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Ram Kumar Mishra ·
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Smart Cities for Sustainable Development

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Editors
Ram Kumar Mishra
Institute of Public Enterprise
Osmania University Campus
Hyderabad, Telangana, India

Sandeep Chachra
ActionAid Association India
New Delhi, Delhi, India

Anupama Dubey
Institute of Public Enterprise
Osmania University Campus
Hyderabad, Telangana, India

Ch Lakshmi Kumari
Institute of Public Enterprise
Osmania University Campus
Hyderabad, Telangana, India

P. S. Janaki Krishna
Institute of Public Enterprise
Osmania University Campus
Hyderabad, Telangana, India

R. B. Singh
Department of Geography,
International Geographic Union
University of Delhi
New Delhi, Delhi, India

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Foreword

While the soul of 'India lives in the villages', the economic strength and future advancement largely rely on the Urban India—Cities. The rapid urban growth, rural–urban migration, and burgeoning socio-economic divide are pushing Urban India to adopt new ways of planning, managing, and operating cities. There are two key characteristics that differentiate Urban India from the Western style of urban planning—the embedded culture which reflects in every aspect of urban lives and governance impeding on implementation of basic urban infrastructure, most notably, physical infrastructures. While the western style of urban planning has its merits and plays a vital role, Urban India must develop its own planning approach and urban management practices to cater for all walks of life in cities. The 'Science of Architecture' has now entered the most critical phase for Urban India—Less is More. With the limited resources, capacity, and time constraints, how is India going to cater for more people, more demands, and more infrastructures?

The first planned city in India, Jaipur (1727), was based on the 'Science of Architecture', depicting the planning and design of buildings, landscape, and streets in harmony with nature. The city was designed with a grid-like system, dividing into nine squares and broad crossings, each symbolising the planetary bodies of astrology. Jaipur presented a successful urban planning model for the world, defying earlier medieval city planning and growth around organic settlements. Before Jaipur, the grid-like systems and urban patterns are evident in the Indus Valley Civilisation (3300 BCE–1300 BCE), with an estimated population between one and five million inhabitants. From 3300 BCE to date, Cities have been the most integral part of the history, culture, and commerce of India. The Democratic India of the twenty-first century has very different political, economic, and environmental challenges and yet, the Cities are at the forefront of the opportunities and solutions.

The 'Science of Architecture' and 'Economics of Cities' are embedded in the new paradigm of Smart Cities. But the underlying principles of the Smart Cities are no different than the Jaipur of 1727—about people, communities, commerce, and security, all in harmony with nature and the environment. The Smart Cities of today have strategic and competitive advantages for Urban India—Leapfrogging and Speed. The legacy infrastructures are one of the biggest liabilities for cities around the

world. Urban India has the advantage to leapfrog and focus on building future urban infrastructures. The technology and innovation, combined with the power of social media, allow Urban India to gain speed in delivering urban planning, operations, and services. The technology has also proven globally to remove the governance impediments and bring transparency and equity in cities. Smart Cities provide a timely opportunity for India in a coordinated effort between the People, Governments, and Businesses in developing Sustainable Cities for the future. The largest democracy in the world sets the new paradigm, that the government of the people, by the people, for the people, is reflected in Cities, where close to 7 billion people around the world are projected to live in urban areas. The opportunities of shared prosperity in Smart Cities are equally challenged by the capacities and the resourcing, where urban institutions at all levels have shared responsibilities in delivering Sustainable Cities for the future. Smart Cities in India aren't just the embodiment of electronic innovations and fibre optics, rather the reflection of hope, freedom, and a better future enabled by technology and human endeavours.

I wish the Institute every success in initiating the Smart Cities programme. I conclude with the words from Wolfgang Nowak from Alfred Herrhausen Society, *If we want the city to remain the driving force behind the human development, we must reinvent it now; otherwise there is the risk that it will become the final stage of the human civilisation in the twenty-first century.*

Prof. Sunil Dubey
Adjunct Faculty—Building
Economics & RE Asset Management
Institutional Advisor—Urban
Innovation and Smart Cities
The University of Sydney
Sydney School of Architecture Design
and Planning
Darlington, Australia
sunil.dubey@sydney.edu.au

Prof. Sunil Dubey is a thought leader in urban innovation and connecting global cities through knowledge networks. He advised Metropolis World Association for over twelve years as a senior advisor. He teaches at the University of Sydney and currently works in NSW Govt in strategy, planning, and innovation.

Preface

The IPE Smart Cities and Sustainable Development publication presents case studies and research papers, focusing on technology, science, urban economy, culture, and environment. The four sections cover the conceptual background, urban attributes, and achievements of smart cities in India, changing aspects of economic and technological sourcing and selected studies from the Smart Cities programme and implementation challenges on the ground. The publication provides comprehensive literature on the various aspects of Smart Cities and reasons for Urban India. Various case studies presented in this book provide practical insight demonstrating the governance and technological challenges faced in implementing the programme at city levels. The comprehensive literature includes the interactions and competing priorities between competitiveness, capital, and sustainability while demonstrating an example of 'Magarpatta' near Pune, a mini city, where circular economy and sustainability is achieved through connecting living and working in community infrastructure and environment. The role of Corporate Social Responsibility (CSR) is examined through the policy changes and impact on local communities and an assessment of energy mix is provided with the comparative reference of the foreign investments in renewable energy sources. A pressing case is presented for the adoption of online geodata repositories as advanced planning and management tools for Smart Cities in India. The publication, in totality, provides a good outline of the Smart Cities programme in India—Challenges and Opportunities, where institutions can play an important role in fulfilling the capacity and applied knowledge gaps through bringing national and international collaborations.

This book reviews the structure, applications, technologies, governance, environmental sustainability, smart communities, gender space, and other related issues to smart cities. This book is divided into four sections. The first Part entails the Conceptual Background, Growth, and Development. This includes papers from Australia, China, South Africa, and India. The second Part represents a diversity of issues on smart cities covering the issues of Environmental sustainability, role of community, and Gender space. The third Part revolves around the Economic and technological issues and presents Case Studies concerning smart cities.

This volume presents a holistic view of smart cities as it unfolds diverse issues relating to Smart Cities by the authors. Different innovative concepts such as digital governance, Polycentric Structures, Geo data Repositories, Geo web Services, and Advanced Geospatial Technologies in Smart City Planning, Urban Microclimatic Parameters, and Urban heat Islands would contribute to knowledge creation.

The various approaches and methodologies adopted by the authors present an alternative approach to academicians, researchers, experts, and policy makers to assess the current and future status of smart cities.

Hyderabad, India — Ram Kumar Mishra
Hyderabad, India — Ch Lakshmi Kumari
Hyderabad, India — P. S. Janaki Krishna
Hyderabad, India — Anupama Dubey
New Delhi, India — R. B. Singh
New Delhi, India — Sandeep Chachra

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Contributors

Aditi School of Humanities and Social Sciences, Indian Institute of Technology Patna, Patna, India

Subhash Anand Department of Geography, Delhi School of Economics, University of Delhi, New Delhi, Delhi, India

Anushka Public Policy and Management, Indian Institute of Management Calcutta, Kolkata, India

Asmaa Effat University, Jeddah, Saudi Arabia

Mijing Gwra Basumatary Department of Geography, Delhi School of Economics, University of Delhi, New Delhi, Delhi, India

Nalin Bharti School of Humanities and Social Sciences, Indian Institute of Technology Patna, Patna, India

Hemant Bherwani CSIR-National Environmental Engineering Research Institute, Nagpur, Maharashtra, India;
Academy of Scientific and Industrial Research, Ghaziabad, Uttar Pradesh, India

Shivkumar L. Biradar Hirachand Nemchand College of Commerce, Solapur, India

Roshni Chakraborty ActionAid Association, Delhi, India

Louis Dexter ActionAid Association, Delhi, India

Anupama Dubey Institute of Public Enterprise, Osmania University Campus, Hyderabad, India

Buddhadev Hembram Department of Geography, The University of Burdwan, Burdwan, India

Rima Hibare Hirachand Nemchand College of Commerce, Solapur, India

Ibrahim Cairo University, Giza, Egypt

N. C. Jana Department of Geography, The University of Burdwan, Burdwan, India

P. S. Janaki Krishna Institute of Public Enterprise, Osmania University Campus, Hyderabad, India

Chris Johnson Urban Taskforce, Sydney, Australia;
Institute of Public Enterprise, Hyderabad, India

Harish Karnatak Indian Institute of Remote Sensing, Dehradun, India

Rakesh Kumar CSIR-National Environmental Engineering Research Institute, Nagpur, Maharashtra, India

Suman Kumar Academy of Scientific and Industrial Research, Ghaziabad, Uttar Pradesh, India

Ch Lakshmi Kumari Institute of Public Enterprise, Osmania University Campus, Hyderabad, India

Andrew Lillywhite ActionAid Association, Delhi, India

Fang Liuqing College of Economics, Hangzhou Normal University, Hangzhou, China

Ashok Kumar Lonavath Department of Geography, University College of Science, Osmania University, Hyderabad, India

M. Maschendar Gaud Institute of Public Enterprise, Osmania University Campus, Hyderabad, India

Gregor H. Mews QUT Design Lab, Queensland University of Technology & Urban Synergies Group, Brisbane, Australia

Ram Kumar Mishra Institute of Public Enterprise, Osmania University Campus, Hyderabad, India

Kamal Pandey Indian Institute of Remote Sensing, Dehradun, India

Vinita Pandey Department of Sociology, Nizam College (Osmania University), Hyderabad, India

Sant Prasad Department of Geography, Delhi School of Economics, University of Delhi, New Delhi, Delhi, India

Pushpanjali Central Research Institute for Dryland Agriculture, Hyderabad, India

V. Raghavaswamy National Remote Sensing Centre, Balanagar, Hyderabad, India

K. Bhavana Raj Institute of Public Enterprise, Hyderabad, Telangana, India

Usha Rani Department of Geography, Delhi School of Economics, University of Delhi, New Delhi, Delhi, India

Suresh Kumar Rathi Indian Institute of Public Health, Public Health Foundation of India, Madhapur, Hyderabad, India

G. Ravindra Chary Central Research Institute for Dryland Agriculture, Hyderabad, India

Attia Sahar Cairo University, Giza, Egypt

Josily Samuel Central Research Institute for Dryland Agriculture, Hyderabad, India

K. L. Sharma Central Research Institute for Dryland Agriculture, Hyderabad, India

Anju Singh National Institute of Industrial Engineering, Mumbai, Maharashtra, India

Daisy Singh Research Scholar, Department of Humanities and Social Science, IIT Kharagpur, Kharagpur, India

R. B. Singh Department of Geography, Delhi School of Economics, University of Delhi, New Delhi, Delhi, India

K. T. Suresh ActionAid Association, Delhi, India

K. Venkanna Central Research Institute for Dryland Agriculture, Hyderabad, India

Karunakar Virugu Department of Geography, University College of Science, Osmania University, Hyderabad, India

Peng Weibin Institute of Population Development and Health Governance, Hangzhou Normal University, Hangzhou, China

Lin Xiaojing College of Economics, Hangzhou Normal University, Hangzhou, China

Jun Yamashita Kyushu University, Fukuoka, Japan

Chapter 1
Smart Cities for Sustainable Development: An Overview

Ram Kumar Mishra, Ch Lakshmi Kumari, P. S. Janaki Krishna, and Anupama Dubey

Abstract Globally, cities are under enormous pressure due to burgeoning population growth, stranded economic reforms, and climatic distress. Realizing the need to cope up with these challenges, strong initiatives are being taken the world over, to make cities smart and sustainable. In this chapter, the authors synthesize the conceptual framework and contents of the various chapters detailed in the book. This chapter while dovetailing the national and international status of smart cities presents in a nutshell, the works presented in various chapters ranging from innovative concepts and technologies in smart city development to presenting a way forward. Although in developed countries urban development is very strong and systematic, in developing countries including countries like India, smart city development is faced by several challenges such as deferred investments, coordination of stakeholders at local, state, and central level, timelines, and displacement of funds toward rural infrastructure instead of urban infrastructure, etc. As a way forward, undeterred attention of policymakers is suggested for the successful development of cities that are smart and sustainable.

Keywords Smart cities · Local bodies · Urban governance · Policymakers · Sustainable development

1.1 Background

Globally, a substantial percentage of population is currently residing in the urban region because of the rapid urban growth, rural–urban migration, and burgeoning socio-economic divide. The rising urban load is creating abundant pressure on existing cities in using the available resources in a ‘Smart way’, and gradually leading toward a new concept known as ‘Smart Cities’. The term ‘smart’ is considered as synonymous with ‘Connected City’, ‘Resilient City’, ‘Intelligent community’ or ‘digital community’. Generally, inner operability, sustainability, city-wide

R. K. Mishra · C. L. Kumari (✉) · P. S. Janaki Krishna · A. Dubey
Institute of Public Enterprise, Osmania University Campus, Hyderabad 500 007, India
e-mail: laxmi_k@ipeindia.org

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connectivity, security, effective transportation, and development of private/public partnerships are considered as the crucial components of a smart city.

Smart cities caught fire a decade ago in North America and have spread to Europe over the past year ending in 2015. Definition of 'smart cities' is also applied rapidly in India. Although India's current urban population of 31% produces 60% of the country's GDP, the vast majority of its people live in the countryside. It is estimated that in the next fifteen years, urban India will contribute 75% of the country's GDP. Today, much of the rural-to-suburban transition has occurred. because of the scarcity of rural land and increasing urban pressure, towns must be made more 'smarter'.

To make a 'Smart City' successful, it's critical to incorporate key features such as competition, capital, and sustainability. Inclusive, effective, forward-looking cities should be able to provide good infrastructure such as clean water, sanitation, health care, and so on, but above all, they should have an open, non-restricted access to such amenities. They must draw significant investments. They must have open and honest business practices to operate socially, economically, and commercially. There are also safe and pleasant online and uncomplicated means for obtaining approvals for various citizen-oriented services. It is clear that the environment plays a critical role in keeping cities safe and green, and municipal and local governments need to reflect this as well. The impacts of urbanization and climate change are converging, threatening lives and progress in urbanized regions worldwide.

At the same time, the concentration of human capital, infrastructure, industry, and culture in cities, has the potential to make cities center of attraction for social and economic good. In urban societies, resilience depends on slow-changing variables such as climate, land use, nutrient stocks, human values, and policies. A variety of factors ranging from increasing pollution leading to the deterioration of air, water and food quality, fixed subsidies that encourage unsustainable use of resources. Institutions that do not adequately respond to the needs of society can degrade the resilience of urban areas. In order to mitigate hazards, a climate-resilient smart city must have a focus on strong disaster-resistant infrastructure, policy, and response capacities. Thus, cities are the places of choice to live, on one hand, and on the other hand, they have become unliveable because of vicious urbanization issues and challenges of which climate change becoming the pressing problem. The paradigm shift of 'Smart Cities' changed from technology-centric to citizen-centric followed by environmental friendly.

However, while Florida (2002) places importance on the rivalry between cities, Landry (2006) states that city officials should not focus on making the world's best city but rather a strong local one. The discipline of urban governance has been very complex over the years, but it has recently been linked to other disciplines that are focused on creativity and technology. The fields of e-government and innovation are being integrated with the concept of urban governance to better realize this objective (Nam and Pardo 2011). Although in his book about innovative cities, Florida (2002) stresses the rivalry between cities from other cities around the world. The increased interconnectedness of individuals, houses, and traffic networks is one of the key characteristics of the modern city (Batty et al., 2012). It's crucially important to consider how to create synergy between social structure and new technology during

e-government studies over the last decade (Danziger et al. 1982; Fountain 2001). A range of different innovations has been tested to ensure government services are of better quality and increased in effectiveness.

Zamblli et al. (2018) described how ubiquitous and mobile technologies help the urban environments to self-control, implement normal actions, and support city functions by providing real-time actuation, sensing, and computation. Various research studies used an examining model that incorporated neural networks and pair association to develop the smart growth strategy of the cities. Cities can learn a lot from the model, particularly in developing countries.

It was observed that more thrust is needed in the big data-based urban environment, society, and sustainability (UESS) research. Thibault Werle and Rachid el Ameri (2021) reiterated the fact that smart city development is totally integrated with IoT solutions. However, the supplier landscape worldwide is struggling to work together hindering the exploitation of potential benefits and suggested inter-operability for seamless information exchange.

What we are seeing in the current crises is that the social and technological issues are now intertwined and moving from the agency to citywide and even regional levels. Existing principles and theories are appropriate for use but must be improved upon to be applicable to urban experiences.

Keeping the above dynamics in view the current book titled 'Smart Cities for Sustainable Development' is placed before the readers to present a better understanding about the smart cities and the various dimensions, issues, and challenges that are to be taken care of while developing them with a way forward.

1.2 Smart Cities for Sustainable Development: At a Glance

This book is divided into four sections. The first section includes papers from Australia, China, South Africa, and India. The second section represents a diversity of issues on smart cities covering various aspects of environmental sustainability, the role of community, gender space, etc. The third section revolves around the economic and technological issues, and the fourth section is a notable compilation of different case studies in connection with the development of smart cities. These cases are presented by the authors who have fundamental and practical knowledge and gained experience in their respective domains by working many years in different locations. This book presents a holistic view of smart cities. Innovative concepts such as digital governance, polycentric structures, geo data repositories, geo web services, and advanced geospatial technologies in smart city planning, urban microclimatic parameters, urban heat islands were thoroughly discussed in this book which will add value toward the knowledge creation and development of the individuals and institutions working in this domain.

The first section entails the conceptual background, growth, and development of smart cities, wherein the first chapter discusses the conceptual framework, issues, and challenges in developing smart cities that are sustainable and various aspects

discussed by eminent authors that are presented in the book. The second chapter on monocentric city plans to polycentric structures elaborates the paradigm shift of smart cities in the current circumstances. The author echoed the fact that the COVID-19 pandemic will stimulate the rethinking of the shape and structure of cities. A likely post-pandemic model will be to restructure cities as being a cluster of mini cities where there is a much closer relationship between the people where they live and where they work. This will reduce travel times and the congestion that comes with this. This paper observed the traditional form of Indian cities and the role of geometry from ancient texts that gave structure to temples, towns, and cities. India's capital city of New Delhi evolved as a series of separate city centers focused around the palace of the latest ruler to give a spider's web of streets and boulevards that tied the parts together. The growing interest in the polycentric structuring of cities is examined including the cases of city plans from different parts of the world. The city of Sydney in Australia is a case study of a city becoming polycentric based on a new metro rail transport system. The Indian mini city of Magarpatta at Pune is examined as an illustration of a work/live structure that combined nature with a built-in environment. Finally, the paper promotes the polycentric approach to city planning as a realistic response to the COVID-19 pandemic that manages large cities as being a combination of many mini cities.

In the Third Chapter, Gregor H. Mews emphasized the significance of communities in shaping smart cities. He observed that cities are becoming an integral part of the human conditions on a global scale. They hold the capacity to transform human life with increasing acceleration beyond what is possible. However, at the same time, the everyday life experiences of humans in cities have become increasingly complex. These experiences need to be understood in order to shape urban conditions and prevent consequent systems' collapse. Of particular concern is the ability to achieve shared visions such as the New Urban Agenda and the implementation of the Sustainable Development Goals (SDG's) in relation to the human-caused COVID-19 pandemic and associated setbacks. The dilemma is deeply rooted in the human condition; in the way how reality is being conceived, impacts our health, and solutions being offered to solve challenges in cities from a smart city perspective. Undoubtedly to achieve the SDG's we need to undergo a transformational change. In order to resolve this dilemma, this contribution suggests urgently renegotiating our ontology of practice. This new ontology of practice embraces or may embrace the concept of Intelligent Communities which aligns 'thinking' with 'doing' and enables meaningful actions that enrich everyday life experiences in cities in a way that yet has to be collectively realized.

The fourth Chapter titled 'Digital Governance for Smart City and future community construction: from concept to application' is contributed by WeibinPeng, Liuqing Fang, and Xiaojing Lin of China. The authors state that the interactions between technology, community, and citizens are the core of smart city development. With the increasing penetration of Internet applications, digital governance is advancing constantly. As the basic carrier of smart city, future community is the embodiment of urban sustainable development. To change the situation of single national governance, the Chinese government has begun to integrate the concept of smart city into

community construction, actively using big data to explore the digitization of community governance over the past five years. In some central cities of eastern developed regions, digital technology and community governance are gradually integrated to improve grassroots governance through community digital empowerment. Based on Hangzhou, Zhejiang, this paper discusses the necessity of using digital ways to promote the theory intellectualization of grassroots governance; it expounds on the importance of future community in relation to a citizen's production and living, especially while responding to public health emergencies (such as COVID-19), and proposals for achieving urban sustainable development.

The sixth chapter contributed by Jun Yamashita, Faculty of Social and Cultural Studies, Kyushu University, Fukuoka, Japan analyses the smart city initiatives in Japan by presenting the achievements and the pressing issues in connection with the development of smart cities in Japan.

The second section of the book dovetails on a dimensional look of smart cities. The seventh chapter deals with an emerging concern of urban deprived communities in the existing smart cities in India by KT Suresh of ActionAid, India. The Author elucidates that for the first time in history, the majority of people on the planet live in urban areas. Urbanization is a ubiquitous phenomenon and India's urban population is projected to grow to 600 million by 2030. Cities might be the engines of economic growth, but there is an urgent need to plan, not just for the accommodation of millions of people, but also an improved quality of life for all. Indian cities were not designed for the most vulnerable and provide constant reminders of the stark inequality in the country. With the increasing risk of climate-related catastrophes, our cities need to become resilient to natural hazards. India's approach to urban development has typically comprised disparate attempts to upgrade infrastructure and invest in water, sanitation, utility, education, housing, etc. The Smart Cities Mission gives us the perfect opportunity to synthesize these different methods and integrate them into a plan that aims to build 'smart' cities which are sustainable and resilient while keeping in mind the need to democratize access to services and infrastructure in order to protect the most vulnerable.

The eight Chapter authored by Vinita Pandey deals with the environmental sustainability of smart cities and cues based on the experiences of publication on garden cities. According to Pandey, India is expected to be home to seven megacities with a population above 10 million by 2030. Several innovations are taking place in the direction of making cities environmentally sustainable. Sir Ebenezer Howard is famous and acknowledged for his publication on Garden Cities of Tomorrow (1898). The publication is a description of a utopian city in which people amicably reside in harmony with nature. The idea of the garden city evolved as an effective response to ensure good quality of life in overcrowded and dirty industrial towns, the environs of which have deteriorated and posed serious health risks. There is a need to understand the various facets of garden city and adopt them in contemporary urban planning in the Indian context. Thus, the paper based on a review of literature endeavors to present various aspects of garden city and how they can be adopted by contemporary urban planners to make city life relatively pollution free and provide green and safe public spaces as envisaged in Sustainable Development Goals (SDGs) 2030.

Ninth Chapter authored by Daisy Singh, India, correlates the sustainability of smart cities to education and health. Based on an extensive review of literature and reports on smart city initiatives, this chapter is essentially focused on understanding the need and importance of human capital for inclusion and sustainability. A review of 10 smart cities proposals under the 'Smart City Mission' of the Government of India showed that the scores of education and health care have considerable influence on the composite scores of the cities, demonstrating the resulting influence of the sectors on human capital generation, and thus help in the sustainable development of smart cities. The finding suggests that in addition to the development of physical infrastructure, inclusiveness, and sustenance, the smart city mission requires an adequate emphasis on the development of social infrastructure particularly in respect of education and health care.

India has a rich culture and tradition of celebration of diversified festivals with belief and faith. It helps to inculcate cultural and traditional values in the new generation. Nowadays the nature of celebration of public festivals has changed significantly; now public festivals are celebrated on a mass basis in a contesting way. The present nature of celebration of public festivals has socio-environmental implications in society. The tenth chapter is a unique assessment of the celebration of public festivals in Solapur, which is a perceptual study conducted by Shivkumar L Biradar and Rima Balkrushna Hibare, India. The paper aims to understand the perception and purpose of celebrating public festivals and the existing nature of celebration of public festivals in Solapur across demographic variables and its socio-environmental issues. It is found that there is a need to change the approach toward celebration of public festivals. It should be celebrated in an eco-friendly, healthy, and peaceful manner.

Public space is gendered, where men have better access at all times of the day, while women have to have a purpose for their legitimate access to public spaces. City planning and public services are responsible for violence and intimidation faced by urban women, especially poor transportation and street-lighting make them more vulnerable. What indicates all this is that the fear of crime is continuously modifying a woman's spatial realities. The eleventh chapter on 'Gendered Spaces: A spatial perspective of women's fear of violence' contributed by Anushka, India, discussed the gender aspects with respect to smart cities. This paper, through a critical review of literature related to gender and urban planning, attempts to suggest directions for the planning of 'inclusive cities' respectful to the specific needs of women, which can contribute to reducing violence and enhancing safety for women.

The third section of the book extensively discusses the economic and technological issues pertaining to smart cities. Structures, as well as social, economic, and technological barriers of cities since the advancement of the ICT industry, tends to disregard, thus mischaracterize certain legacies, traditions, beliefs, and histories. Both social and technical and economic shifts have caused a rise in the demand for modernization services, and the emergence of ICT (Internet of Things) and IOT (Internet of Things), so businesses are being hit by these in succession. ICT enabled cities to be more effective, safer, more inclusive, more prosperous, and more sustainable, while still protecting the cities' cultural assets. Culture is at the heart of modern

smart cities, and not only serves as a tool to implement engineering initiatives but also obtaining creative and/suggestion input from multiple individuals or groups.

This paper describes crowdsourcing for sustaining smart cities and their ICT practices and is contributed by K Bhavana Raj, India.

Technological development is the base of 'Smart Mission Plan' in India. Harish Karnatak, Kamal Pandey, and Raghavaswamy presented the geo-web services and advanced geospatial technologies in smart city planning in the tenth chapter. Currently, fast and innovative advances in data processing, an internet- and broadband-based paradigm shift in data generation, distribution, and sharing has occurred in the field of geospatial data and information. Several online location-based databases and geographic web services are now making various data collection and access possible for the public. Geospatial innovations that use creative data collection, sharing, and access techniques are making a big impact on the public sphere. Today, the users are applying internet platforms such as spatial querying, visualizing geospatial, and using 3D modeling and complex computations for decision-making in VR. Many organizations and individuals have developed world-changing geographic information-focused digital applications for use in open data platforms. Spatial knowledge and databases provide a computational-based methodology for city planning. The geospatial data from online geo-data repositories, web services, crowdsourcing through POI (Points of Interest), APIs, and mobile apps are being extensively used by GIS professionals and researchers in the country. Integration of advanced technologies, Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL), Internet of Things (IoT)-based Smart sensors, Digital Twin (DT), and Geo-Intelligence can play a significant role in the development of smart data solutions. The concept of self-sustainable city or smart city is being implemented by various countries for providing smart citizen services. The smart city mission by the Indian government is developing 100 cities across the country in an effort to provide smart solutions to area-based city planning. Location intelligence is an integral part of the development of smart city mission. The smart sensors will provide location and seamless data using a sensor network that can be integrated with geospatial technology for better decision-making and planning. Emerging technologies like Digital Twin with Geo-Intelligence allow modelling simulated scenarios of complex spatial problems for arriving at possible solutions in smart city planning.

Hemant Bherwani, Suman Kumar, Anju Singh, and Rakesh Kumar from India presented an assessment of urban microclimatic parameters in various urban landscape settings using computational fluid dynamics as a tool in the fourteenth chapter. Urbanization is happening at a great pace throughout the world. On one hand, the quality of life is improving through better job opportunities, better standard of living, but the environment in which people live is suffering due to increased pollution and extreme weather events. Recent advances in the field of urban science have created a focus on urban microclimate. Microclimate refers to the local climatic conditions of the city which are peculiar in nature and are distinct as compared to the surrounding environment. Cities are generally a few degrees warmer than their surroundings because of higher absorption of solar radiation due to the use of high heat capacity materials. In addition, the flow of the wind is obstructed leading to lesser dissipation

of heat. Further, the green/open and water bodies also play a vital role in the overall energy and mass balance of the city, leading to reduced quality of the microclimate of the city. The paper discusses the evaluation of microclimatic parameters like wind speed, temperature, solar insolation using computational fluid dynamics as a tool. This study focuses on the variation in local climate characteristics in different urban landscapes. The study shows that urban green spaces, water sources, proper planning of the building and roads, materials help in improving urban climate which is crucial for sustainable development.

The fifteenth chapter contributed by Nalin Bharti and Aditi Singh from India, deals with the restructuring of India's energy sector. As a part of this initiative, secondary energy is generated from a blend of primary resources, such as coal and natural gas, and is converted into direct energy, i.e., electricity. Hence, the study tries to conceptually rectify the relevance of investment in renewable energy for triggering energy efficiency in developing sustainable cities in India through a content analysis method of various government and international organizations reports like IEA, NITI Aayog, World Bank, TERI institute report, etc. Further, an overview of government policies, FDI (Foreign Direct Investment) inflows on PPP framework, and cases of some foreign countries are also provided with a few recommendations in devising a robust energy policy for Indian cities.

The sixteenth chapter presented by Ashok Kumar Lonavath and KarunakarVirugu, India, elaborates the economic activities of smart cities in Telangana. This chapter examines the changing patterns of economic activities of Hyderabad, Warangal, and Nizamabad towns in Telangana state from 1961 to 2011. The statistical tool used to find out the concentration of each economic activity in these cities is the Standard Deviation (SD) method. SD from the mean was, therefore, calculated for each economic activity of all the three cities and kept under appropriate categories. When this method is applied to smart cities, some cities showed more than one economic activity in outstanding proportions.

In the fourth section, informative case studies on Indian smart cities were narrated by renowned authors.

The seventeenth chapter is a case study about Varanasi city and explains about the assessment of Urban Heat Island (UHI) using the Satellite Data in Varanasi city, India, and was contributed by Sant Prasad and R B Singh, India. UHI was previously considered an anomaly due to human activities, it was found to be a part of the city that was unusually warm in the urban environment. For the past decade, Varanasi has been suffering from exponential growth. For this research, Landsat 8 satellite data of March and May 2018 was used to examine the effects of UHI in Varanasi, Uttar Pradesh.

For this research, Landsat 8 satellite data of March and May 2018 was used to examine the effects of UHI in Varanasi, Uttar Pradesh. An algorithm was used to retrieve the LST distribution, along with normalized difference between vegetation index and normal vegetation image (NDVI) and normal land accumulation index (NDBI) were obtained Additionally, LST, NDVI, and NDBI were examined to investigate the potential effect on vegetation and built-up areas in green areas. As a result, the effects of UHI in Varanasi City are located mainly in suburban areas.

Also, the study shows that a negative correlation between LST and NDVI suggests that a green area can reduce the effect of UHI, while a positive correlation between LST and NDBI indicates that the built-up land increases the effect of the UHI within the study area.

The seventeenth chapter contributed by B. Srinagesh and K. Sudarshan, India, analyses the urban infrastructure and sustainability which is a comparative study of some smart cities of Telangana. Authors in this paper specify that in the decision of investors to locate in a city, the presence of infrastructure facilities is always a major factor. In order to ensure the successful running of the economy, comprehensive and productive infrastructure is crucial since it is a significant factor in deciding the position of economic activity and the kinds of activities or sectors that will grow in a specific case. In the modern digital age, the use of technology can lead to better manufacturing, higher performance, mobility, and usability, the factors that improve competitiveness. Therefore, the information and communication technology (ICT) and preparedness of the government is critical. Cities and large towns, in particular, are hubs of economic development, drawing investment and resources from their surroundings, clusters, and the provinces in which they are located. In general, smart city does things like enhancing transport and accessibility, reinforcing social care, fostering sustainability. Telangana has 3 smart cities, viz; Hyderabad, Warangal, and Karimnagar that have several infrastructural shortcomings. The paper aims at a comparative study of these three smart cities in terms of infrastructural facilities that includes the road network, the distance from the city to various points of entry, the amount of visitor accommodation facilities, basic services, and infrastructures like water and electricity availability, connection to ICT (Internet Service Providers, etc.) number of public transport vehicles, health, and educational infrastructure and access to ATM's.

The eighteenth chapter is an ideal case study drafted by Mijing Gwra Basumatary, Subhash Anand, and Usha Rani, India. This study entails a SWOT Analysis to determine the feasibility for Guwahati Smart City. The data collected through primary and secondary sources has been categorized into strength, weakness, opportunity, and threat for the city. It has been found that Guwahati city is highly feasible for the smart city. The strength of the city is its strategic location, numerous educational centers and institutions, medical facilities, affordable rent houses, recreational places and natural water bodies, the Brahmaputra River, and numerous small streams, heritage, and Culture. The cities need to develop into a regional hub for education, IT, and ecotourism destination. Urban Expansion/Urban sprawl, rising vehicular population, sewage, and pollution finding its way into this stormwater drainage, earthquake zone, underground water depletion, theft, disappearing of small enterprises are the main threats of the city. The main problem in the city is its sanitation facilities. When it comes to public health, the city's technology is very primitive. In the rainy season, the biggest threat is flash flooding and landslides. While this issue is short-spanned during the monsoon season, it causes extensive losses for both life and property. Traffic is growing as with the recent rise in vehicles on the roads. The key reason for traffic problems is that there is not enough room on the narrow roads and not enough parking. More than a third of the road is taken up by parked cars, but the

other two-thirds is reserved for residential, commercial, and delivery vehicles. Water supply to the part of the city gets affected during the rainy season, from April to June, but this issue can be solved by piping water from the Brahmaputra River because the city has the capacity to dig it out of the ground during that time.

The nineteenth chapter on 'Smart City Surat: A case study for urban health system and climate resilience' raises the health issue in connection with Smart City. Flooding the city would be seen as having a significant impact on its health because of urbanization and global warming. The possible interventions in the form of integrated operational resilience action plan are developed.

The twentieth chapter discusses Industrial Pollution and Soil Quality: A case study from industrial area, Visakhapatnam, Andhra Pradesh, India. As per the authors, the environmental and industrial emissions are both equally deplorable and have the potential to decrease both human and agricultural productivity. Rapid industrialization leads to a substantial increase in the generation of industrial wastes leading to contamination of air, water, and soil. The pollution of soils by heavy metals has a major impact on the production and the quality of food. The authors investigated some physical, chemical, and biological properties of soil around Hindustan Zinc (HZ) and agricultural fields in the most polluted areas of Vishakhapatnam, India. Paddy was chosen as the main cash crop to be grown in this location because of fallow soil nearby and non-exposure to effluents. These samples were obtained from areas such as paddy field where the effluents were not present. Results show that the soil quality of both fallow and agricultural land near Hindustan Zinc limited are severely affected by the effluent coming out of the industry and require immediate attention for the benefit of the people living in this area.

The twenty-first chapter analyzes the urban extension and land use changes in Kalimpong Municipality using Remote Sensing and GIS and is contributed by Buddhadev Hembram and N C Jana, India. In this study, urban growth in the Kalimpong Municipality area is analyzed spatiotemporally using remote sensing and population change from 1991 to 2015. The objectives of this study are: (i) identifying the major land use changes in the Kalimpong Municipality area from 1995 to 2015, and (ii) study the pace of urban growth and its demographic change in the municipality from 1991 to 2011. Multi-temporal satellite images were used during the study period to identify and extract changes in land cover classes. Results show that the land cover classes with significant changes are the built-up land and the tea garden, with the former steadily increasing and the latter steadily decreasing.

The twenty-second Chapter deals with the water aspects of cities. The study has been conducted with the objectives of analyzing the status of water availability toward agriculture and domestic uses, studying the socio-economic conditions of the farmers, analyzing the revenue, cost, and profit in the production of selected crops, the cropping pattern of the farmers and the factors influencing the shift in the cropping pattern, looking at the water resources and the impact of water scarcity on the production of crops in the study area.

1.3 Conclusion and Way Forward

'Smart City' concept in India was initiated two decades before and formally 'Smart City Mission' was established in 2014. InIndia, initially, technological development was given prime importance but gradually many ambiguities drew the attention of policymakers to contemplate other issues. Critical gaps in the regulation of Smart City Mission were identified such as the mission limited to few large cities, delays in investments, coordination among the local, state and central government during the project implementation, timely completion of projects, and de allocation location of funds toward rural infrastructure instead of urban infrastructure. In addition to this, social and environmental issues in India, such as informality, absorption of migrants, inclusiveness, sustainable urbanization, green space, gender space, disaster resilience, livelihood guarantee, citizen's participation in decision-making, and the enhanced role of intangible connectivity and innovation of technology are being considered as the subdomains of smart city development. The draft on 'Climate Smart Cities' was released in 2019 as an assessment of smart cities development. The major areas of concern are the responsibility of local bodies, air, water, waste, urban governance, energy, and green buildings. During the course, it was observed that instead of focusing on massive and high-tech investment, it is essential to focus on important issues such as health which has become a major area of concern.

It was also felt that there is a need for strong coordination and micro-level planning involving all the stakeholders from bottom to top in order to include and resolve the emerging issues. However, investment is the base of smart city development and unless India receives huge funding from corporate and international donors to transform the existing cities into smart cities, Central or State Governments alone will not be able to bring the required changes. Smart cities are built on the pillars of sustainability; they try to build resilient cities and provide investments, livelihood guarantees, water, energy, transport, and built-in grievance redressal system. Also, there is a need to develop the fringe areas with basic resources to pull migration and sustain the migrants into their working places. Innovative methods for the proper implementation of land use planning are essential. Poverty, social inequality, occupational hazards, environmental concerns, namely availability of clean air, health and hygiene, absence of land use patterns are the greatest challenges. Municipalities in India should play a crucial role. Municipalities are very strong and well developed in countries like Germany and South Africa, because of which, urban development is very systematic. India needs to focus on strengthening the municipalities.

It is pertinent to have a data-driven economy to reach the goals of smart cities. Successful regulation of smart cities is depending upon the availability of data. Therefore, data transparency and data availability are considered as two pillars of planning. The feedback should be collected from citizens of the region before and after creating any policy in connection with their native places, because smart communities are the main driving force of a smart city. People occupy space in the urban environment, so they should be accounted for decision-making process too.

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Part I
Smart Cities: Conceptual Background, Growth and Development

Chapter 2
Monocentric City Plans to Polycentric Structures

Chris Johnson

Abstract The COVID-19 Pandemic will stimulate a rethink of the shape and structure of cities. A likely post-pandemic model will be to restructure cities as being a number of mini cities where there is a much closer relationship between where people live and where people work. This will reduce travel times and the congestion that comes with this. This paper will examine the traditional form of Indian cities and the role of geometry from ancient texts that gave structure to temples, towns and cities. Finally, the paper will promote the polycentric approach to city planning as a realistic response to the COVID-19 pandemic that manages large cities as being a combination of many mini cities.

Keywords Polycentric cities · Traditional Indian city patterns · Mini cities · Walkable cities

2.1 Introduction

India's capital city of New Delhi evolved as a series of separate city centres focussed around the palace of the latest ruler to give a spider's web of streets and boulevards that tied the parts together. The growing interest in the polycentric structuring of cities will be examined including case studies of city plans from different parts of the world. The city of Sydney in Australia is a case study of a city becoming polycentric based on a new metro rail transport system. The Indian mini city of Magarpatta at Pune will be examined as an example of a work/live structure that combines nature with a built environment.

C. Johnson (✉)
Urban Taskforce, Sydney, Australia

Institute of Public Enterprise, Hyderabad, India

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2.2 Indian City Patterns from Traditions

Indian architecture and city planning evolved from early texts that used geometry to give order to the built form. A good example is the temple town of Trichy in Southern India where the Sri Ranganathaswami Temple, located in the nearby town of Srirangam, becomes a mini city with seven walls that surround the inner sanctum. Dedicated to the Indian god Vishnu, the living history of the temple can be traced back over one thousand years. The temple and the city combine as a place for people to live, worship, trade, promenade and meet. At the time of the 1961 census, 42,000 people lived inside the walls (Fig. 2.1).

The Sri Ranganathaswami Temple's plan comes from a vast body of Sanskrit references on architecture that led to the Vastu Sashtra—the science of building—and from the science of building, the most applicable mechanism for the architecture of houses, temples or even whole cities was the Vastu Purusha Mandala. This was a square pattern divided into a number of sub-squares of an even or an odd breakdown. Most drawings of the mandala show a strange twisted form of an old man fitting into the square mandala. In an article on the *Wisdom of the Ancients*, Madhu Khanna outlined the myth behind the strange diagram.

'The myth proclaims the victory of order over chaos, good over evil and light over darkness. The narrative of Vastu Purusha is recounted in the Matsya Purana. A drop of sweat, a condensation of Shiva's fury trickled to the ground and assumed the form of a gigantic demon. Ugly and fierce, torn with ravenous hunger the demon

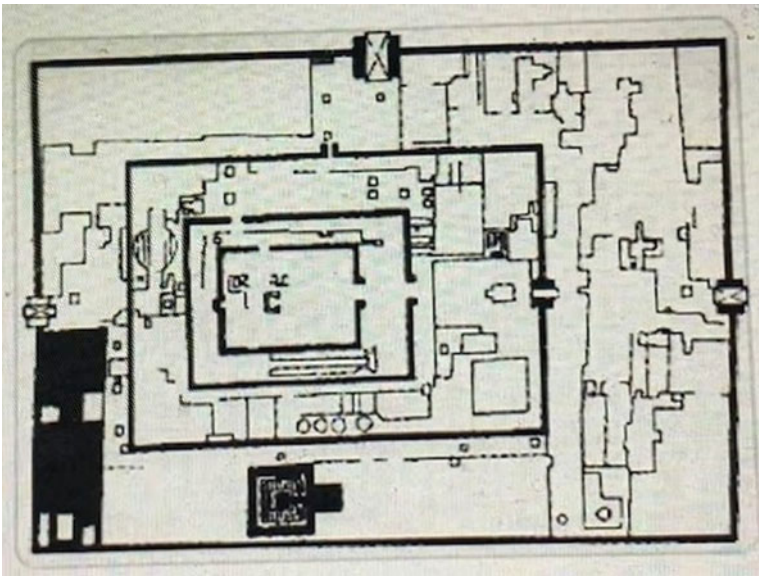

Fig. 2.1 Sri Ranganathaswami Temple with multiple enclosing walls. *Source* Phamplet given to author