

Smart Cities Initiatives Driven by Citizen Insights - The Role of IoT Devices

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Abstract - The Internet of Things (IoT) is an appropriate technology to sustain a smart city operation. This paper presents smart city initiatives driven by citizen insights by exploring the role of IoT applications in modern cities. The research uses a descriptive methodology and employs secondary data only. The research findings indicate the role played by IoT devices to improve people's life by cutting costs and providing efficient services. The paper will provide solutions to a smart city's most common problems: policing, environmental issues, traffic congestion, affordable healthcare facilities, wireless connectivity, and open data initiatives. IoT devices allow devices to connect, store, and share data through sensors, networks, etc., within a smart city. These electronic and mechanical devices are connected to the internet and cloud to form a smart city infrastructure system. Citizens interact with these technologies to improve their lives as humans depend on machines to virtually do every work.

Keywords: Internet of Thing; Smart City; Information and Communication Technology.

I. INTRODUCTION

Modern cities are becoming multipart and multi-dimensional municipal systems vital to human existence in a globalized ecosystem. Among the key reasons is humans' desire to expand their cities into inter-municipal settings increasingly [1] [2]. Modern cities harbor most of the world population, accounting for more than 75% of the global GDP, and contribute approximately 75% of carbon emissions from the international final energy use [3]. A smart city uses Information and Communication Technologies (ICT) to develop, deploy, and promote sustainable development practices to solve the rising urbanization challenges [4].

The smart city initiative's goal is to better human living conditions through high-quality services, as acknowledged by several scholars [5] [6]. Smart city as a functional city [7] with a core concept of municipalities based on workers interconnections. Smart city ICT scheme is fundamentally an

intelligent system of objects and machines linked to transmit data using wireless technology and the cloud. The cloud-based IoT applications receive, analyze, and manage data in real-time, helping municipalities, enterprises, and citizens to make sound decisions that improve the quality of life [4].

IoT comprises a network of physical objects embedded in sensors, software, and numerous other technologies to exchange data with other devices using the internet as the bedrock [8]. These IoT-devices can either be household objects or sophisticated industrial equipment. Today, more than 7 billion IoT devices are interconnected, prompting scholars to predict that this number will grow to 10 billion in 2020 and 22 billion in 2025[8].

The global citizens interact with smart city systems in countless ways using ICT devices, smart phones, and mobile devices linked to their household and office devices, transportation system, healthcare system, commerce, governance, and several other needed smart city infrastructures. Connecting devices and data to a municipal's physical infrastructure and services reduces costs and enhances sustainability.

Cities can evenly distribute energy, modernize garbage collection systems, traffic congestion, improve the healthcare systems, and improve the quality of air in our atmosphere using IoT applications [4].

The study provides solutions to the following research questions: RQ1: Why do we need smart cities in the first place? RQ2: How is IoT making municipalities smarter and more efficient? Therefore, the study contributes to the strategic management of technology and innovation studies using IoT applications to improve smart city residents and enhance people's wellbeing [9].

Figure 1 illustrates a typical example of smart city infrastructure, with IoT devices fulfilling societal needs' challenges in a smart city.

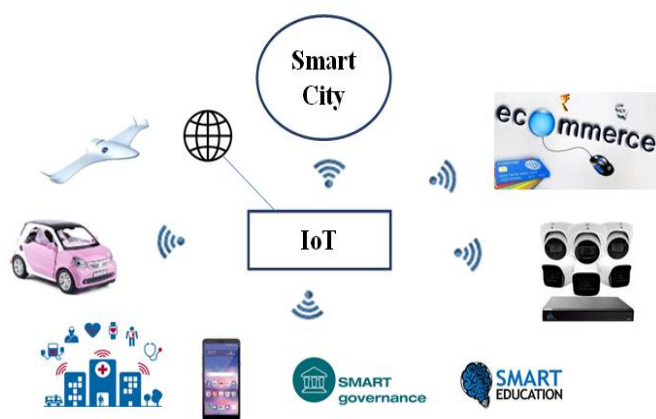


Figure 1: Smart City Infrastructure

II. LITERATURE REVIEW

2.1 Smart City

A smart city is a modern municipality that provides a better economy, mobility, secure environment, citizenship participation, a better quality of life, and good governance structure [10]. These municipalities are increasingly changing as a result of new challenges to fulfill societal needs [5] [11] and the opportunities of new technologies and innovations in societies [12] [11] [13] [14] [15] as those described by Zhang et al. (2016) [16]. IoT enables smart city applications to provide quality education, comfort, security, reduce costs, and adequate management capacity, within an inclusive society that improves creativity and boosts innovation [4].

IoT serves as an essential tool to meet societal needs (traffic light systems), self-driving, and automated cars that prevent road accidents. Smart trash system helps to recircle the city wastes and citizens' smartphone to perform our daily routines. Furthermore, smart city platforms help to optimize our infrastructures, mobilities, services, and utilities. One of the research questions is, why do we need smart cities in the first place? The answer to this question is that urbanization is a non-ending phenomenon, just like human needs are non-ending.

Approximately 54% of the global population lives in big cities, which is expected to reach 66% in 2050 [4]. With the continuous global population growth, another 2.5 billion people will move to cities over the next three decades, according to the secure, sustainable smart cities and the IoT (2020). Environmental, social, and economic sustainability must be implemented to keep pace with this rapid expansion taxing our cities' resources. Citizens and national governments are undoubtedly more alerts to launch rapid initiatives, and smart city technology is needed to succeed and to meet these goals.

2.2 Internet of Things (IoT)

Nowadays, IoT is seen as a fundamental pillar of smart cities around the world. Smart city residents can virtually connect everyday electronic and mechanical devices—home and office appliances, cars, healthcare equipment, surveillance cameras, smartphone, smart governance, smart education—to the internet using miniature instruments, and seamless communication between people, processes, and things [8].

The second research question is, how is IoT making municipalities smarter and more efficient? Secure wireless connectivity and IoT technology are transforming traditional elements of city life – like streetlights-into next-generation intelligent lighting platforms with expanded capabilities. Technologies including cloud computing, big data, block chain, 5G technology, smart devices, -mobile technologies, and physical devices can connect, collect, and share data with negligible human involvement. In this globalized community, digital systems can record, monitor, and adjust each interaction between connected devices [8]. This synchronization allows the physical world to interact with the digital world utilizing cooperation. For instance, London gained 1st position among the top ten 2019 smartest cities globally [17] [18]. It has a data store platform used by more than 50,000 individuals, companies, researchers, and developers every month. IoT devices have boost transportation at the Heathrow International Airport, as one of the busiest airports globally. New York is a global financial hub, with almost 7,000 high-tech firms and stands out for its integrated technological services, such as the Big Apple and the free Wi-Fi service Link NYC. Amsterdam has continuously used IoT technologies to integrate financial technology, energy efficiency, and culture to become one of the European tech powers [17][18]. Some 90% of Amsterdam households have bicycles and an advanced system of automated services for the public use of shared bikes. It has also put forward a project to ban gasoline and diesel cars by 2025, becoming Europe's first zero-emissions municipality.

III. METHODOLOGY

The research uses a descriptive methodology and employs secondary data only. The secondary data consists of related journal articles, the internet, blogs, and textbooks on smart cities and IoT devices.

IV. ANALYSIS OF RESULTS

Smart city initiative influences citizens' health and wellbeing while also providing new economic development opportunities [19]. In 2022, smart cities initiatives will account for \$158 billion [19], with significant growth expected from emerging innovations. For instance, police officers will use

wearable devices with real-time information for better decision-making [20]. Cities must adopt real-time crime detection, gunshot detection, and predictive policing tools to help identify potential hotspots and prevent crimes from happening to ensure public safety [19].

Vehicle to everything (V2X) connectivity permits automobiles to communicate with other cars, transport infrastructure, and pedestrians [20]. The open data initiatives will enable every citizen to access data that guarantee the United Nations Convention on the right to access information. Open Data initiatives further contribute to the governance system's transparency and smart city initiatives [20]. Furthermore, the smart trash collection system with solar-powered and sensor-equipped-smart bins allows waste collectors to track waste levels and optimize their fuel usage [20]. The intelligent city platforms collect data from different sectors (pollution levels, waste management, water supply, transportation system, hospitals, governance, and traffic density) to better manage smart cities [20].

The greenhouse gas emissions generated by cities can be cut by up to 15% with smart city solutions that reduce electricity and heat production [19]. Water consumption can also be reduced by intelligent city solutions using smart irrigation systems, water-leakage, and consumption supervision could save cities between 25-80 liters of water per person per day [19]. Technologies provide new strategies for the prevention and treatment of chronic diseases. The facial recognition technology in China tracks people affected with corona virus to ensure they do not break quarantine and risk spreading the virus [19].

However, the most effective use of technology is data-based health interventions for maternal and child health [19], which rely on analytics to identify new mothers and direct prenatal and postnatal educational campaigns. These technologies could lead to a wide range of transformative effects for cities willing to embrace them and subsequently answer the research questions.

V. DISCUSSION AND IMPLICATIONS

Smart cities use IoT for innovative management and monitoring widely dispersed processes. IoT can be exploited to better the quality of living, especially in municipalities, by sustaining environmental sustainability, reduce crime rates and traffic congestion, and offers efficient energy distribution. IoT allows us to know things in advance, as it can effectively monitor devices from a distance. Their low cost makes it possible to monitor and manage previously unreachable traditional cities' activities [21]. The financial implication is that this new technology could replace humans in monitoring and maintaining supplies.

Hence, it is cost-effective to use low-power sensors, wireless networks, and mobile-based applications to measure and optimize everything to maximize efficiency and sustainability within a city. Also, IoT makes it possible to gain completely new insights, e.g., a citywide Wi-Fi for public use. Real-time updates will offer citizens information on traffic congestion, parking spaces, and other city services. Furthermore, smart city solutions can improve energy consumption monitoring and management, water leakage detection, and water portability monitoring within smart cities [22]. Smart cities offer intelligent, adaptive fast lanes and slow lanes (cycling, walking) to their residents and provide charging stations to power EVs. Air pollution control and renewable energy will make for greener cities. Rooftop gardens or side vegetation are integrated into building designs to help with insulation, provide oxygen, and absorb CO₂. Heating, energy distribution, lighting, and ventilation will be managed and optimized by technology. Solar panels will be integrated into building design, replacing traditional materials. Fire detection and extinguishing are tailored to individual rooms. Therefore, IoT is a force to reckon it in smart cities infrastructure that would provide better insights into citizens' wellbeing.

VI. CONCLUSION

IoT technologies and applications provide countless opportunities to humans and their environments. It provides solutions in all sectors, including the healthcare system, quality education, energy sector, city traffic management, environmental hazard control, manufacturing, transportation, city water management system, fashion, security, entertainment industry, restaurant, etc. IoT platform can connect several cities through a shared smart city platform. The cloud-based IoT solutions system for smart cities is suitable for conveying a platform based on open data. Small cities can form a shared urban ecosystem. In this way, small and large smart cities are networked and controlled via the central cloud platform. Furthermore, cities in the smart city ecosystem benefit from intelligent technologies and innovations provided by IoT devices. The end goal is to improve smart city residents' quality by establishing a relationship between humans, the environment, and objects (devices) around them.

Despite the numerous benefits, there still exist several challenges in smart cities and IoT. With the increasing potential of machine learning, cloud computing, and other innovative technologies, many existing tasks will disappear. New jobs will appear with new skills, but numbers are most likely not equal [23]. This will subsequently create massive unemployment. Therefore, governments and politicians should think of alternative ways to address this issue. Also, since one

of a smart city's features is information sharing (open data initiative), privacy and security become critical challenges about profiling, stealing, and losing control [24]. To address these concerns, researchers in [25] [26] have acknowledged several privacy issues that require further future research, including data communication, graph matching, awareness, and evaluation of privacy-preserving services. Data exchange in complex networks with large-scale networks and interoperability for all IoT devices are crucial for smart city initiatives. Numerous malicious decisions may result if the data are incorrect, missing, use the wrong format, and are incomplete [27].

VII. FUTURE DIRECTION

Mercedes-Benz Vision Van is a van concept developed for municipalities characterized by several innovative technologies such as the autonomous drone delivery system. The drone can autonomously deliver parcels within a radius of ten kilometers, with less time for loading and delivering [28].

The smart eye technology is embedded with sensors, Wi-Fi, and Bluetooth that provides options and accessibility features using the eye without causing distraction [29]. It is similar to Google's most ambitious project – the Glass. This technology makes it possible to read messages, surf the internet, and more.

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