Smart Cities

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ABSTRACT

Smart City is a smart city concept that is a solution to urban cities in the world. The authors will discuss the concept, components, and implementation of smart cities in the context of sustainable urban digital transformation. Smart cities integrate information and communication technology (ICT), internet of things (IoT), and artificial intelligence (AI) to improve the efficiency of public services, citizens' quality of life, and environmental and infrastructure resilience. Various key devices and systems such as smart lighting and smart building will be described. In addition, the hardware supporting edge computing, data storage systems, and microcontroller-based intelligent system prototypes are also discussed. Future trends such as Quantum AI, autonomous systems, and adaptive cybersecurity and blockchain-based urban resilience frameworks will be depicted. By displaying implementation examples from various countries, it is hoped that it can provide a comprehensive insight into the direction and challenges of developing inclusive, efficient, and resilient smart cities.

INTRODUCTION TO SMART CITIES IN THE AGE OF AI

The development of cities around the world faces increasingly complex challenges as urbanization increases, climate change, and the need for efficient resource management. By 2050, it is estimated that more than 68% of the world's population will live in urban areas, which drives the urgency of smart and sustainable urban planning (UN-DESA, 2024). The concept *of* smart city was born as a response to these challenges, by offering a technology-based approach to managing and improving various aspects of city life holistically.

Smart cities utilize information and communication technology (ICT) as the backbone of an integrated urban system (Susilowati, Rachmawati, & Rijanta, 2025). By connecting physical and digital infrastructure in the fields of transportation, energy, health, education, security, and waste management, smart cities aim to improve operational efficiency while improving people's quality of life. However, in today's digital era, ICT alone is not enough—it requires technology that is able to learn, adapt, and make decisions automatically, namely artificial intelligence (Quiles-Rodríguez, Palau, & Mateo-Sanz, 2025).

The integration of AI in smart cities has revolutionized the way cities manage data and provide public services. AI enables city systems to process big data in real-time, recognize patterns, predict needs, and

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provide adaptive solutions without constant manual intervention. For example, machine learning algorithms can set traffic lights based on the current of actual vehicles, or predict a surge in energy demand to avoid power outages (Matura, Singh, & Kumar, 2025). In the scope of healthcare, there has been the development of intelligent healthcare systems that can otherwise provide remote medical services, from consulting services to treatment. This method of remote medical services maintains patient privacy and there are certain authentication protocols in place to prevent malicious possibilities from parties who may be pretending to be doctors or patients (Y. He, Fan, & Zhang, 2025). In smart cities, health care for the middle aged and elderly utilizes the health data of retirees. With a smart healthcare system that has been tested on a smart city model, it can improve the health of the middle-aged and elderly due to their limitations with digital technology (Deng, Zhou, & Guo, 2025).

Furthermore, AI in smart cities does not stand alone. These technologies work alongside digital ecosystems that include the Internet of Things (IoT), cloud computing, and big data analytics. IoT devices serve as sensors that collect data from the city's environment continuously—from air quality to vehicle presence—while AI systems analyze and translate that data into intelligent actions. Cloud computing supports data storage and processing at scale, allowing city systems to function without geographical restrictions or local capacity (Ramchand, Baruwal Chhetri, & Kowalczyk, 2021).

The expected goal of local governments is the successful implementation of a good and effective smart city framework (van Twist, Ruijer, & Meijer, 2023) The concept is relatively new and the desire for further research on smart cities is quite significant because based on recent data shows that seven out of ten citizens worldwide will live in urban areas by 2050 (Stegerean, Trincă, Tămaş & Nistor, 2022). The World Bank states that if managed well, urbanization has the potential to contribute to sustainable growth by encouraging increased productivity and innovation in urban areas. This makes sense due to the fact that the world's major cities account for more than 80% of the total GDP (WorlBank, 2022).

Many researchers have divided the idea of a “smart city” into several characteristics and dimensions in an effort to better define it, based on the degree of difficulty in realizing the idea of a smart city holistically. From several articles, a diagram of the main important dimensions of the smart city can be developed and shown in Figure1 below.

Figure 1. Smart City Components