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Simon Elias Bibri *Editor*

Smart City Innovations: Navigating Urban Transformation with Sustainable Mobility

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ISSN 2522-8714 ISSN 2522-8722 (electronic)
Advances in Science, Technology & Innovation
IEREK Interdisciplinary Series for Sustainable Development
ISBN 978-3-031-57384-2 ISBN 978-3-031-57385-9 (eBook)
https://doi.org/10.1007/978-3-031-57385-9

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

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The Editors warmly thank all the Reviewers who have contributed their authority to the double-blind review process, to ensure the quality of this publication.

Preface

The book *Transformative Urban Futures: Innovations in Smart City Development and Sustainable Mobility* stands as a key extension of the influential Future Smart Cities (FSC) and Urban Transit and Sustainable Networks (UTSN) conferences series. These series have solidified their standing as seminal and dynamic platforms that explore the convergence of data-driven technologies, sustainable strategies, and advanced systems for urban planning and development. Much like the conferences, this book serves as a catalyst in elucidating the transformative power and innovative application of advanced Information and Communication Technologies (ICTs) on a global scale, particularly in the context of smart urban development and sustainable transportation. It provides valuable insights and captures the attention of policymakers, practitioners, researchers, and business leaders, who, in unity, contribute their extensive expertise towards shaping the visionary future of smart cities and their infrastructure, systems, and services.

In this volume, a compilation of high-quality research papers illustrates the transformative impact of emerging data-driven technologies, especially the Internet of Things and big data analytics, as well as advanced transportation and mobility strategies and solutions, on the wider urban landscape. These innovative contributions form an essential part of the joint forthcoming editions of the FSC and UTSN conferences, aiming to showcase the global significance of smart cities and their progress towards sustainability. The overarching goal is to foster sustainable urban development, improve urban services, and enhance the quality of life for citizens through the integration of emerging technologies and strategic sustainability. It invites participants to engage with leading experts and innovators in the field, fostering the exchange of novel ideas in a unique setting.

Themed "Smart City Innovations," this collaborative edition tackles the imperative of exploring and harnessing cutting-edge solutions. It responds to the pressing need for urban environments to seamlessly integrate technological advancements with sustainable practices. Addressing challenges such as rapid urbanization, ecological degradation, climate change, and resource constraints, the joint conferences uniquely align technology with sustainability. This dynamic intersection inspires groundbreaking strategies, laying the foundation for the future development of cities that are not only technologically advanced but also resilient and environmentally conscious.

The dual proceedings contribute to various domains, including renewable energy, city design, climate change mitigation, virtual urbanism, mobility and accessibility, and sustainable transportation. Tailored to resonate with policymakers, practitioners, researchers, and business leaders, this book provides a comprehensive framework that bridges theoretical insights with practical applications, offering actionable strategies to navigate the dynamic landscape of urban development and innovation. These stakeholders, eager to drive transformative change within the urban landscape, play a pivotal role in shaping the narrative and trajectory of cities for future generations.

Lausanne, Switzerland — Simon Elias Bibri

Acknowledgements

We extend our sincere gratitude to the dedicated editorial team at IEREK for their unwavering support and expertise in bringing this edited volume to fruition. While this book has a single editor, the commitment of the editorial team has been instrumental in shaping its content, structure, and ensuring academic rigor.

A special note of appreciation is directed towards the diligent reviewers, who generously invested their time and effort in evaluating the submitted papers for this volume. Their insightful feedback significantly contributed to maintaining the high quality and scholarly integrity of this publication, enriching the content and fostering its overall excellence.

Our sincere thanks are also extended to the authors who contributed their research papers, sharing innovative ideas and novel insights into the future of smart and sustainable cities in the context of this edited volume. Their collective expertise forms the cornerstone of this publication, offering diverse perspectives that enhance our understanding of the subject matter.

Lastly, but by no means least, we acknowledge the continued support of IEREK in advancing the global dialogue on smart and sustainable cities through the collaborative efforts that made this book possible. Their visionary approach to disseminating knowledge and fostering interdisciplinary discussions has been invaluable. We express our appreciation to all who have played a role in this volume, contributing to the ongoing discourse surrounding sustainable urban development. Thank you for your contributions and dedication to advancing knowledge in this rapidly burgeoning field.

A Word from the Editor

It is with great pleasure that I welcome you to the latest editions of Future Smart Cities (FSC) and Urban Transit and Sustainable Networks. As the editor, I am delighted to present a collection of insightful chapters that delve into the forefront of smart sustainable urban development.

This joint edition reflects the dedication and expertise of our contributors, whose research has significantly contributed to the discourse on smart cities and sustainable networks. From innovative urban planning to cutting-edge transportation solutions, each chapter offers a unique perspective and adds value to the ongoing scholarly debate about shaping the cities of the future.

I extend my sincere gratitude to all the reviewers and contributors who have played a crucial role in bringing this volume to fruition. Their commitment to advancing knowledge in the field of urban development is truly praiseworthy.

I invite you to explore the diverse and thought-provoking content within these pages. May this edition inspire new ideas, foster collaboration, and contribute to the continued evolution of smart and sustainable cities.

Introduction

In an era marked by rapid urbanization, ecological degradation, and technological advancement, coupled with a growing urgency for sustainable development, the discourse surrounding smart cities and sustainable mobility has become central to discussions on transformative urban innovations. This edited volume stands as a compendium of scholarly insights and investigations into the expansive tapestry and strategic trajectory of the evolving urban landscapes. This collection explores urban innovations and sustainable mobility solutions, weaving together a narrative that captures the complexities and possibilities inherent in the dynamic relationship between technology, transportation planning, urban design, and environmental consciousness.

Cities worldwide grapple with a complex web of challenges arising from factors such as population growth, resource scarcity, and the impact reverberation of climate change. Against this backdrop, the imperative to reimagine urban environments and mobility solutions becomes not just a choice but a necessity. The introductory chapters of this volume unfold against the canvas of these complexities and wicked problems, asserting that smart city development and sustainable mobility are not disparate pursuits but integral components of a cohesive urban future.

In tandem with the challenges inherent in urban complexities, the significance of inclusive urban design and sustainable technology emerges as a crucial theme (Bibri 2022). As cities evolve, the need to ensure accessibility, equity, efficiency, resilience, and social inclusivity in urban environments becomes increasingly pertinent. Inclusive urban design and sustainable technology principles can serve as catalysts for addressing urban complexities. It plays a key role in fostering communities that are adaptable and responsive to the diverse needs of their inhabitants. Understanding the symbiotic relationship among urban design, sustainable technology, and the social fabric is paramount for shaping smart cities of the future. This synergy is also giving rise to novel approaches to sustainable urban development, which are enabled by advancements in smart city technologies. These approaches include innovative concepts such as sustainable smart cities and smarter eco-cities, where emerging technologies and models such as Artificial Intelligence (AI), Artificial Intelligence of Things (AIoT), Urban Digital Twin (UDT), and other manifestations of platform urbanism are increasingly being leveraged to optimize resource management, reduce environmental impact, and enhance the quality of life for residents through data-driven urban planning and governance (Bibri et al. 2024a, b).

Furthermore, the significance of efficient and effective transportation takes center stage. Beyond the physical layout of urban spaces, the seamless and well-orchestrated movement of people within a city not only shapes its structural development but also significantly contributes to its overall growth, functionality, and vitality. Transportation development can enhance mobility options for all residents, ensuring that diverse communities have equitable access to efficient and sustainable modes of transportation. Addressing accessibility challenges and promoting smart solutions become key components in fostering a more accessible urban environment. Examining the interplay between urban design and transportation dynamics offers a holistic perspective on shaping cities that prioritize accessibility and mobility for everyone, regardless of their background or abilities. This approach is part of wider integrated

models for strategic sustainable urban development, which seek to harmonize environmental protection, economic growth, and social inclusion (Bibri 2021). These models emphasize the importance of collaboration among governments, communities, and businesses to create holistic solutions that can be adapted to different urban contexts worldwide.

In light of the above, this edited book is organized into four distinct parts, each delving into specific facets of the book's overarching theme, offering a comprehensive exploration of diverse perspectives and research insights within the field.

The first part, *Smart Cities and Sustainable Technologies*, initiates the exploration by contemplating the potential of smart cities through innovative technological lenses. The chapters within this part transcend geographical boundaries, offering a panoramic view of transformative applications. From harnessing advanced mapping applications to bolster urban planning to conducting nuanced analyses of shared automated mobility solutions, the contributors unravel the dynamic interplay between technology and urban living. Additionally, the exploration extends to alternative energy solutions and knowledge-driven problem identification within the realm of developmental initiatives, emphasizing the transformative influence of technology in shaping the trajectory of sustainable urban environments. From the utilization of advanced mapping applications empowering urban planning to insightful examinations of sustainable transportation through the development of wind turbines for vehicle battery recharge, the contributors skillfully unravel the dynamic interactions between technology and urban living. Furthermore, explorations into alternative energy solutions and knowledge-driven problem identification in the context of developmental initiatives underscore the transformative power of technology in shaping the future of sustainable urban environments.

The second part, *Smart Cities and Sustainability*, broadens the discourse beyond technological considerations. Here, the focus expands to encompass the cultural and environmental dimensions of smart and sustainable urban living. The Metaverse becomes a platform for addressing climate change impacts through a digital lens, as well as for enhancing tourist experience through virtual heritage, Cultural biases within smart city initiatives are scrutinized. The second part positions smart cities not just as technological hubs but as holistic ecosystems where human values and environmental sustainability converge.

The third thematic part, *Urban Public Transport and Mobility Planning*, delves into the strategic orchestration of urban mobility. It transcends the realm of technology to address the very fabric of urban life. Chapters within this part unravel the complexities of reorganizing urban public transport strategically. They explore innovative solutions for urban mobility, employ advanced spatial analyses to measure accessibility, and scrutinize transportation network dynamics. The third part encapsulates the essence of sustainable mobility planning, where technology aligns with strategic organization to redefine the urban mobility landscape.

The final thematic part, *Transportation and Urban Challenges*, confronts head-on the multifaceted challenges embedded in contemporary urban landscapes. From probing behavioral aspects through exploring the potential of Shared Automated Electric Vehicles (SAEVs) to addressing urban transportation challenges, this part encapsulates the real-world hurdles of urban transportation. It evaluates the potential success and implications of emerging transportation technologies and introduces sustainable alternatives for addressing weather-related issues in urban areas. The fourth part crystallizes the challenges and innovations needed for urban transportation to seamlessly integrate with the city fabric.

As readers navigate through the chapters, they encounter a spectrum of methodologies, from analytical studies and behavioral assessments to technological applications and design strategies. This methodological diversity not only enriches the content but also mirrors the multidimensional nature of smart city development and sustainable mobility challenges. Moreover, the volume is not merely a snapshot of the present; it is a forward-looking exploration, anticipating future trends and challenges. The contributors collectively envision the sustainable, smart cities of tomorrow and provide a roadmap for scholars, urban planners, policymakers, and practitioners alike.

In essence, this edited book is more than a compilation of chapters; it is a profound intellectual journey through the complexities, challenges, and transformative potentials embedded in the nexus of smart city development and sustainable mobility. The pages of this volume invite readers to embark on a journey of discovery, encouraging them to contemplate the complex interweaving of urban living and mobility within the context of an ever-evolving technological and environmental landscape.

References

Bibri, S. E. (2021). Data-Driven Smart Eco-Cities of the Future: An Empirically Informed Integrated Model for Strategic Sustainable Urban Development. *World Futures, 79*(7–8), 703–746. https://doi.org/10.1080/02604027.2021.1969877

Bibri, S. E. (2022). Eco-Districts and Data-Driven Smart Eco-Cities: Emerging Approaches to Strategic Planning by Design and Spatial Scaling and Evaluation by Technology. *Land Use Policy, 113*(6), 105830. https://doi.org/10.1016/j.landusepol.2021.105830

Bibri, S. E., Huang, J., Jagatheesaperumal, S. K., & Krogstie, J. (2024a). The Synergistic Interplay of Artificial Intelligence and Digital Twin in Environmentally Planning Sustainable Smart Cities: A Comprehensive Systematic Review. *Environmental Science and Ecotechnology, 20*, 100433. https://doi.org/10.1016/j.ese.2024.100433

Bibri, S. E., Huang, J., & Krogstie, J. (2024b). Artificial Intelligence of Things for Synergizing Smarter Eco-City Brain, Metabolism, and Platform: Pioneering Data-Driven Environmental Governance. *Sustainable Cities and Society*, 105516. https://doi.org/10.1016/j.scs.2024.105516

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