Chapter 2
Smart Infrastructure and Sustainable Urban Systems

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ABSTRACT

Smart Infrastructure and Sustainable Urban Systems integrate advanced technologies with sustainable practices to tackle urbanization challenges. Focusing on environmental sustainability, social equity, technological integration, and climate resilience, it highlights strategies like IoT, renewable energy, and nature-based solutions to enhance urban quality of life. Emphasizing collaboration and inclusive policies, it offers a roadmap to develop adaptive, resource-efficient, and equitable cities for a sustainable future.

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1.INTRODUCTION

The rapid urbanization of the 21st century has turned cities into complex ecosystems, accommodating more than half of the global population. This growth fuels economic development and innovation but also brings challenges like resource depletion, environmental damage, inadequate infrastructure, and social inequality. Traditional urban systems are ill-equipped for these demands, calling for a new approach that combines advanced technology with sustainability to build efficient, inclusive, and eco-friendly cities. This has led to the emergence of smart infrastructure and sustainable urban systems aimed at creating resilient urban environments (Kasai et al., 2015; Makvandi et al., 2024).

Smart infrastructure uses technologies like IoT, AI, and big data to optimize city operations. These tools allow real-time monitoring and resource management, improving systems such as transportation, energy, and water, while enhancing public services. For example, AI-driven smart grids reduce energy waste by adjusting power distribution, and IoT-based transport systems improve mobility through data analysis. The integration of these technologies with sustainability practices maximizes efficiency and reduces environmental impact (Angelidou et al., 2018; Kasai et al., 2015). Sustainability now plays a key role in urban planning, as cities strive to grow responsibly. This includes using renewable energy, implementing circular waste systems, and promoting green building designs. Cities like Copenhagen and Amsterdam exemplify this approach, focusing on reducing emissions and enhancing livability. These efforts support global goals for climate resilience, emphasizing the need to tackle environmental issues while supporting urban development (Parekh & Smith, 2024; Ruiz-Vanoye et al., 2025).

One of the critical components of sustainable urban systems is environmental sustainability, which prioritizes the responsible use of resources to minimize harm to the planet. Cities are major contributors to climate change, accounting for over 70% of global greenhouse gas emissions. By integrating renewable energy systems, smart cities can significantly reduce their carbon footprint. Smart energy grids, solar-powered streetlights, and energy-efficient buildings exemplify how technology can drive sustainability (Sargsyan, 2024; Setiawan et al., 2024). Moreover, innovative waste management practices such as recycling, composting, and waste-to-energy technologies create circular economies, reducing the strain on landfills and promoting resource recovery (Okwandu et al., 2024; Sargsyan, 2024; Setiawan et al., 2024).

Social equity is another key pillar of sustainable urban systems. Modern cities are often characterized by stark inequalities, with marginalized communities bearing the brunt of poor infrastructure, environmental hazards, and limited access to resources. Inclusive urban planning seeks to address these disparities by prioritizing affordable housing (Ariaee & Takalloo, n.d.), equitable access to public services, and active