Smart Cities: Development and Governance Frameworks

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Cities have been identified as carriers of development activities worldwide. Unfortunately, they are faced with a series of constraints. One among them is high population density in cities. In the next several years, 58.2 percent of the world and 75.8 percent of the European population will live in urban areas. According to current projections, by 2050 two-thirds of the world population will live in cities. Cities are confronted with constant need to increase energy consumption, transportation, buildings, public spaces, etc. All of this points to the need for "smart" solutions that ensure economic prosperity and social wellbeing for cities' citizens. The most efficient way to achieve this is by mobilizing cities' resources and stakeholders using new technologies and policies. In the literature this concept is known as the Smart City concept. It contains several smart dimensions that relate to smart economy, smart people, smart governance, smart mobility, smart environment, and smart living.

This book focuses on cities, with comprehensive investigation of development, management, governance, and monitoring approaches to create smart cities.

Smart cities are defined in almost all chapters keeping in mind the appropriate dimension of smart cities. Definitions of smart cities are scattered throughout the book and in many respects coincide with the definitions imposed in other research papers. Contributions to the book represent the latest research of thirty-two authors focusing on different aspects of methodologies and approaches, frameworks, current trends, case studies, and suggestions for further improvement of the Internet of Things (IoT)-based smart cities vision.

The book is divided into three parts—*Part I: Frameworks and Models*, *Part II: Challenges and Opportunities*, and *Part III: Examples and Case Studies*.

In the center of attention of *Part I: Frameworks and Models* are approaches and methodologies that refer to a prosperous degree of urbanization. In the first chapter, out of four, "Modeling Smart Self-sustainable Cities as Large-Scale Agent Organizations in the IoT Environment", prepared by Igor Tomičić, Bogdan Okreša Đurić and Markus Schatten, the key issue is a recursive and layered approach to modeling large-scale resource management systems in a hierarchical manner by using IoT technologies. After a comprehensive overview of corresponding literature on agent-based modeling approaches, the authors present the organizational metamodel that is used for modeling a smart city's resource management system. They also provide a broad description of modeling techniques for smart cities as self-sustainable Large-Scale Multi-Agent Systems (LSMAS) that address several important problems. An analysis of a simplified example scenario is presented in detail explaining the essential elements. At the end of the chapter, the authors present that the model allows large-scale self-sustainable smart cities with special regard to resource management, using the LSMAS organizational metamodel that is still under development. Conclusions of this research paper relate to the fact that, by bringing a hierarchical structure into the Smart Self-Sustainable Human Settlements (SSSHS) framework, it becomes realizable for large-scale systems like smart cities. The authors have provided guidelines for future research into two directions—further enrichment

of the provided models and the introduction of learning techniques for smart devices in residential buildings.

The second chapter, "Cybersecurity System: An Essential Pillar of Smart Cities" written by Lata Nautiyal, Preeti Malik and Amit Agarwal, discusses the cybersecurity and privacy issues in relation to social, management, economy, and legal aspects of a smart city. This is important because more than half the population lives in urban areas. In the literature smart cities are described in terms of technological developments, but the town planning and urban development policies are neglected. In this part of the book, the authors present the nontechnological aspects of smart cities and integrate them with technology. The conceptualization of the smart city describes the features of the smart city in a broader sense starting from the past, with the recognized ICT-driven city, efficient city, cyber city, digital city, and ubiquitous city (U-city), to the present, where the intelligent city, knowledge city, and smart city have been brought into existence. Smart city is a concept whose major characteristics include changing with time and adapting according to the needs. It interacts with innovations and ICT and, because of that, its implementation is very complex. Development of the smart city concept is also expected in the future, where the smart city can be called a Mobile Efficient Subtle Heuristics (MESH) city—a sense, soft and warm technology city, performing in a forward-looking way. In this part of the book, the essential pillars of a smart city—social, management, economy, and legal dimensions—are presented. All of these pillars are important for the improvement of inhabitants' lifestyle and the development of every city. The security and privacy of information in a smart city have always been important issues. The motive is that the information security should exist in a way to ensure the continuity of major local public services in the city (governance, education, healthcare, utilities, etc.). To provide such a secure information management system, several factors such as governance, social and economic factors are taken under consideration. Special attention is given to different technological factors (radio frequency, smart grids, biometrics, and smartphones).

"Towards Heterogeneous Architectures of Hybrid Vehicular Sensor Networks for Smart Cities" by Soumia Bellaouar, Mohamed Guerroumi, Abdelouahid Derhab and Samira Moussaoui is presented in the third chapter of this book. The authors describe the architecture for hybrid vehicular wireless sensor networks—vehicular ad hoc networks (VANETs) and wireless sensor networks (WSNs)—as a crucial component of smart cities. They point out that one of the main goals of smart cities is to minimize their transportation problems, which cause congested roads and accidents. This means that smart transportation is an important building block of a smart city and VANETs can provide wide inter-vehicle communication and disseminate data and safety-related information. On the other hand, WSNs ensure high detection of events. The combination of VANET and WSN technologies into one hybrid architecture carries the potential for identifying intelligent transportation systems in smart cities. Smart technologies in smart cities need to manage the growth of the city's inhabitants and secure long-term sustainability with optimized operation cost. This can be improved by using vehicular cloud computing (VCC), which is based on mobile cloud computing. This solution has attracted researchers to ensure greater road safety and more traffic applications for a smart city.

The paper ends with explanations of several directions for further research in the area of wireless vehicular sensor networks. One of the possible directions is related to the issue of communication compatibility. It is important to support the development of green transportation through solutions such as cooperative mobility applications, public transport carpooling, car sharing, etc. Because of the security and privacy open issues, it is necessary to focus on road infrastructure (use of wireless sensors and wireless multi-hop communication paradigm). The proposed architecture system suggests allowing interoperability (of multiple technologies), standards, and latency of network architecture.

The fourth chapter is entitled "Pricing Mechanisms for Energy Management in Smart Cities" and its authors are Anulipt Chandan, Vidyasagar Potdar and Champa Nandi. They propose a pricing mechanism for the management of

natural resources, with particular emphasis on the energy sector, in the context of smarter living environments. In this chapter, the authors provide explanations for the power supply network, smart grid, to be implemented in smart cities. They also give the context for the demand-side management (DSM) in smart grids and microgrids, by implementing dynamic pricing using smart meters. The literature lists various pricing schemes. For this reason, several case studies are presented: a day-ahead pricing experiment from Belgium, a time of use/critical peak prices (TOU/CPP) pilot study from British Columbia, a critical peak prices (CPP) and peak time rebate (PTR) experiment from Michigan, and a critical peak prices (CPP) field experiment from Kitakyushu and Kyoto. These practical examples are of great help in exploring various dynamic pricing schemes which can be used for the demand response program.

Part II: Challenges and Opportunities comprises five chapters that focus on issues and solutions in using technologies in smart cities. In the fifth chapter, "Building Intelligent Systems for Smart Cities: Issues, Challenges and Approaches", authors Amrita Ghosal and Subir Halder discuss generic challenges of building intelligent distributed systems for smart cities. Implementing the concept of smart cities requires the integration of different technologies such as the Internet of Things (IoT) and information and communication technology (ICT). There are many architectural approaches for smart city development. They include architectural layers, service-oriented architecture (SOA), event-driven architecture (EDA), IoT and ICT. All of these factors are important in developing the vision of the smart city. In this chapter, the authors mention the issues and challenges of building intelligent systems for smart cities. The most important issues are public safety, healthcare, transport, connectivity, energy and water systems. Among the various challenges, the authors examine the following: implementation cost, high energy consumption, privacy and security, integration of technologies, traffic management system, mobility, scalability, fault tolerance, and upgradation. At the end of this chapter, the authors present the research areas for building intelligent systems for smart cities. There are four areas: cloud platform usage for

development, incorporating IoT in a broader prospect, securing interoperability, and data management. All of these areas need to be explored in the future for better implementation of the smart city concept.

The sixth chapter, "IoT Challenges in Data and Citizen-Centric Smart City Governance", is prepared by authors A. Sebastian, S. Sivagurunathan and V. Muthu Ganeshan. In this chapter, the authors discuss the nature of data and citizen-centric smart city governance and describe the challenges and solutions in such connected environment. They focus on the building blocks for data and citizen-centric knowledge-based governance of smart cities and look into the related IoT challenges. The strategic objective of IoT technology for smart city governance is to support and simplify governance, where all stakeholders (citizens, civil society organizations, private companies, government lawmakers, and network regulators) can take active participation in nation-building. Among many other factors, in this part of the book the authors analyze factors that make the IoT environment suitable for smart city governance. These factors are: connected environment for connected government, growth rate of internet access, growing number of smart devices, people's awareness on the role of government, advancements in ICT, and effort towards sustainable growth. The authors propose data and citizen-centric smart city governance and discuss several approaches to smart city governance such as business model (BM), service-oriented approach (SOA), role or attribute-based approach (RBA), context or content-aware approach (CAA) and data and citizen centric approach (DCA). The major IoT challenges for smart city governance are as follows: data management, data reusability, identity, privacy, and cybersecurity. To meet these challenges, the authors suggest trust, multilayer integration, open data standards, open source software, and social media integration. On the other hand, the most important challenges—lack of interest of government personnel towards digital governance, lack of digitizing of government data and processes, low computer literacy rate of citizens, lack of smart city governance infrastructure and privacy and security concerns of citizens—need to be solved.

"Smart City Surveillance at the Network Edge in the Era of IoT: Opportunities and Challenges" is the seventh chapter in this book. Ning Chen and Yu Chen provide a holistic vision of smart city surveillance and fog computing paradigms, including challenges and opportunities. In this chapter, the concept, current research progress, and open issues regarding smart city surveillance are discussed. The authors present smart city surveillance as one of the smart city application domains aiming at discovering, locating and dealing with anomalies occurring in urban environments. The timely detection of an anomaly is very important because it may result in serious consequences. Situational awareness (SAW) can help dealing with smart surveillance and requires urban planners to maintain a holistic understanding of the cities. Research dealing with surveillance issues focuses on video surveillance of crowds or vehicles. At the same time, the authors point to anomaly detection and smart traffic surveillance applications. A case study of urban traffic surveillance to prove the effectiveness and efficiency of fog computing in smart city surveillance is also presented. The authors explain a fog computing paradigm. For all of us, it is very well known that cloud computing is attractive to industrial users and academic researchers. Cloud computing consists of smart city applications that can leverage the fog computing platform by connected vehicles, mobile big data analytics, smart grid, eHealth and smart home. The research challenges are given at the end of the chapter and it is concluded that fog computing in smart city surveillance needs to be discussed. Unfortunately, there is a list of open issues to be solved to make the fog computing paradigm more effective and practical for smart city surveillance applications.

The eighth chapter, entitled "Big Energy Data Management for Smart Grids—Issues, Challenges and Recent Developments" and prepared by Vidyasagar Potdar, Anulipt Chandan, Saima Batool and Naimesh Patel, discusses issues and challenges relating to big data management and analytics relevant to smart grids. In this chapter, progress in the field of big energy data is discussed. In particular, data management aspects such as data collection, data preprocessing, data integration, data storage, data analytics, data visualization and decision-

making are elaborated. In addition, various challenges in data management, as well as open research areas in big data management, especially in relation to smart grids, are presented. The authors point out that smart grid big data is characterized by volume, velocity, variety and value. Thereby, volume refers to the size of ever-increasing data; velocity to the speed of such data generation; variety to the heterogeneous nature of data gathered from diverse sources; and value to the identifying and extracting of hidden data patterns within the data. In this chapter of the book, special attention is given to smart grids in producing and consuming energy. It is obvious that this activity has resulted in enormous data management challenges for power generation and power distribution companies. To overcome many challenges in this sector, governments and power distribution companies try to manage big data generated by the energy sector. This activity consists of several duties—data collection, data processing, data integration, data storage, data analytics, mining and knowledge discovery, data representation and visualization, and real-time decision-making. Special attention is given to data management issues in smart grids. The large data collected from different sources bring a number of challenges that need to be managed. The most important relate to standards and interoperability, big energy data volumes, reliability and scalability, high bandwidth, and security and data privacy. All of these challenges are explained in great detail. At the end of this chapter, open research directions are presented and the data management aspect of smart grids is recognized as the most important research question.

"Risks and Challenges of Adopting Electric Vehicles in Smart Cities" is the ninth chapter, written by Vidyasagar Potdar, Saima Batool and Aneesh Krishna. This chapter considers the risks and opportunities of adopting electric vehicles in smart city environments in view of oil prices and increased carbon emissions. The authors present several arguments explaining that the electric vehicles industry is one of the fastest growing industries in the world, aiming to reduce oil dependence and manage carbon emissions. In addition, the electric vehicles industry is the best green alternative to the traditional transport mode. Adoption of electric

vehicles has always been challenging due to battery defects, range anxiety of the driver, auxiliary loads, battery cost, lack of charging infrastructure, etc. All of these challenges are described in great detail in this chapter. Additionally, some important solutions are given too. Government regulations regarding adoption of electric vehicles are also presented. One issue relates to the situation when customers are waiting for a sufficient number of charging stations to be built before purchasing electric vehicles, and investors are waiting for an adequate customer base before they make significant investments. In the chapter, supply chain challenges are also discussed. There are two main issues regarding the electric vehicles supply chain—unreliable supply of rare earth battery materials and waste management of used electric vehicles batteries. At the end of this chapter, research directions for future work are presented. There are three main directions—electric vehicles adoption as mainstream transportation, successful integration of electric vehicles into the smart grid and steps towards a reliable electric vehicles supply chain.

In *Part III: Examples and Case Studies*, four chapters that focus on ongoing research on sustainability illustrate several case studies. The tenth chapter, "Rising of Yokohama, Keihanna, Kitakyushu, and Toyota Smart Cities in the Land of the Rising Sun" prepared by Somayya Madakam, Rajesh M. Holmukhe and Siddharth Tripathi, looks at the design and sustainability approaches for building smart cities. The chapter starts with a literature review explaining the role of cities as places of development for the local community and their transformation into smart cities that allow high quality of life to citizens. The literature review begins with a review of advanced technologies, IoT, that help in providing almost all local services for higher efficiency. In this chapter, great attention is given to the review of literature on smart cities. A Web of Science database search yielded over 12,000 journals and 148,000 conference proceedings in many different research areas. Japanese smart cities receive huge amounts of money via subsidies from the Ministry of Economy, Trade and Industry (METI). It is estimated that the market for smart cities by 2020 will increase to JPY 3.8 trillion. In this

chapter, the authors explore smart city projects in four Japanese cities. These four examples are completely different. The first project is in Yokohama—the Yokohama Smart City Project (YSCP). This project is one of the largest smart city experiments in Japan and contains an initiative to establish overseas expansion of Japan's smart grid technology. The YSCP wants to establish a social system with 30 percent CO2 emissions reduction, testing with wide-area energy management (WAEM) and demand response (DR) systems. A possible solution is to introduce an automatic demand response (ADR) system for condominiums. Keihanna Eco City is the second project and the second oldest science city in Japan where the Next Generation Energy Society System inspection project was developed. Keihanna Eco City is the location of many corporate laboratories and other research institutes, as well as universities, companies, and other institutions. This makes it the ideal location for testing and verifying the outcomes of research on advanced IoT technologies and new social systems in cooperation with the city's residents. Kitakyushu City is the third project. It has transformed itself in terms of environmental sustainability, from a brownfield project to a sustainable smart city of the future. The fourth project is Toyota Smart City, which is working on a public–private partnership (PPP) model for smart community development. Toyota supports a low-carbon society and promotes IT/IoT-based smart power grids for more stable supply and energy conservation.

The eleventh chapter, "A Business Model for Digital Services for Smart Cities in India" written by Chandrakumar Thangavel and Parthasarathy Sudhaman, proposes a sustainable business model to implement smart city digital services in relation to smart city initiatives in Indian cities. This chapter presents a comprehensive definition and major components of smart cities. The Government of India launched the Smart Cities Mission (SCM) in 2015 with the goal to promote sustainable and inclusive cities that deliver all needed infrastructure and provide a good quality of life to their citizens. The whole idea was to set examples that can be replicated, catalyzing the creation of similar smart cities in various regions and parts of the country. A Smart Cities Business Model has been

developed which can be used to improve digital services for open information to all in the city. This model is expected to help the government and public sectors to include digital services in the cities with various business perspectives.

"Opportunities for Brazilian Smart Cities: What Is Realistic and What Is Not" is prepared by Lucio Agostinho Rocha and explores the challenges and opportunities in relation to smart city projects in Brazil. This chapter offers an overview of technologies that are suitable for smart cities, including the main factors that are needed to make new services available to Brazilian smart cities. It is well known that there is a set of ten indicators for smart cities: mobility, urbanism, environment, energy, technology and innovation, health, security, education, entrepreneurship, and governance. Special attention is given to technology and innovation, and the author proposes five indicator groups: internet connection bandwidth, optic fiber connection, 4G mobile coverage, free high bandwidth, multimedia communication service access and inclusion in the "cidade digital" project. In this chapter, a case study is presented exploring how Brazilian cities use technology and innovation for their citizens. It states that Brazilian smart city success factors are the following: planning, incentive, assistance, and governance; ICT technologies; universities, research centers, and government incentives; government investment; investment in technology infrastructure; and innovation. The author discusses related factors such as collaboration, communication, sustainability, and automation.

The last chapter, "Standards-Based Sustainability Requirements for Healthcare Services in Smart Cities" written by Sofia Ouhbi, Ali Idri and José Luis Fernández-Alemán, discusses the sustainability requirements for the provision of healthcare services. One of the tasks of smart cities is to offer healthcare provision to citizens by providing them with s-health which includes telecare, telehealth, telemedicine, mHealth, digital health and eHealth services. The development of ICT proposes technological innovations to develop connected health to improve healthcare services for smart cities' citizens. There are two types of health records—electronic personal health records (EHRs) and personal

health records (PHRs). In addition, this chapter presents a widespread connected health system as a clinical decision support system (CDSS). Connected health applications have a huge range of applicability (cardiology, blood donation, and obstetrics) and provide the possibility of improved range at a relatively low price with enhanced time efficiency. As a conclusion, it is said that connected health has the potential to transform health and social care in the future.

In conclusion, *Smart Cities: Development and Governance Frameworks* contains a number of findings about smart cities, from definitions and key factors to the technology that contributes to them. The book could be more readable if it contained key figures for elaboration of all smart city elements. In that way, it would become essential reading for researchers, city managers, students and all other professional publics interested in smart city topics.

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