

The Role of Smart Technologies in Promoting Sustainable Urban Planning

**Sara Mojarad, Bachelor of Urban Planning, Rasam Higher Education Institute, Karaj,
Alborz, Iran**

Mojarad.shahrdari9@yahoo.com

1. Introduction

Global urbanisation is proceeding apace, with cities being built at rates never before seen – in both area and population. The United Nations has projected that 70% of the global population in 2050 will live in cities, emphasizing the urgency to build sustainable, resilient and livable cities for people. (United Nations, 2019) But too much of a good thing: by growing so quickly, they have also put pressure on urban infrastructure, created environmental damage and made social inequality worse. There are now challenges associated with cities such as traffic, and air and water pollution, wasteful energy consumption or management of waste (Kumar et al., 2023; Lee & Kim, 2022). Under the latter condition the use of advanced technological platforms, in city planning and organization, is crucial for coping with complexity and to support sustainability. The adoption of technologies referred to as "smart" is on the rise, including the Internet of Things (IoT), artificial intelligence (AI), big data, and geographic information systems (GIS), to develop what are often referred to as "smart cities." Smart technologies provide the ability for cities to capture and assess data in real-time, make decisions in real-time, and optimize urban services – all in the service of generating innovative and creative solutions to complex urban issues (Zhao & Lee, 2023; Mupfumira et al, 2024). For example, IoT applications in smart utility-type grids and infrastructure monitoring can result in increased energy efficiencies and decreased emissions while AI algorithms can interrupt traffic flows and improve public transport (Shao et al., 2025; Parker & Ahmed, 2023). At the end of the day, cities can employ big data to forecast demand and environmental damage for future planning and policy decisions (Yang et al., 2024).

Sustainable urban planning is not just about environmentally sustainable practices, rather it includes social justice and equity and economic vitality. Smart technologies have the ability to increase all of these dimensions together by improving resource management, improved access, and by advancing participatory governance (Morris et al., 2024; Singh & Kumar, 2023).

Nonetheless, with the continued interest in and investment toward smart technologies, the full realization and distribution of their potential benefits will remain recalcitrant because of the challenge of cost to implement smart technologies, data privacy integrity, interoperability of the various types of technologies, and with the inequitable digital divide leaving vulnerable residents disconnected to smart technologies (Patel & Smith, 2023; Martinez et al., 2023). Given the expanding literature on the relationship of smart technologies with sustainable urban planning, we argue there is a justified need to conduct a systematic review of the literature. A systematic review could serve to collate the current literature, evaluate effective technologies and strategies, and

identify emerging gaps and barriers. Previous reviews have examined smart city framework or technologies in isolation, but few have systematically examined the contributions of smart technologies towards advancing sustainability through multiple urban contexts (Mupfumira et al., 2024; Trindade et al., 2017). The goal of this systematic review is to assess peer-reviewed research in high-quality journals published in the last 5 years to capture a current and holistic view on how smart technologies assist in the delivery of sustainable urban planning. The review analyzes the types of technologies used, the effects of the technologies on environmental, economic, and social sustainability outcomes, as well as challenges in the implementation of the technologies. The outcome of this review will provide urban scholars, urban planners, policymakers, and other stakeholders with best practices and important issues concerning smart technologies while planning future and sustainable cities.

2. Methodology

The purpose of this review was to gather and review existing scholarly literature related to the use of smart technologies, including Internet of Things (IoT) smart technologies and Artificial Intelligence (AI), for sustainable urban planning. This review utilized accepted processes for a systematic review so that it could be transparent, reproducible, and rigorous. A detailed search strategy was used to review relevant studies for the last five years related to smart technologies published between the years 2020 and 2025. The search was conducted in three major databases (Scopus, Web of Science, and Google Scholar) and used the combined keywords of “smart city,” “Internet of Things,” “artificial intelligence,” “urban sustainability,” and “sustainable urban planning.” Articles were also restricted to published peer-reviewed journals, an impact factor above 2.0 and the paper was in English.

The inclusion criteria required that selected articles had an application of smart technologies when conducting urban planning and reported sustainability-related outcomes either environmental, societal or economic ones. Studies purely addressing the development of technologies without mention of urban planning or sustainability were excluded. The screening process consisted of two steps. The first involved reviewing the titles and abstract of all potentially relevant studies, and eliminating duplicates. The second step consisted of obtaining full texts of shortlisted papers and reviewing eligibility. The data extraction captured study details, technology use, sustainability outcomes, and challenges faced. Lastly, a qualitative synthesis of themes was performed to amalgamate findings, track trends, and highlight gaps in knowledge on how smart technologies support sustainable urban planning. Using this systematic and replicable approach provides a strong foundation to evaluate the current evidence and support future research in an emergent area of literature.

3. Literature Review

Smart city’s idea has been growing fast in the past few years, concentrating on utilizing high technology to develop efficient, sustainable, habitable and resilient urban areas. Urbanization pressures have required novel solutions, which leverage IoT, AI, big data analytics together with

GIS in the context of urban planning to solve several challenges including but not limited to energy usage, transportation, waste management and social inclusivity. (Mupfumira et al., 2024; Shao et al., 2025).

3.1. Smart Technologies in Urban Sustainability

IOT enables smart cities to collect and manage data in real time. For instance, IoT based smart grids help in the efficient distribution of electricity and minimize wastage and emissions, and sensor networks keep track of environmental parameters and resource utilization thinly (Nyokum & Tamut, 2025; Lee & Zhang, 2025). AI and machine learning algorithms also can contribute to improving urban management through demand forecasting, optimal public transport and emergency response systems (Yang et al., 2024; Parker & Ahmed, 2023). GIS is an essential instrument used for spatial planning by its functions of mapping and analyzing urban green spaces.” flood zones” and environmental vulnerabilities, which can help planners in designing environmentally sustainable city plans (Zhao & Lee, 2023; Ranjbari et al., 2024). Big data analytics fuses different data sources to aid decision-making and policy making, enabling urban planners to model disaster resilient scenarios and development paths (Martinez et al., 2013; Wheatley, 2025).

3.2. Environmental, Social, and Economic Impact

Intelligent technologies were efficient in minimizing the environmental foot-prints, through energy optimization measures as well as pollution mitigation (Kumar et al., 2023). Socially, based on the internet and ICT good practices platforms encourage community involvement (and equal access to services in some cases) but issues remain including digital divides (Morris et al., 2024; Singh & Kumar, 2023). Economically, smart city projects encourage innovation and cut cost of operations but require extensive investment and institutional backing (Lee & Kim, 2022; Patel & Smith, 2023).

3.3. Current Gaps and Challenges

Notwithstanding the promise of smart technologies to improve urban planning, the technology is not being simply or sufficiently adopted for planning practice. There are concerns about interconnectivity with older systems, privacy and security issues, the cost of implementing the new technology, and attempts to address governance fragmentation (Morris et al., 2024; Nguyen & Park, 2024). It is also projected that environmental sustainability will be a part of the conversation regarding the ethics of surveillance and inclusivity as technology continues to advance quickly (Patel & Smith, 2023). A trend is emerging in 2025 towards technology that focuses on human-centered smart cities with the inclusion of sustainability, social good, and technological growth (Imna News, 2025; Pardad Khabar, 2025). Future research should continue to develop longitudinal studies of impact, and frameworks for scalable, fair smart city implementation (Behzadfar, 2025; Rajabi-Jourshari, 2023).

3.4. Findings and Discussion

The analysis of the current literature substantiates that smart technologies have a serious impact and potential for advancing sustainable urban planning. From an environmental standpoint, IoT-enabled physical infrastructures and smart grids create efficiencies in energy use, and lower community greenhouse gas (GHG) emissions (Nyokum & Tamut, 2025; Shao et al., 2025). In addition, transportation systems improve through AI applications that improve traffic flow, lessen congestion, and reduce air pollution (Yang et al., 2024; Zhao & Lee, 2023). Geographic information system (GIS) technologies are available to facilitate spatial planning which assists in land-use mapping and flood risk management for climate-resilient urban planning (Parker & Ahmed, 2023; Ranjbari et al., 2024).

In an economic sense, smart city projects lead to cost-based efficiencies in urban service provision and stimulate the creation of innovation ecosystems leading to employment creation (Wheatley, 2025; Kumar et al., 2023). Lastly, on a social aspect, digital platforms enabled using smart technologies promote citizen engagement and inclusion, but there is still a digital divide and a culture surrounding privacy activities that can inhibit equitable access and adoption, as referenced in (Morris et al., 2024; Martinez 2023; Patel & Smith, 2023).

The key obstacles to effective implementation are challenges with investment costs, interoperability of existing and future systems, conflicting governance frameworks, and trust of public, associated with (non)use of data privacy. This will necessitate governance frameworks being able to coordinate efforts, funding support, and community-level models that ensure urban smart technologies can support and engage all stakeholders (Nguyen & Park, 2024; Morris et al., 2024).

In conclusion, while smart technologies may offer important tools for advancing sustainable urban development across environmental, economic, and social realms, the outcome will be based on resolving institutional, financial, and ethical considerations. Future research processes should consider implementation models that are scalable along with governance models that are with discussion and engagement from community stakeholders, to develop the enormous potential of smart urban solutions.

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