

Editorial

# Smart Technologies for Sustainable Urban and Regional Development

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## 1. Introduction

In the dynamic landscape of contemporary living spaces, cities, and societies, the call for sustainable urban and regional development resonates with increasing urgency. This Special Issue addresses this urgency head-on. It is dedicated to exploring the multifaceted challenges and burgeoning opportunities in the domain of sustainable development, leveraging the immense potential of advanced technologies.

As the complexities of our urban and societal environments escalate, manifesting in various forms such as natural pandemics, disasters, civil unrest, and economic disparities, this Special Issue aims to provide a critical platform for discourse and innovation. Anchored by the United Nations' Sustainable Development Goals (SDGs), this Special Issue underscores the imperative for urgent, comprehensive, and collaborative action towards achieving the triple bottom line of sustainability—encompassing social, environmental, and economic dimensions. This Special Issue transcends the conventional boundaries of technological exploration. It explores the strategic application of a plethora of advanced technologies—from the miniaturization and digitization of sensors and actuators to AI and big data-driven insights and optimizations; digital twins; and cloud, fog, and edge computing. These technological advancements are not merely tools for efficiency but are envisioned as catalysts for sustainable urban futures, guided by ethical, responsible, and long-term sustainable practices [1–3].

Bringing together a diverse range of research articles and literature reviews, this Special Issue serves as a melting pot of ideas and innovations. It fosters a much-needed dialogue among various communities engaged in policy and infrastructure research, aiming to understand the interplay of cross-disciplinary issues and collaboratively forge holistic, sustainable, and globally optimized solutions. As we navigate through the pages of this Special Issue, we the Guest Editors invite our readers to immerse themselves in the rich tapestry of insights and perspectives. Each contribution is a piece of the puzzle in understanding and shaping sustainable urban and regional development in our intricately connected and rapidly evolving world. Within this editorial, the 13 published papers are primarily organized into five themes for simplicity and clarity, though it is important to note that many of these papers intersect with multiple themes.

Figure 1 depicts the top keywords from the articles published in this Special Issue. The word cloud visually encapsulates the thematic essence of the Special Issue. Dominant

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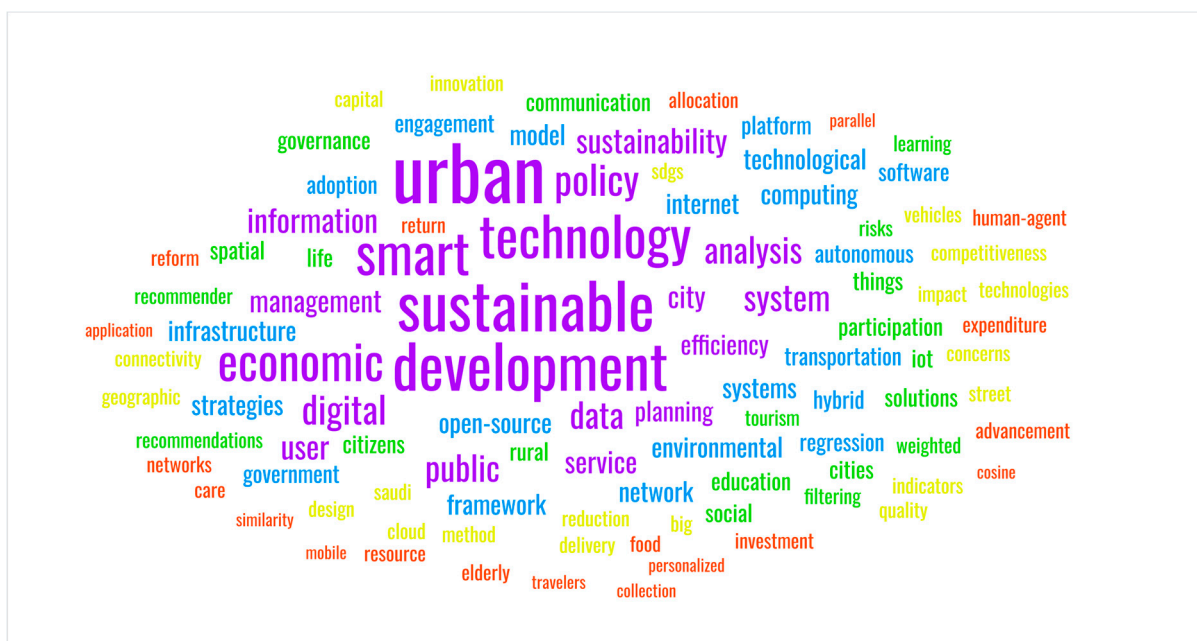
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terms like “urban”, “smart”, “technology”, “sustainable”, and “development” affirm the centrality of innovative, tech-driven approaches relative to urban and regional development. Supporting keywords such as “economic”, “digital”, “system”, “data”, and “policy” reflect the multifaceted discourse spanning economic considerations, digital infrastructures, systematic planning, data utilization, and policy making. The inclusion of “citizens”, “public”, “education”, and “environmental” underscores a commitment to inclusivity, educational outreach, and environmental stewardship. This graphic synthesis illustrates the interconnectivity of concepts that are pivotal to advancing sustainable urban futures.

Next, we discuss each of these themes, exploring how they collectively and individually contribute to the broader narrative of sustainable urban and regional development.



**Figure 1.** Word cloud depicting the top keywords from the articles published in this Special Issue.

### 1.1. Technological Innovation for Sustainable Urban Development

This theme explores how technological innovation, particularly in the realms of AI, IoT, big data analytics, and blockchain, serves as a cornerstone for sustainable urban development. It encompasses the development and application of advanced technologies to create smarter, more efficient, and sustainable urban environments. Alshamlan et al. (Contribution 1) introduce a novel weighted parallel hybrid recommendation system to enhance the tourism experience. By providing personalized travel recommendations, it addresses the limitations of existing tourism mobile applications. This system signifies the application of AI and data analytics in improving user experiences in urban tourism, showcasing how technology can personalize and elevate sustainable urban interactions. Binsaedan et al. (Contribution 6) explore the development of an urban computing framework for smart neighbourhoods in Jizan City, Saudi Arabia. Their work underscores the pivotal role of digital technologies in urban development. This study aligns with the theme by showcasing how urban computing can improve quality of life, environmental protection, and economic growth in urban neighbourhoods.

Xiang et al. (Contribution 7) focus their research on the application of smart technologies in street renewal, emphasizing sustainable urban development in China. They investigate smart street management and control in five Chinese cities, categorizing applications into areas such as smart transportation and environmental monitoring. This study exemplifies the integration of IoT and smart technologies in urban planning, enhancing the sustainability of street spaces. Goldsmith et al. (Contribution 13) investigate the

potential of blockchain technology in addressing governance challenges in Oman. Their paper examines how blockchain can enhance, supplement, or reform existing governance systems. This exploration emphasizes the role of technological innovation in facilitating more transparent, efficient, and accountable governance in urban settings, showcasing its potential impact on modern urban development.

Each of these contributions underscores the vital role of technological innovation in shaping sustainable urban environments. They reflect the diverse applications of advanced technologies, from enhancing tourism experiences to improving street management and governance systems. These studies collectively illustrate the transformative impact of technology on urban sustainability.

Future research in the realm of technological innovation for sustainable urban development, drawing upon the studies of Alshamlan et al. (Contribution 1), Xiang et al. (Contribution 7), Goldsmith et al. (Contribution 13), and Binsaedan et al. (Contribution 6) could focus on expanding the scope and scalability of urban computing applications. This involves exploring sophisticated AI and IoT integrations for diverse city functions, from traffic and environmental management to public safety and utility services. The potential of blockchain technology, as investigated by Goldsmith et al., can be extended to broader urban contexts, providing efficient, transparent, and secure solutions for urban governance and service delivery. Future studies should also emphasize user-centric design in urban technology innovations, ensuring solutions are tailored to the diverse needs and preferences of urban populations. Additionally, there is a significant opportunity for interdisciplinary research that merges urban planning, information technology, and social sciences, aiming to develop holistic and sustainable urban solutions. This comprehensive approach will contribute to the advancement of smart urban environments, aligning technological sophistication with social welfare and environmental sustainability. Moreover, the insights from Binsaedan et al.'s urban computing framework (Contribution 6) highlight the importance of incorporating digital infrastructure in a way that enhances the quality of life and economic growth in urban neighbourhoods. By focusing on these areas, future research can ensure that technological advancements in urban development are not only innovative but also inclusive, adaptable, and aligned with the broader goals of sustainable urban living.

### *1.2. Smart and Sustainable Mobility and Infrastructure*

This theme focuses on the advancements and challenges in developing smart, sustainable mobility solutions and infrastructure. It encompasses the use of innovative technologies to enhance transportation systems, improve digital infrastructure, and ensure efficient, eco-friendly urban mobility. Li et al. (Contribution 2) discuss the impact of open-source platforms in challenging the digital infrastructure triopoly of major operating systems. It emphasizes the role of government incentives and stakeholder collaboration in fostering sustainable, open-source digital ecosystems, highlighting a shift towards more equitable and accessible digital infrastructures. Golbabaee et al. (Contribution 3) explore the socio-demographic factors influencing perceptions and attitudes towards autonomous demand-responsive transit (ADRT), particularly autonomous shuttle buses. This study aligns with sustainable mobility, examining how various social groups perceive and interact with emerging transportation technologies. Maluleke et al. (Contribution 8) focus on the economic feasibility of deploying 5G networks in rural South Africa and contribute to the infrastructure aspect of sustainable mobility. They examine the integration of terrestrial and aerial networks for 5G coverage, addressing the digital divide and enhancing connectivity in rural areas. This research is pivotal in understanding how advanced telecommunication networks can support sustainable development in less urbanized regions.

Future research in the realm of smart and sustainable mobility and infrastructure, drawing from the works of Li et al. (Contribution 2), Golbabaee et al. (Contribution 3), and Maluleke et al. (Contribution 8), could explore the seamless integration of autonomous transportation systems into existing urban fabrics, emphasizing both efficiency and public

acceptance. Investigating the expansion of advanced telecommunication networks, such as 6G, is crucial for supporting smarter infrastructure across diverse landscapes, from bustling urban centres to rural areas. Future studies should also focus on ensuring equitable access to digital resources, a challenge highlighted by Li et al., to bridge the digital divide and foster inclusive urban development. Additionally, the environmental impact of new mobility solutions, particularly their role in promoting green transportation and reducing urban carbon footprints, is a pertinent area for exploration. This comprehensive approach, encompassing technological, social, and environmental aspects, is key to advancing sustainable urban mobility and infrastructure.

### *1.3. Citizen Engagement and Participatory Governance*

This theme emphasizes the importance of involving citizens in the governance and development of sustainable urban environments. It explores how participatory approaches and digital governance can enhance decision-making processes, ensuring that urban development aligns with the needs and aspirations of the community. Alamoudi et al. (Contribution 5) present a framework for citizen participation in the development of smart sustainable cities in Saudi Arabia. They underscore the significance of engaging citizens in urban planning and decision-making processes, highlighting the crucial role of human involvement alongside technological advancements in creating equitable and sustainable urban environments. David et al. (Contribution 11) focus on the adoption strategies of digital technologies by local governments and investigate the challenges and opportunities of digital governance. They stress the need for a balanced approach that includes public participation, skill development among employees, and a clear understanding of the technology's impact, advocating for a more inclusive and transparent governance model.

Building on the insights from Alamoudi et al. (Contribution 5) and David et al. (Contribution 11), future research on this theme could explore the development of more interactive and user-friendly digital platforms for civic engagement, enhancing the accessibility and inclusivity of governance processes. Studies could also investigate the impact of digital governance tools on enhancing transparency and accountability in urban management, drawing from the advancements in digital technologies discussed by David et al. Investigating strategies for effectively integrating citizen feedback into urban planning and policy making, as suggested by Alamoudi et al., is another critical area for future research. This approach should focus on understanding the diverse needs of urban populations, ensuring that governance models are adaptable and responsive to the changing dynamics of urban societies. Additionally, the exploration of novel participatory models that leverage emerging technologies like blockchain, as mentioned by Goldsmith et al. (Contribution 13), could further enhance the efficacy and trustworthiness of participatory governance systems.

### *1.4. Socio-Economic Aspects of Sustainability*

This theme reveals the socio-economic dimensions of sustainability, showing how urban development initiatives impact and are influenced by social and economic factors. It encompasses studies on education, healthcare, quality of life, and economic patterns and how these elements interplay with sustainable development goals. Golbabaee et al. (Contribution 3) investigate the socio-demographic predictors influencing public perception and attitudes towards autonomous demand-responsive transit use. Their research offers critical insights into how different societal segments respond to new transportation technologies. This study underscores the necessity of addressing diverse societal needs and perspectives in urban development initiatives, emphasizing the importance of inclusivity in the evolution of urban transportation. Kuzior et al. (Contribution 4) investigate the relationship between adult education and a country's economic competitiveness and innovative potential, highlighting the significant role of lifelong learning in sustainable development. Their study reveals the profound socio-economic impact of education on

national progress, drawing attention to the crucial interplay between educational initiatives and a nation's developmental trajectory. Ding et al. (Contribution 10) offer an analysis of the economic spatial patterns within the Chengdu–Chongqing urban agglomeration, focusing on the factors that influence economic development in these urban clusters. Their study sheds light on the uneven spatial distribution of economic development and underscores the importance of policy interventions that aim to address regional disparities. This research provides essential insights into achieving balanced economic growth, highlighting a key aspect of sustainable urban development.

Future research in this area, inspired by the works of Golbabaie et al. (Contribution 3), Kuzior et al. (Contribution 4), and Ding et al. (Contribution 10), could further investigate the intricate relationship between urban development and socio-economic factors. Studies could explore more comprehensive strategies to integrate education, particularly lifelong learning, into urban development policies to foster economic growth and innovation, as discussed by Kuzior et al. Research could also explore the social implications of emerging urban technologies, assessing their accessibility and impact across different demographic groups, building on the insights provided by Golbabaie et al. Additionally, there is a need to examine the economic disparities within urban regions, as highlighted by Ding et al., to develop more equitable and inclusive urban development strategies. This future work should aim to create a sustainable urban environment that not only advances technologically but also nurtures social well-being and economic equity.

### *1.5. Green AI and Sustainable Systems*

This theme addresses the intersection of artificial intelligence, sustainability, and environmental consciousness. It focuses on how green AI and other sustainable technologies can be used to create systems that are not only efficient and innovative but also responsible and ecologically sound. This theme explores the development and application of technologies that prioritize long-term sustainability over short-term gains, aligning with the broader goals of sustainable urban futures.

Trieu and Lin (Contribution 9) present an important study on developing a service system for optimizing food resource allocation and service exchange, employing multi-agent systems and AI. Their work showcases the potential of advanced technology in enhancing the sustainability and efficiency of food networks. This research is a notable example of how technology can be adeptly used to bridge urban–rural sustainability gaps, offering innovative solutions to complex logistical challenges. Hung's paper (Contribution 12) offers an insightful exploration of smart elderly care services in China, addressing both the challenges and advancements in this evolving field. The integration of smart technologies in elderly care is a testament to a broader commitment to improving the quality of life for the aging population, while simultaneously promoting sustainability within healthcare systems. This study highlights the vital role of technology in transforming healthcare services to meet the needs of an aging urban society.

Future research, drawing from the findings of Trieu and Lin (Contribution 9) and Hung (Contribution 12), could explore the development of AI-driven systems that prioritize ecological and social sustainability. This includes advancing AI technologies in urban agriculture and food systems, optimizing resource use, and reducing waste. Research should also focus on creating smart healthcare systems that are not only technologically advanced but also sustainable and accessible to all segments of society, as highlighted in Hung's study. Additionally, there is scope for investigating how green AI can be integrated into various urban systems, such as waste management and energy consumption, to promote sustainable living practices. This research direction would align with the overarching goal of developing urban environments that are technologically advanced, socially inclusive, and environmentally responsible.

## 2. Discussion

The array of contributions in this Special Issue not only illuminates the multifaceted nature of sustainable urban and regional development but also weaves a narrative that underscores the critical interplay between technology and sustainability. As we navigate through the insights offered by each paper, a mosaic of innovative approaches and thought-provoking perspectives emerges, collectively advancing our understanding of smart technologies in the urban and regional context.

Notably, the thematic categorization of the contributions reveals an intricate tapestry of research directions. From the detailed exploration of technological innovation for urban development, as observed in the works of Alshamlan et al. (Contribution 1) and Binsaedan et al. (Contribution 6), to the profound considerations of socio-economic aspects of sustainability, highlighted by Golbabaie et al. (Contribution 3) and Kuzior et al. (Contribution 4), each theme contributes a unique hue to our understanding of sustainable development.

A critical observation across these themes is the harmonious balance between technological advancements and the human element—be it through citizen engagement, as emphasized by Alamoudi et al. (Contribution 5), or the socio-economic implications underscored by Ding et al. (Contribution 10). This balance is pivotal, ensuring that while we march forward with technological prowess, we remain grounded in the realities and subtleties of human experiences and societal needs. Furthermore, the contributions collectively underscore the importance of adaptable and resilient systems, as delineated in the discussions on green AI and sustainable systems. The innovative approaches of Trieu and Lin (Contribution 9) and Hung (Contribution 12) not only advocate for technological efficiency but also stress the need for sustainability and ethical consideration in our pursuit of urban development.

The findings and insights presented in this Special Issue have significant implications for practice and policy in the realm of sustainable urban and regional development. They highlight the integration of urban computing and AI in improving urban planning and management efficiency and the transformative role of blockchain in enhancing governance transparency. The emphasis on citizen engagement and inclusive governance underlines the importance of participatory urban development. Additionally, the focus on green AI and sustainable systems emphasizes the need to balance technological advancements with environmental sustainability. This compendium serves as a crucial guide for stakeholders in fostering innovative and sustainable urban development.

This Special Issue acknowledges the challenges and limitations in current research, offering a realistic perspective for future development. Key challenges include integrating advanced technologies like AI and IoT into urban infrastructures, revealing a gap between theoretical models and real-world applications. The scope of research also faces limitations in addressing diverse socio-economic and cultural contexts, underscoring the need for more comprehensive studies. Additionally, issues with data availability and scalability of solutions highlight the need for research that is universally applicable. Future work should focus on collaborative, interdisciplinary research, developing adaptable solutions, and bridging the gap between innovation and practical implementation. These efforts are crucial for evolving the field and creating more robust, inclusive urban solutions.

As we synthesize the insights from this Special Issue, it becomes evident that the journey towards sustainable urban and regional development is not linear but a multifaceted endeavour. It demands a collaborative approach, integrating diverse perspectives and expertise and a willingness to adapt and evolve with the changing dynamics of our urban landscapes.

## 3. Conclusions

As we draw to a close on this Special Issue, it is clear that the journey towards sustainable urban and regional development is multifaceted and continuously evolving. The diverse array of research presented here not only contributes to a deeper understanding

of smart technologies in urban settings but also highlights the importance of integrating these technologies with social, economic, and environmental considerations.

The contributions in this Special Issue, from the implementation of innovative urban computing frameworks to the exploration of green AI and sustainable systems, collectively paint a picture of a future where technology and sustainability go hand in hand. However, as we have seen, this journey is not without its challenges. The limitations and obstacles faced by researchers remind us of the complex reality of urban development and the need for adaptable, inclusive solutions.

Looking ahead, the consolidated future work directions offer a roadmap for addressing these challenges. Building upon the insights and findings from this Special Issue, future research can explore sophisticated AI and IoT integrations for diverse city functions, expand the application of blockchain technology in urban governance, and emphasize user-centric design in technological innovations. It should also aim to develop holistic solutions that balance technological advancement with ethical, social, and environmental considerations.

Finally, this Special Issue stands as a beacon, guiding us towards innovative, sustainable, and globally optimized solutions for urban and regional development. The path forward calls for collaboration, adaptability, and a commitment to not just envision but actively construct sustainable cities and regions of the future.

**Conflicts of Interest:** The authors declare no conflicts of interest.

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