

## EMERGING TECHNOLOGIES AND APPLICATIONS FOR SMART CITIES

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### Abstract

The large deployment of the Internet of Things (IoT) is empowering Smart City tasks and activities everywhere throughout the world. Items utilized in day-by-day life are outfitted with IoT devices and sensors to make them interconnected and connected with the internet. Internet of Things (IoT) is a vital piece of a smart city that tremendously impact on all the city sectors, for example, governance, healthcare, mobility, pollution, and transportation. This all connected IoT devices will make the cities smart. As different smart city activities and undertakings have been propelled in recent times, we have seen the benefits as well as the risks. This paper depicts the primary challenges and weaknesses of applying IoT innovations dependent on smart city standards. Moreover, this paper points the outline of the technologies and applications of the smart cities.

**Keywords:** *Internet of Things (IoT), Smart Cities, IoT Devices and Sensors, Technologies of Smart Cities, Applications of Smart Cities;*

### 1. Introduction

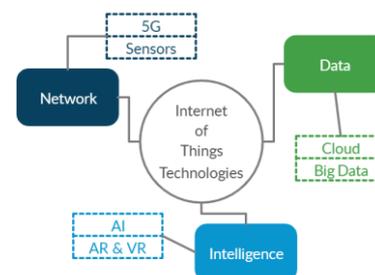
As shown by the United Nations report around 3.5 billion people live in urban areas and around 5 billion and more are anticipated to live in the urban areas by 2030. The Evolution of the current interconnected network and objects into the development level of pervasive systems of interconnected objects. That not just take the data from the environment and communicate with the physical world yet, besides, gives the data transfer, analytics, and applications. Internet becomes more immersive and pervasive by the revolutionary communication paradigm (Internet of Things). For some better open public services and infrastructure, people move from provincial to urban areas. So, for some legislatures and colossal business edifices has become a necessity to develop urban areas.

A Smart city is an ecosystem aiming at making the public resource more useful, more attractive, and a better sustainable life to live in, and a unique place. Smart City is only the one to make the city services and monitoring, interactive and efficient. Devices or Sensors (IoT objects) that convey or sense through many networks. To have the least human communication in monitoring, verifying, and to guarantee the staunch of the foundation. For the Fast-growing of the urban area, the population presents a major role for the upcoming challenges in the daily lives. IoT in Cities will improve the advancement of the urban areas to give the administrations to the citizens,

organizations, and the open organization through medicinal, social, and user context.

To Deploy the innovation in the Cities to make the life of the citizens facilitate the cost will broadly increase. Adapting the new technologies, engineers around the world are now moving to innovation – such as the 5G, Artificial Intelligence, Cyber-Security, and many more. IoT is a modern world infrastructure which includes physical devices, modern vehicles, building, actuators, computers, and even your phones that all are interconnected over the internet. The essential arrangement is to get in touch with you to all the different parts of the Smart City using IoT.

### 2. Technologies



**Fig 1 Technologies of IoT**

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Headway of Technologies as in Fig 1 will soon be improving the ecological, money related, and social parts of urban life. Many technologies are used in different types of application which makes a better way of living:

## 2.1. Network Technology

### 2.1.1. 5G

5G technology is a ground-breaking system that is required in a smart city for interconnecting every device to each other. 5G provides very strong devices with all the devices and sensors and qualifies IOT to work more efficiently. Technology is made to be a high data rate and low latency which allows transmitting the data in real-time. The advent of new 5G the next-generation wireless communication technology will accelerate the life of the society to an entirely different level. [4]

### 2.1.2 Sensors

Sensors are present in each physical device of the IoT that makes the IoT system. Nowadays, All the devices that you are in contact with have sensors that capture and send information to the cloud for computing. In the IoT system, all the sensors interconnect every device making them flawlessly cooperate that makes the Smart city even smarter.[4]

## 2.2 Data Technology

Distributed computing and Big Data advancements assume a significant role in taking care of and dealing with a wide range of information as per their necessities.

### 2.2.1 Cloud computing

Cloud computing mainly functions on-request self-service, broad network access, and rapid elasticity. Data is stored and maintain which is created by IoT devices and sensors.[2] Cloud computing drives all the information collected from the city into IoT devices and sensors to the computing infrastructure for computing.

### 2.2.2 Big Data analytics

Big Data, part of the smart city infrastructure, sort, cluster, analyze the data from the IoT devices. IoT creates much more information that ought to be analyzed and proceed to execute smart city service. Data will mine information and cluster data that has been collected from IoT devices and sensors from smart cities that provide information regarding smart cities' services.[3]

## 2.3 Intelligence

### 2.3.1 Artificial Intelligence

AI is the science and engineering of making the machines intelligent which collects forms and investigates information generated with consideration to smart cities, smart infrastructures, and more.[4] IoT devices and Artificial technology both together improves the life of the citizens and business that inhabit smart cities. AI helps to detect every action ongoing in the city and provides a useful solution to that

action which makes the city smarter. AI helps people to solve their daily life problems.

### 2.3.3 Augmented Reality and Virtual Reality

Virtual Reality and Augmented Reality take up a remarkable job in the advancement of urban areas. AR is a mesmerizing technology that superimposes the computerized content onto the user's real environment. AR has sufficiently developed to expand its level of access and ease of use to the individual people's market. VR technology place an important role in the healthcare sector.[5]

## 3. Applications

Infrastructure gives the open assistance applications identified with the smart city as in Fig 2, for example, Smart mobility, Smart buildings, Smart healthcare and that's only the tip of the iceberg. The middle trademark that underlies most of these segments is that they are related and that they make data, which may be intelligently used to guarantee the optimal utilization of resources and improve execution. This area presents some key parts of the smart city system.

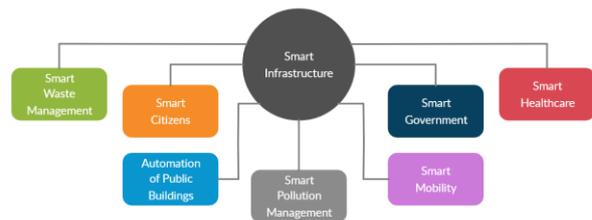


Fig 2 Applications of IoT

### 3.1 Smart Waste Management

Management incorporates the monitoring, assortment, transport, preparing, reusing, and removal of waste in the city to make the easy life of the people in the cities. Sensors, availability, and the Internet of Things offer ways to deal with lighten additional costs rising out from wastefulness like we sent a truck to get squander when containers are unfilled. Smart waste management system engages the advancement of different kinds of waste to be checked, and innovation may be used to all the more likely to comprehend and manage the progression of waste from source to expulsion. [6]

### 3.2 Smart Mobility

Smart mobility is best portrayed as approaches that reduce obstruct and encourage greener and more affordable transportation. Its frameworks incorporate mass travel frameworks just as individual portability frameworks that element bike sharing, ride sharing (or carpooling), vehicle sharing, and all the more as of late, on-request transportation. Smart Transportation Management: Traffic signal control-lining algorithm has been implemented to put diverse circumstances to control traffic which helped the individuals of the city.[3]

Smart parking: Parking areas through utilizing keen leaving, different vehicle appearance, and could follow for various parking lots spread in the city.

### 3.3 Automation of public buildings:

Buildings with IoT advancements technology may aid both diminishing the utilization of assets associated with buildings (power, water) just as in improving the satisfaction level of people populating it. A smart structure organizes the distinctive physical systems present in an astute way to ensure that all the systems demonstrate together in an enhanced and proficient way.[1] The board systems can improve building imperativeness capability, decrease waste and assurance ideal utilization of water, with operational practicality and inhabitant satisfaction. Smart structures have different sorts of sensors and actuators that control lights, temperature, and dampness.

### 3.4 Smart Healthcare

Smart Health-care services that administrators change over wellbeing related data into clinical and business bits of information, which fuse propelled wellbeing records, home wellbeing organizations and remote determinations, treatment, and patient checking systems. It encourages the arrangement of medicinal services administrations using IoT advances progressions that help to screen the wellbeing states of residents.[5]

### 3.5 Smart Government

A smart government portrayed as organizing and overseeing different parts and areas in an organization reliant on the coordination of data, correspondence, and operational advances by referencing the fantastic activity of IoT design in changing government into smart governments. Smart government fuses the sensitive regions and hard space of Smart City. [3]

### 3.6 Smart Citizen

Citizen's commitment to Smart city with real support utilizing characterizing legitimate citizen's commitment, getting to related data, well-preparing, and social commitment are the incredible factor toward more smart individuals. The significance job of social media life and individuals' profile to partake in Smart city has been something worth being thankful for towards the new upheaval. The execution of the 5G innovation interfaces the resident to any IoT devices a lot quicker and smoother.

### 3.7 Smart Pollution Measuring & Controlling

Diminishing the carbon impression is of a significant enthusiasm for smart urban areas to give its citizens a solid domain to live healthily by utilizing sensors and other IoT devices. Manageability Cloud technology empowers you to monitor, gauge, and decreasing air contamination in a city through significant information.[7]

## 4. Open Challenges

Despite of, there are various endeavors to implement smart city, yet this technique still in the beginning stage. It goes facing plenty of challenges and checks as far as innovation and security.

### 4.1 Security Concern

For the effortlessness of life and quality, the resident's insurance should not be a penance, and they should be picked to pick what to share and what not to with authorizations like the current web-based life security and privacy settings. The framework's availability, integrity, and confidentiality of the citizens ought to guarantee a safe and proficient help without break in the smart urban communities which utilize network technologies in IoT devices.[9] In the Smart city, the information gathered must be confident and safe, the integrity of that information must be kept up or maintained and the accessibility of the information gathered must be accessible or seen to the approved individuals. The security challenge in SC is the ceaseless checking of the physical world which has near heaps of interconnections between IoT gadgets while offering brilliant sorts of help to them.

### 4.2 Data Concern

Trouble emerges with dealing with the information in a smart city. The difficulties that come in a large number of data are, for example, technical, storage, compatibility that can be used by end-user applications. Finally, these measures of data ought to be dug for examples to be analyzed on advantageous premises to offer quality assistance. Information in Smart city gave by various partners, suppliers, IoT devices, and areas which should be integrated, and approved by numerous sources and customers. Absence of legitimate institutionalization just as poor data sharing by the IoT devices prompts poor inter-operable smart city applications.

## 5. Research Gap and Analysis

**Table 1** Comparative Analysis

Cities	Technologies	Application	Remark
New York City, USA	CCTV, AI, Noise Sensors, AR & VR	Mobility, Noise Pollution, Public safety and Healthcare	Decrease noise pollution and improve public safety for better quality of life
London, UK	Ambient Sensors, Big Data, Machine Learning	Air Quality and Smart Public Transport	Energy savings and lower waiting times for commuters in public transport.
Copenhagen, Denmark	Telecommunication, Zigbee, Machine Learning, AI	Intelligent Waste Bins, Healthy Buildings and Smart Energy Grid	Decrease the problem of lack of dustbin available for disposing waste. Improving air quality in buildings by monitoring presence of gases like CO <sub>2</sub> , other harmful gases
Reykjavik, Iceland	Telecommunication, Big Data, Machine Learning	Smart Transportation and Smart Government	Use Smart phone Application and other sensor data for improving quality of governance.
Hong Kong, SAR China	Biometrics, Parking lot Sensor, CCTV	Smart Airport, Smart Parking and Smart Traffic Management	Checking Using Biometric Data. Display empty parking spaces

With smart services to greener structures, smart urban communities are rapidly altering the manner in which we expect about urban living. By look at the urban areas of the world, they're at present grasping the developments and applying them to actuate helpful assets out of it. It will change the life of the residents of the nation. By the development inside the IoT field, new advances are being designed and hence the application is getting increasingly broad and progressively broad. Inside Table 1 are some smart cities that have adjusted new IoT Technologies and Applications which can assist their resident with measuring an increasingly powerful life.

In Ahmedabad (Gujarat, India), the advancement to shift the city to a smart city by realizing a few applications, for instance, Digitalization, Mobility, and Environment. In any case, presently of mechanical transformation 4.0, numerous new advancements can be useful to build up a smart city. Utilizing Network Technologies, for example, 5G, sensors, and a lot of more will help in extra straightforwardness and unwavering quality in Digitization and Digitalization. Modify the Frequency of transport in sync with past traffic data (Big Data). Considering the clinical ignorance among the individuals of Ahmedabad we will utilize AR and VR to help the patient better picture their ailment. Let us consider the issue of Ahmedabad Municipal Corporation (AMC), the remaining burden with AMC authority might be stunningly lessened by AI-based chatbots. Utilizing a cloud-based framework we can store the clinical record of the patient together with biometric information to deliver better medicinal services to the resident. However, this could cause protection concerns the advantages out-way the bothers.

Considering high migration rates to Ahmedabad and an increase in traffic day by day, we can change private vehicular traffic control bolstered air quality sensors data. Waste collection intensity from public bins may be adjusted by using smart dustbins. We will utilize the experience gain by other smart cities around the world to assist in improving Ahmedabad. By implementing these technologies, we can significantly improve the resident's satisfaction. To induce the

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required outcomes, we require the citizens to possess an improved awareness of those technologies. And also, Political co-activity and leadership are required for implementation and execution.

## 6. Future of Smart Cities

Imagine a scenario where all the information accumulated and action at the edge could be given a new life. By the advancement of new processing advances Fog and Edge computing will change the situation of figuring the data accumulated through the IoT devices, this will change the smart urban areas [8]. Edge computing will make the lives of the citizens quicker by computing the information at the IoT devices, and legitimately send the outcome on the request of the client. Edge computing will altogether lessen the expense. In smart urban communities when uncovering information about the city condition, data and organizations must be nonpartisan and objective. The present research hopes to see and sort out blocks associated with splendid city improvement as far as innovation headway similarly as policymakers. In the advancement of wireless power charging, Fast charging of the IoT devices will be a fantastic improvement to the smart cities of the modern world.

## 7. Conclusion

In this paper, we have discussed the rapid development of emerging IoT technologies. We have just overviewed the current technologies, applications, and the challenges which we will face in developing the IoT devices in Smart Cities such as Healthcare, Waste Management, and some more. Smart cities won't have the option to accomplish their motivations without dealing with the issues of Data privacy and Security. To develop a better smart city the cost of implementing the IoT technologies will go on increasing and the expense of executing the IoT innovations will continue expanding with the new headway of advancements. Government policy will also play an important role in developing Smart cities. In future, the similar supposed to be done for other cities too.

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