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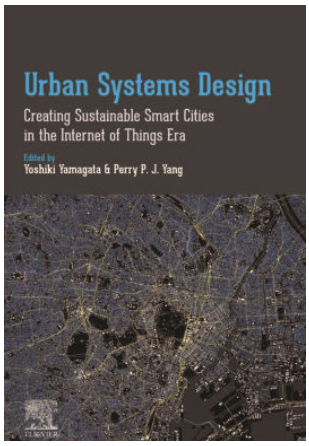
# Book Review

## Urban Systems Design

### Creating Sustainable Smart Cities in the Internet of Things Era

**Reviewed by:**
**Dr. Pradeepta Kumar Samanta**[1]

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Urban systems thinking are becoming very important for addressing sustainability issues in cities, especially in regard to climate change in terms of mitigation and adaptation measures. International agreements such as the Paris Agreement for climate change and Sustainable Development Goals (SDGs) prompt policy makers to implement these measures at cities based on their population size and economic activities. Smart cities are emerging as new

[1] Sr. Associate Professor, School of General Management, National institute of construction Management and Research (NICMAR), pksamanta@nicmar.ac.in

global movement that uses technologies to drive urban development. Urban design is becoming data-driven in the context of Internet of Things (IoT). IoT is changing human perception in cities, in which urban spaces are becoming situational. IoT as a new form of infrastructures is embedded in urban physical environment .Urban environment is now both physical and digital. Cities are an intelligent and interactive environment in which humans' perceptions, experiences, senses, responses, and decisions are crucial in promoting performance for designing sustainable smart cities.

This book introduces urban systems design, an approach that is based on an integration of urban design, system science, and emerging technologies. It explores how sustainable and future smart cities can be created in the IoT era. New methods of urban systems design are exemplified in various empirical applications by using urban analytics, big data, and artificial intelligence (AI). An attempt is made to outline a research agenda of smart cities that consists of data capturing and analytics, performance modelling and assessment, and design decisions and implementation. By setting performance goals such as sustainability, resiliency, economy, and human well-being, a comprehensive framework of modelling methods is provided in the book that can be validated and used in practical urban systems design for the making of sustainable and future smart cities.

There are14 chapters contributed by 35 authors divided into four parts. *Part one* of the book defines urban systems design as a novel approach by articulating urban design and system science. Intellectual legacy of urban design and the theories of urban complex systems were reviewed, which lead to four possible models of urban systems design as its conceptual framework.

*Part two* of the book explains the methodological details of the urban systems design approach and their applications to experimental case studies, particularly a series of Tokyo smart city projects run by urban design studios based on an international collaboration of the National Institute for Environmental Studies of Japan, the Georgia Institute of Technology, and the University of Tokyo. New ideas of smart urban systems modelling methods are tested through urban design studios. Firstly, the overarching urban systems design framework is elaborated through urban complexity modelling and data analytics tools using big data and AI for improving sustainability of cities. Modelling and design of smart buildings as an essential element of urban systems and approaches of scaling them up to smart communities are discussed. Potential alternatives of building typologies, urban forms, and how they influence human behaviour and properties of urban systems have been explored. By the use of massive data, the idea of big data analytics arising from the 2010s was rapidly adopted as a basis for a new scope of agent-based transport modelling. Mobility patterns and their consistency with the underlying network infrastructures are examined. The emergence of IoT technologies is also supporting the idea of managing cities as organizational systems. Making cybernetics as the basis for management of near real-time control can be applied as a new concept of urban systems design for smart cities projects.

*Part three* of the book discusses more sustainability-focused case studies to do with urban systems design. Smart cities can function as digital twin interaction empowered by sets of connected subsystems. The archetype urban structure can be designed around land use activities and their economic linkages, and the archetype can be represented by smart mobility movement. The key idea of demand response feedback is that the dynamics that holds systems together is represented in terms of a new version of city operations systems which aims to control the pattern of these interactions as an information system in time. New ICT notions (cloud, fog, edge servers) are useful for seeing how elements of urban systems scale up according to their system hierarchies which are beneficial in managing how local actions and interactions lead to multi-scale patterns. This new view is about how emergent urban systems patterns can be generated using information that changes the city from the bottom up. We also look at models of cities in buildings and transport, where we illustrate how interactions between key urban systems elements can be accessed from resilience and sustainability perspectives using key performance indicators. New complexity design can also create agglomeration economies. However, the ultimate goal of this new design is to improve human well-being.

*Part four* of the book discusses issues regarding transition toward smart communities at the implementation phase. None of the urban systems design models could be perfect for operationalizing smart cities in policy contexts. The socioeconomic local dynamics such as financial mechanism needs to be carefully considered when conducting urban systems design. Institutional instruments behind urban local area planning and management are explained as a key to the success of implementing urban systems design.

The information and communication technologies also change the way we understand cities. Technologies enable researchers to think of the non digital aspect of cities digitally, by using computer simulation and modelling, geographic information system (GIS), and building information modelling (BIM) to visualize, model, design, and manage physical urban environment from large-scale urban to small-scale building systems. Cities are now far more designable than ever before due to our capability to digitize, analyze, design, manipulate, and predict the outcomes of building and infrastructural systems, and to a certain extent the urban systems by making suitable changes in them.

IoT as a new smart infrastructure empowers cities to be more resilient to the emerging challenges such as, severe weather and extreme climate conditions. For instance, about 13 states in India faced flood situation in 2019. High frequency of natural or human-made disasters can lead to energy shortages, heat waves, flooding, and other consequences in cities. Many modern urban infrastructure systems,incitiessuchasTokyo,London,andNewYork,whichwereestablished decades or even centuries ago, were not necessarily designed keeping the resiliency factor in mind. IoT infrastructure and big data analytics as a new smart city infrastructure provide new approaches to empower cities and communities to track energy, material, water, transportation, and informational flows in the physical environment and turn them into real-

time information for better decision-making. It facilitates building a precise just-in-time response mechanism to deal with unpredictable changes. Smartsystems have to be flexible and responsive to make the overall urban systems more robust and resilient.

The authors in their papers show how to design, model and monitor smart communities using a distinctive IoT-based urban systems approach. While focusing on the essential dimensions that constitute smart communities energy, transport, urban form, and human comfort, the book explores how IoT-based sharing platforms can achieve greater community health and well-being based on relationship building, trust, and resilience. Uncovering the achievements of the most recent research on the potential of IoT and big data, this book shows how to identify, structure, measure and monitor multi-dimensional urban sustainability standards and progress.

This book demonstrates how to select a project, which technologies are most cost-effective, and their cost-benefit considerations. It also illustrates the financial, institutional, policy and technological needs for the successful transition to smart cities, and concludes by discussing both the conventional and innovative regulatory instruments needed for a fast and smooth transition to smart, sustainable communities. Further, the book reviews the various assessment and urban sustainability certification systems such as LEED, BREEAM, and CASBEE examining their smart technology address criteria. It also examines the existing technologies for efficient energy management, including HEMS, BEMS, energy harvesting, electric vehicles, smart grids etc.

The authors in the book have depicted several operational case studies and best practices from cities throughout Europe, North America, Latin America, Asia, Australia, and Africa. The authors have also provided instructive examples of the social, environmental, and economic aspects of smartification. The book is intended for researchers, professionals, and students who are interested in smart cities design, system engineering, and policy using IoT, big data, and AI, in which the new approach urban systems design would prepare them for advancing their works in research activities and learning. The authors hope that the book would stimulate academic and professional communities to build up cross-disciplinary collaborations which are essential to the making of our future cities as sustainable, resilient, and just places.