

# Chapter 20

## Optimizing Urban Intelligence: A Comprehensive Study on IoT With Edge Computing in Smart Cities

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### **ABSTRACT**

*Urbanization and population growth are creating significant challenges for cities, including increased demand for resources, traffic congestion, pollution, and waste management. This paper provides a comprehensive review of research focused on optimizing urban intelligence using IoT and edge computing. We analyze how sensors, connectivity, data analytics, and intelligence at the edge can provide real-time monitoring and efficient management of transportation systems, energy grids, water distribution, waste collection, air quality, and public safety. Challenges around security, privacy, integration complexity, skill gaps, and adoption barriers are examined. A quantitative model is presented analyzing the economic impact and sustainability gains from smart city projects employing IoT and edge computing. Additionally, best practices are proposed for designing robust urban IoT infrastructure supported by edge intelligence. Our findings indicate that an urban IoT networked with edge computing can enhance quality of life for citizens.*

### **1. INTRODUCTION**

Cities are new hub for economic activity and innovation, but as they have become more urbanization that creates negative effects on infrastructure, resources, and the environment (Verhulsdonck et al., 2023). Various modern and advanced technologies provides solutions for cities to get “smarter” and deal with urban challenges and issues in a sustainable way (Singh et al., 2022). The Internet of Things (IoT) enables and makes possible through a dynamic network of connected sensors and devices which monitors and

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manages infrastructure efficiency (Jiya et al., 2022). The IoT creates a powerful and potent platform for improving the urban systems when paired with edge computing that provides real-time data processing and intelligence at the node, (Alhalafi et al., 2023).

The research to enhance and improve urban intelligence can be analyzed by comprehensive analysis of research focused on harnessing IoT and edge computing. The terms “smart city”, “intelligent urban infrastructure”, and “urban IoT edge computing networks” are being used mutually exclusive. Section 2 examines the urban challenges and various issues driving development of smart city technologies. Section 3 basically reviews IoT and edge computing ideas while Section 4 focused on key architectural components. Sections 5 and 6 analyze smart city use cases across major sectors - transportation, energy, utilities, waste management, air quality, and public safety. Section 7 evaluates economic and sustainability gains based on a quantitative model. Section 8 highlights security, privacy and adoption risks. Section 9 proposes best practices and guidelines for implementing urban IoT edge computing projects. Section 10 concludes with an outlook for the future.

## 2. URBAN CHALLENGES DRIVING SMART CITY INNOVATION

Cities struggle with stressed infrastructure, pollution, resource scarcity, climate risks, and lack of insight into the status of operations (Pandya et al., 2023). Key points include:

- **Traffic Congestion:** Increasing vehicle density and sub-optimal traffic management causes massive economic losses from fuel waste, pollution, and human productivity declines from long commute times (Alshamaila et al., 2023).
- **Energy:** Buildings and transport combined account for 75% of electricity usage. Inefficiencies lead to higher costs and blackout risks from grid overloads (Singh et al., 2020).
- **Water:** Leaking pipes result in losses exceeding 30%. Aging infrastructure causes drinking water contamination and wastewater overflows during storms (Akhter et al., 2019).
- **Waste:** Inefficient collection systems and low recycling rates lead to untreated discharge into land and waters, exacerbating public health hazards (Bohli et al., 2015).
- **Pollution:** High particulate matter from vehicles, industries, and construction causes respiratory illnesses. Noise pollution also severely impacts well-being (Qiao et al., 2021).
- **Public Safety:** Inadequate surveillance, emergency response, and disaster prevention capabilities pose major threats to citizen security and resilience (Mukhopadhyay et al., 2023).
- **Other Challenges:** Urban stressors also include lack of open public spaces, food deserts, homelessness, aging populations, and socioeconomic disparities (Page et al., 2021).

To summarize, cities require urgent solutions to enhance resource efficiency, resiliency, sustainability, livability, and equity across infrastructure systems (Sánchez-Corcuera et al., 2019). Intelligent technologies like the IoT and edge computing offer promising pathways.

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