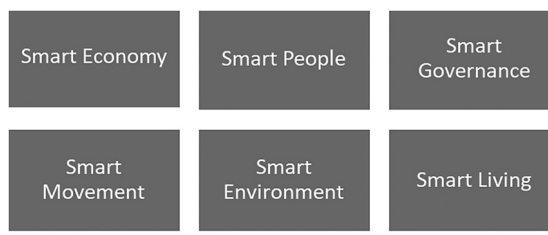

Figure 2.1 Components of smart cities.

(Giffinger, 2007.)

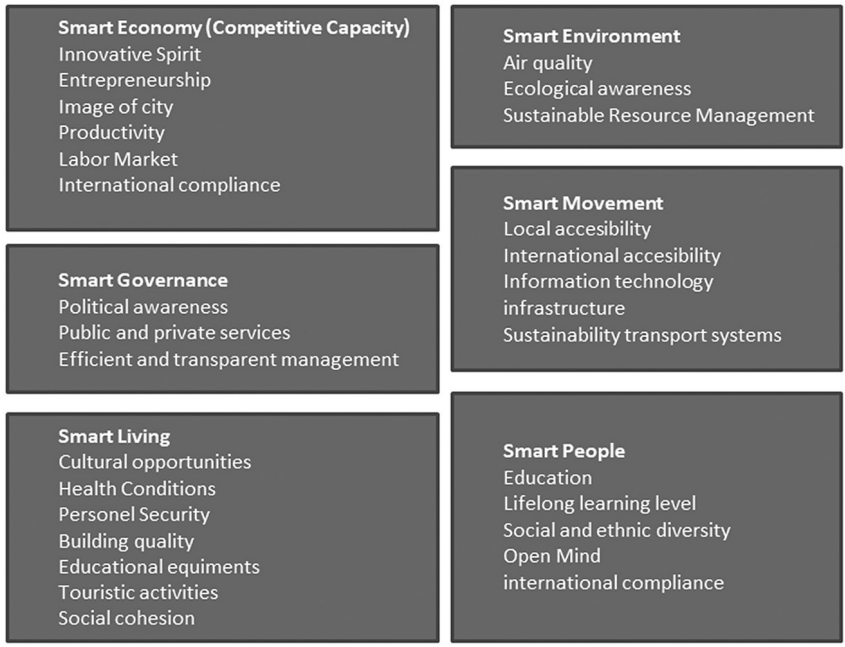

Figure 2.2 Main and subcomponent of smart cities.

(Giffinger, 2007.)

it is important to equip new cities with technological solutions. It also has risks such as creating problems in terms of sustainability.

The most important component of sustainable smart urbanization is data. Especially with big data, the internet of things is an important factor in determining the feasibility of smart city initiatives (Hashem et al., 2016). In addition, the smart city is also an application of the internet of things (Macke et al., 2018). However, in order for the data to be evaluated using information technologies and to provide a tangible benefit to increase human efficiency and comfort, smart cities must keep up with the developments and changes required by the digital age. At this stage, it is necessary to instantly analyze and report a wide variety of data collected by the internet of things, using the right techniques.

The collected data can be analyzed in different ways by different user groups and reports can be created. For example, strategic level reports can be created for the mayor and senior managers at the strategic level, and tactical level managerial reports can be created for the managers at the head of the department. For this reason, analyzing the data with different filtering and analysis methods ensures that the right report is delivered to the right person and effective decisions are taken quickly.

Sustainable smart urbanization: It is a process that is constantly advancing, innovative and has no end in terms of development. In order for this

process to be successful, there are basic factors that must be taken into account during the design phase. Chourabi et al. (2012) identified these factors by reducing them to eight key components: (1) management and organization, (2) technology, (3) governance, (4) political context, (5) people and communities, (6) economy, (7) infrastructure and (8) natural environment. The six basic components that make up smart cities provide an operational definition that removes the uncertainty about the concept (Caragliu et al., 2011). Madakam and Ramaswamy (2014) listed the characteristics of six basic components as follows:

Sustainable smart economy: It refers to an economy that is compatible with an innovative approach and entrepreneurial spirit instead of a traditional economy based on natural and scarce resources. For this, there is a need for a sustainable smart person who is a lifelong learner, creative, open-minded and participates in social life.

Sustainable smart governance: It is a management approach that has features such as accountability, rule of law, participation in the decision-making process and uses technology to facilitate these processes. While sustainable smart transportation aims for healthy, safe and innovative transportation for people, it is also sensitive to climate change and energy security. It aims for innovations such as parking systems, bicycle use, electric vehicles, traffic monitoring systems and vehicle sharing services. Sustainable smart environment describes an environment that is heavily equipped with sensors, processors, communication and control tools. Sustainable smart living, on the other hand, enables the smart city components to be implemented with a holistic approach, with the home environment that adjusts itself according to the user's wishes by constantly perceiving the environmental conditions, and the objects connected to the internet by perceiving both the preferences and the social context of the user.

2.3 BASIC REQUIREMENTS OF SUSTAINABLE SMART CITIES

In order for a city to be not only a smart city but also a sustainable smart city, it must have basic competence in issues such as reliability of information and technology, technological life cycle, compatibility with existing platforms and security.

2.3.1 Reliability of information and technology

Reliability/resilience standards in traditional infrastructure investments are typically 99.997%. It is very difficult to reach these standards for new hardware and devices used in sustainable smart city applications.