

## **Sustainable Smart Cities: The Guidelines for the Future Urbanization Developments**

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### **Abstract**

The rising global connectedness and environmental consciousness have fueled the need for sustainable urban development. The rapid growth of urban populations and centers in most countries in the 21st century has raised concerns about the state of the environment. Most cities are unsustainable because they increase pollution, housing problems, social issues, and the overexploitation of natural resources. This emerging challenge necessitated adopting sustainable smart cities to leverage technology, information, and governance to promote environmentally friendly urban development. Sustainable smart cities integrate the three aspects to ensure urban residents live a quality life without compromising the needs of future generations. The concept also enables developers to employ artificial intelligence (AI), e-governance, and modern transport infrastructure to develop town environments that promote ecological consciousness. Therefore, a sustainable smart city is an appropriate strategy to guide future urbanization developments.

**KEYWORDS:** Sustainability, smart cities, technology, urbanization, urban planning, and environment.

### **Introduction**

The rise of urbanization and its impacts on the environment raise critical debates in most countries globally. In the 21st century, this concept has hit a new record, with approximately 50 percent of the world population living in urban centers (Szmigiera). Although the trend improves economies, infrastructures, and employments, it can lead to significant challenges, such as increased crime rates, housing problems, and environmental pollution. Consequently, in favor of urbanization's gains, countries must make their cities smarter to leverage the benefits and avoid the adverse implications of the development. Although the sustainable smart city concept is an emerging idea, it acts as a platform to address the negative consequences of urbanization.

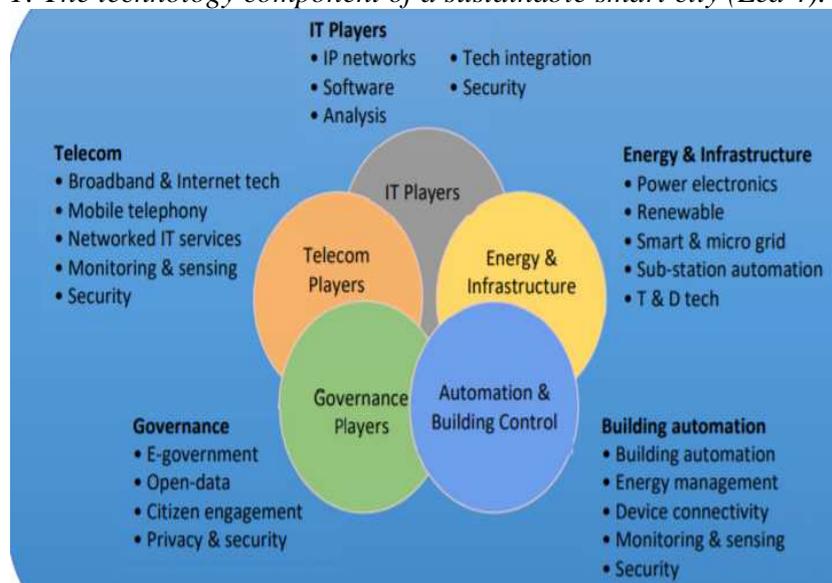
### **The Concept of Sustainable Smart City**

The sustainable smart city concept refers to the urbanization process with minimal or no adverse outcomes on the environment and the residence. While citing the National Resource Defense Council (NRDC), Toli and Niamh define a sustainable smart city as an efficient, innovative, livable, and efficient urban center (1). The authors also use the concept to refer to a town environment featuring social equity, quality life, economic buoyancy, natural resources efficient utilization, and ecological conservancy (Toli and Niamh 2). Therefore, a sustainable and smart city allows its inhabitants to leverage the optimal benefits of urbanization with minimal or no adverse implications, such as

housing shortage, crime, or pollution. This goal relies on modern technology to design and build smart urban areas.

Technology plays a critical role in designing sustainable and smart cities free from the negative impacts of urbanization. According to Bhattacharya et al., digital and communication technologies (ICTs) enhance the quality of services and the performance of urban utilities to reduce resources consumption and costs and improve the lives of residents (2). Lea also indicates that such cities leverage various innovations, such as mobile telephony, surveillance, automation, e-governance, networked IT services, and the internet, to improve inhabitants' quality of life (4). Therefore, technology is a component of sustainable and smart urbanization since it ensures effective and efficient use of available resources to meet the population's needs without compromising the welfare of future generations (see figure one for details). However, technology is not the only ingredient to building smart cities.

Figure 1: The technology component of a sustainable smart city (Lea 4).



Besides technology, sustainable smart cities have two other significant features that make them operate efficiently and effectively. Trindade et al. posit those residents and institutions are essential components of sustainable smart cities. The authors argue that smart cities require creative, educated, and diverse inhabitant that adhere to the policies, regulations, and laws developed by authorities (3). While the innovative and informed features of these residents promote responsible use of available resources without compromising the needs of future generations, institutions require governance capacities to institute order, equality, and innovation to improve people's lives. The interplay between the three dimensions has made the sustainable smart city concept a critical component of urban planning.

### *Sustainable Smart City Concept in Urban Planning*

Designers and developers have vastly applied the sustainable smart city concept in urban planning globally. Lima et al. argue that urban planning is a daunting and complex task in most countries due to population increase, land use challenges, occupational laws limitations, housing problems, social issues, and environmental pollution (3). For

example, these challenges compelled Brazil to adopt an urbanization policy in its constitution to ensure cities develop in favor of collective welfare and security of citizens and the environment (Lima et al. 3). However, the sustainable smart city concept has eased urban planning since developers can employ technologies, such as ICT, artificial intelligence (AI), e-governance, modern transport, and infrastructure, to develop town environments that promote quality life and ecological consciousness.

### **Sustainable Smart City Concept in Environmental Protection**

Integrating the sustainable and smart city concept in urban planning is a vital strategy to attain environmental balance. The growing world population has made urbanization a significant threat to the environment through unsustainable use of natural resources and increased pollution. Despite these challenges, the sustainable smart city concept has emerged as a suitable strategy to support the development of cities while maintaining ecological integrity through pollution reduction, waste management, and efficient consumption of resources (Trindade et al. 4). Therefore, although the sustainable smart city idea is not a solution to all the problems related to the growth of urban areas, it provides a framework to achieve ecological balance and sustainable consumption of resources without comprising the needs of future generations.

Overall, although the sustainable smart city is an emerging concept, it offers a platform to address the negative consequences of urbanization. Although urbanization improves economies and enhances the quality of citizens' lives, it can lead to adverse outcomes, including environmental pollution, housing problems, and social issues. However, sustainable and smart city concepts have become an ingredient in urban planning to avoid the dark side of urban growth by promoting efficiency and effectiveness. The idea employs technology, enlightened populations, and good governance to develop cities that offer quality lives to inhabitants and maintain ecological balance. Therefore, sustainability and smartness are suitable strategies to ensure efficient and effective urbanization.

### **The Problem of Sustainable Smart Cities**

#### **Problem Statement**

An overarching problem of sustainable smart cities is the possibility for data leakage, leading to privacy and security loss. Privacy and security concerns have a significant impact on smart cities' penetration level because interdependent systems are prone to technological problems, such as, hacking. According to Amini et al., smart cities' infrastructure entails sensing components, processing units, heterogonous networks, and control and operating elements (56). Because of each of these control devices and sensors require online feedbacks and accurate actions, they send and receive granular details in an interconnected fashion using smart routing algorithms. Smart cities should use privacy-enhancing technologies to minimize privacy and security threats.

#### **Discussion and Scope**

During the collection, transmission, and processing of private information, some hackers may exploit existing system vulnerabilities to disclose individuals' personal information, location, and identity. Smart cities use cloud servers to process and store

information, which poses a security concern for residents in the event of server breakdown. While cities may use data encoding techniques to prevent server breakdown and improve security, Amini et al. establishes that cloud servers may lack the capacity to perform complex analytical processes for smart cities' applications (54). This research will be based on the findings of a survey conducted among the residents of New York City. According to Braun et al., New York is one of the cities that have adopted smart city principles alongside Toronto, Paris, and Copenhagen (2). The research focuses on identifying New York's interconnectivity in terms of using smart homes, smart transportation systems, and other smart infrastructures.

### **Conclusions and Recommendations**

Sustainable smart cities may lower pollution, foster environmental resilience, and enhance interconnectivity; however, privacy and security risks threaten smart cities' penetration levels. Malicious individuals could access private information by mining details from power lines and related infrastructure. Ismagilova et al. establish that power systems in sustainable smart cities are prone to data leakages, thus, exposing residents to privacy and security problems (8). In particular, malicious individuals could steal data about individuals' lifestyles, consumption patterns, and financial details. Moreover, malicious attackers may use data mining investigation techniques to access private information. To minimize the risk of data loss, smart cities should utilize strong encryption and network access controls. In addition, they should incorporate public education to moderate users' attitudes about new technologies and foster penetration.

To address the problem of privacy leakage, smart cities should adopt strong encryption protocols, implement access control, and foster anonymity. In particular, sustainable smart cities should embody the strongest encryption algorithms to promote the safety of data belonging to diverse stakeholders, including critical government functions. A recent cryptographic approach that may be used in smart cities is privacy-preserving authentication (PPA) protocols (Kumar et al. 17). PPA protocols could secure mobile devices from malicious attacks. To minimize privacy leakages through power systems and reduce third parties' ability to predict consumption patterns, a particle swarm optimization process may be deployed (Ismagilova et al. 9). However, users' perceived trustworthiness of a new privacy and security tool may affect the penetration of smart cities. As a result, technological developments aimed at improving security should combine public education to increase awareness.

Smart cities should invest in network access controls to boost their communication systems and minimize threats to the IoT system. This approach is effective in preventing access by unauthorized individuals through user-centric IoT applications. In addition, it fosters privacy, while at the same time ensuring efficiency and scalability (Ismagilova et al. 12). Smart cities may use foggy dummies and blind third parties to mediate the relationship between trust and user's intention to use smart cities applications. These initiatives should be supplemented with block chain-based solutions and artificial intelligence to increase data control (Chen and Mamoun 10). However, the scope and practice of using artificial intelligence depends on users' perceptions and existing legal frameworks.

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