Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-1 Issue-1 || February 2022 || PP. 22-31 https://doi.org/10.55544/sjmars.1.1.4

Smart City Implications of the Internet of Things

Fuzail Khan[1], Satish Chaturvedi[2] and Arun Jaswal[3]
[1]Department of Computer Science, Yogananda College of Engineering and Technology, INDIA.
[2]Department of Computer Science, Yogananda College of Engineering and Technology, INDIA.
[3]Department of Computer Science, Yogananda College of Engineering and Technology, INDIA.

[1]Corresponding Author: khan.fuz0075@gmail.com

Date of Submission: 21-01-2022 **Date of Acceptance:** 15-02-2022 **Date of Publication:** 28-02-2022

ABSTRACT

The concept of "smart cities" The Internet of Things (IoT) is a multi-layered framework that allows cities to employ urban networks to enhance economic performance, generate innovative technological solutions, and more. Smart Cities are the result of a new age in information technology and smart economy growth, based on Internet mesh networks, communication networks, transmission networks, wireless networks, and other end-to-end sensor networks. The Internet of Things (IoT) is at the heart of it. The Internet of Things incorporates sensors into common things and links them through particular protocols for sharing data and communications over the Internet. Smart detection leads, location, monitoring, and administration are all provided by this modular architecture. A smart city of excellence must overcome three main factors: instrumented, linked, and intelligent, with the help of IoT technology. At this point of IoT development, smart cities can only arise through the interconnectedness of all of these smart elements. The goal of this essay is to learn how the Internet and sensors may assist in the development of smart cities.

The study's main goal is to figure out how the Internet of Things, or IoT, is being used in smart cities. We also want to establish the necessity for IoT systems in these smart cities, as well as the issues that they may pose to individuals and society, via the research.

Review secondary research papers, reviews, dissertations, and online documents from the EBSCO, Scopus, and Emerald databases to analyse and comprehend the usage of IoT in smart cities and the possible problems that its implementation may provide in order to accomplish the following goals.

Municipal requirements are getting more complicated, necessitating the adoption of new technology like the Internet of Things to ensure that all of these cities' duties are completed. Although more cities are becoming smart via the usage of IoT in a number of businesses, the study shows that this IoT system is also creating worries about the security of citizens' data.

Keywords- smart cities, technology, IoT, quality security data.

I. INTRODUCTION

The Internet of Things (IoT) is a communication paradigm for the near future that connects ordinary objects by combining microcontrollers, digital communication transceivers, and the suitable protocol stack. It makes use of the massive amounts of data created by these devices in order to give new services to consumers, businesses, and government organisations. These include: home automation; industrial automation; medical aid; mobile healthcare; aged care; intelligent energy management and smart grids; autos; and traffic management.

However, in these many application domains, finding a solution that fits the needs of all conceivable application situations might be challenging. As a result of this challenge, a plethora of potentially conflicting approaches for the actual implementation of IoT systems have sprung up. As a result, owing to its novelty and complexity, creating an IoT network with the requisite back-end network devices and services is not yet an established best practise. Aside from technological challenges, the IoT paradigm's acceptance is limited by a lack of a clear and generally acknowledged business model that can attract investment and drive the implementation of these technologies.

Applying the IoT paradigm to urban settings is particularly appealing in this very difficult environment because it responds to the huge desire of governments in many countries to use ICT solutions in public administration and achieves so-called smart cities. Although no commonly accepted definition of "smart city" exists, the ultimate goal is to make better use of public resources, save money, and improve the quality of services provided to residents. is. Management The adoption of urban IoT may aid in achieving this goal. A communications infrastructure that offers reliable, rapid, and cost-effective access to a wide range of government services unlocks potential synergies and increases public transparency.

The administration and improvement of conventional public services may benefit greatly from urban IoT. Transportation and parking, for example, lighting, public space monitoring and maintenance, cultural heritage protection,

rubbish collection, hospitals, and schools are all examples. Increase transparency, stimulate local government action toward residents, enhance awareness of citizens' urban problems, and manage citizens by leveraging the availability of various forms of data acquired by the ubiquitous urban IoT. It encourages the development of innovative government services and the Internet of Things. As a result, implementing the IoT paradigm in smart cities is claimed to be very profitable for local governments as well as other regional governments. These governments might be early adopters of these technologies, paving the way for the adoption of wider IoT concepts.

II. CONCEPT OF SMART CITIES

The smart city market is already worth hundreds of billions of dollars, and yearly investment is predicted to reach $ 6 billion by 2020. Smart governance, smart transportation, smart utilities, smart buildings, and smart environments are all part of this market, which is the outcome of synergistic links across important businesses and service sectors. These areas are also taken into account in European smart city programmes, which have established categorization standards for determining a city's "intelligence level." The smart city market, however, has failed to take off owing to several political, technological, and financial roadblocks. The attribution of decision-making authority to diverse parties, , is the biggest political hurdle. One option to overcome this stumbling block is to institutionalise the whole decision-making and execution process by combining all components of smart city strategic planning and administration under a single municipal department. The lack of interoperability across cities and the various technology now employed in urban development is the most pressing technological challenge. In this regard, the Internet of Things vision will be a critical component in achieving a single ICT platform for the whole city, unlocking the smart city vision's potential. Finally, although some steps have lately been done to bridge this gap on the financial side, a clear economic model is still absent. The global economy's disadvantages aggravated the situation, and investment in public services dropped in general.

The role of IoT in Smart Cities

This section lists a number of services that the urban IoT paradigm may provide. These services may be of relevance in the context of smart cities since they may create scenarios that enhance both the quality and development of the services offered. It provides economic advantages to the local administration in the form of lower operating expenses for the average resident.

The soundness of a building's structure: It is vital to regularly evaluate the real status of each structure and identify the regions most vulnerable to external effects in order to effectively manage the city's historic buildings. In the opinion, urban IoT might offer a distributed database of building structural integrity measures acquired by suitable sensors positioned within the structure, in addition to thorough environmental characterization. For more focused preventive maintenance and recovery efforts. Integrated seismic and vibration measurements may be achievable in the future, allowing scientists and engineers to better understand and comprehend the effects of moderate earthquakes on urban infrastructure and infrastructure systems. This database may be made available to the public in order to raise public awareness of the efforts being undertaken to preserve the city's historic resources. However, in order to make advantage of this service, you must first install sensors in your building or surrounding area and connect them to your management system. It is possible that this will need a one-time expense to construct the necessary infrastructure.

Disposal of Waste: Waste disposal is a big concern in many contemporary cities, owing to both service costs and landfill difficulties. Deeper adoption of ICT solutions in this sector, on the other hand, may result in considerable cost reductions as well as economic and environmental advantages. Smart bins, for example, may minimise garbage collection costs and enhance recycling quality by recognising load levels and allowing collection trucks to optimise routes. The Internet of Things (IoT) is required to link terminals, or smart garbage cans, to a control centre where optimization software evaluates data to identify the best collection vehicle management.

The European Union has chosen to implement the 20-20-20 Renewable Energy Directive, which establishes targets for reducing climate change over the next ten years. By 2020, the objective is to cut greenhouse gas emissions by 20% while also reducing energy consumption by 20% via improved energy efficiency. It also mentions a 20% boost in renewable air quality in congested places, parks, and fitness pathways. It may also offer communication capabilities to enable healthcare apps running on the rider's device to connect to the infrastructure. Individuals in this position often seek the most healthful way to engage in outdoor activities while being connected to their favourite personal training software. To offer these services, the city must install air quality and pollution monitors, with sensor data made public.

Noise monitoring may be thought of as a sort of pollution that is akin to carbon dioxide (CO2) in the atmosphere. With this in mind, local authorities have already adopted legislation that limits noise levels in the city centre at certain hours. This service may be used to not only produce a spatiotemporal map of noise pollution in the neighbourhood, but also to improve public safety by using sound recognition algorithms to identify noises like shattered glass and fights. Although this service may improve the city's tranquillity and the trust of public facility owners, the issue with sound detectors and surrounding microphones is privacy, as shown by this kind of site.

One of the smart city services that may be performed by urban IoT is urban traffic congestion monitoring, which is analogous to air quality and noise monitoring. Many cities currently have camera-based traffic monitoring systems in

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-1 Issue-1 || February 2022 || PP. 22-31 https://doi.org/10.55544/sjmars.1.1.4

place, but pervasive low-power communications may offer a more dense supply of data. Traffic monitoring may be done utilising sensors and GPS capabilities inherent in current automobiles, as well as putting a mix of auditory and air quality sensors along specified roadways. This information is critical for local officials and people. The former directs traffic and assigns police when required, while the latter pre-plans a route to work or, better yet, shops downtown.

Urban Energy Consumption: In addition to air quality monitoring, urban IoT offers authorities and residents with city-wide energy consumption monitoring services, including the amount of energy spent by different services (public lighting, transit, and traffic lights). Present a comprehensive and complete review of surveillance cameras, public building heating/cooling, and other topics. This detects and prioritises the primary drivers of energy consumption in order to improve their behaviour. Furthermore, active functions to regulate local energy producing facilities may be added to this service (e.g., photovoltaic modules).

Smart Parking: On April 23, 2009, the European Parliament and the Council held a hearing on Member States' efforts to minimise greenhouse gas emissions in order to comply with EU greenhouse gas rules. Sensors and smart displays are used. Make a pledge to minimise emissions in the city's finest parking lots. This service has various advantages, including speedier parking spot searches, lower CO emissions from automobiles, less traffic congestion, and happier inhabitants. Smart parking services may be incorporated directly into the city's IoT infrastructure, since several European businesses provide market goods for this use. Claim that short-range communication technologies like RFID and NFC may be used to verify parking permits for homeowners (NFC). obstacle. As a consequence, those who use legally accessible area enjoy better service and quicker detection of violations.

Intelligent Lighting: Improving the efficiency of public lighting is a key component of the 20-20-20 agenda. This service, in example, allows users to adjust the intensity of public illumination based on the time of day, weather conditions, and the number of people present. According to Anagnostopoulos, public lighting must be connected into the smart city infrastructure for this service to function well. Using the maximum number of connection points, it is also feasible to offer citizens with a Wi-Fi connection. Furthermore, defect detection systems are simple to integrate into public lighting controls.

Health and Public Building Automation: Another important application of IoT technology, is the energy consumption of public buildings (schools, administration offices, museums) via various types of sensors and actuators that control lighting and monitor the environment's health in terms of temperature and humidity. These elements under control, it is feasible to increase the degree of comfort of individuals who live in these surroundings, which has a beneficial influence on productivity while lowering heating/cooling expenditures.

Figure 1: Role of IoT in Smart Cities

Areas where IoT is applied in smart Cities

For the last decade, the Internet of Things has piqued researchers' and practitioners' curiosity. To actualize the IoT's essential features, you'll need a specialised operating system and communication protocol that allows people and devices to communicate,"contemporary cities are smarter and more efficient in many aspects owing to improvements in information and communication technology (ICT). On the other hand, it is not necessary nor feasible to make every part of a smart city intelligent. Cost and accessibility of key technology have a significant role. Advanced Identification (AIM),

District Information Management and Modeling for Energy Reduction (DIMMER), and Buildings, , are some of the European efforts under the 7th Framework Program for Research and Technology Development (FP7)". There are a variety of IoT middleware solutions that focus on implementing IoT across a wide range of application domains, such as SEEMPubS and IntUBE. Current smart city initiatives rely on networks and communications technologies to solve pressing urban concerns including population growth, overcrowding, and heavy traffic.

Transportation and Mobility

Mobility and transportation are frequently used interchangeably in smart cities. The concept of efficient urban transportation, on the other hand, is more well known. Intelligent Transport Systems (ITS) handle transportation in terms of multiple functions and applications, with a particular emphasis on the development of IoT networks. Smart mobility may also refer to a characteristic of a new service or product that is linked to intelligent software. Smart mobility and smart transportation, on the other hand, relate to the same service in general. In a nutshell, it's an Internet of Things (IoT) network application designed to increase personal mobility in smart cities. Transportation and transportation, comprise sources of pollution to varied degrees, such as public transportation, everyday transportation by private automobile, and leisure travel. People living in smart cities will be able to enjoy a wide variety of accessibility and efficiency, regardless of their physical, sensory or cognitive limitations, as the IoT platform is used for smart mobility and transportation. Community gardens and surrounding parks, for example, play a significant role in modern urban life and help fuel the city's fast expansion. However, open space has been lost (reused) in certain quickly rising cities in the recent decade. Citizens can utilise, share, and govern open areas more effectively with smart mobility. The performance of PEV parking under incentive-based and demand-response price-based strategies was evaluated. The SEMS platform receives real-time historical data from the electric bicycle through sensors attached to the bicycle. The system can check the battery of the electric bicycle without the need for the driver to intervene.

Infrastructure and Housing

The major activities of smart homes and private infrastructure are largely accomplished via the analysis of data acquired by wireless sensors. One of the primary aims of smart homes is to provide effective control over current home gadgets and apps. Electronics, indoor and outdoor home security systems, air conditioners, lighting control, room temperature monitoring, appliance usage, maintenance/health, and so on. Sensors, such as monitoring, are used to keep track of different characteristics, and the data is then transmitted back to the IoT platform for analysis. This data is utilised not only for owners to remotely monitor the state and surroundings of smart homes, but also for real-time control of linked equipment. Intelligent civil engineering infrastructure systems may also be developed. Distributed sensors in civil engineering infrastructure systems offer continuous status evaluation and, in certain situations, control of the system or device. The development of IoT infrastructure is now garnering a lot of attention. Integrate cognitive features into standard IoT frameworks via research initiatives. The Cognitive IoT (CIoT) and Cognitive Dynamic Systems (CDS) are two new paradigms that give guidance for the deployment of systematic cognition. A "find now and search later" paradigm that combines self-powered wireless sensors with low-cost passive RFID-based data retrieval technology has recently been presented. This technology relies on self-powered sensors to detect sub-microwatt signals caused by structural mechanical stress/strain and transfer RFID scan data to the cloud through IoT.

Healthcare and Retail

With developments in IoT, smart cities can assist online shopping and healthcare. To successfully support remote shopping and healthcare, visualise sensor data from smart devices worn or utilised by individuals. Customers generally want to examine a product before making a purchase, thus the display is very vital for online shopping. Display sensors are being used in research to improve the accessibility of important services for individuals with impairments. Users with disabilities have risen in the United States and other areas of the globe in recent decades, so they are healthy and balanced by permitting wider and more fair access to medical services via technology advancements. Research is being undertaken in order to achieve a prosperous society. For speedier and more accurate medical processes, smart cities can monitor patient status. The position of ambulances is constantly tracked and smartly dispatched. Smart health systems have recently resulted in advancements in accessibility, comfort, and autonomy for individuals with impairments in contemporary cities. Through the utilisation of wheelchair users' access to the Internet, researchers have been able to increase their social involvement in online shopping and communication. A blind aid project using an intelligent "E-Cane" system has been described. In order to include wand users into smart cities, the authors propose an integrated hardware-software solution that allows users to access the Internet for up-to-date road and traffic information, as well as an integrated hardware-software solution.

Energy

Almost every facet of a contemporary city is related with energy. Smart houses with Internet of Things capabilities can monitor and regulate residential units to cut energy usage. Smart (remote) education is possible in smart cities because to the Internet of Things, which allows users to access online resources without having to physically attend educational activities. Distance learning may help to cut down on the usage of public and private transportation, lowering energy consumption. Smart energy in traffic, is largely targeted at delivering efficient energy management, such as congestion control, smart parking, and traffic management. "Smart City energy efficiency is now the focus of a lot of

Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-1 Issue-1 || February 2022 || PP. 22-31 https://doi.org/10.55544/sjmars.1.1.4

study. To effectively regulate the energy usage of smart cities, several IoT networks have been built. Mobile phone-based apps, are a typical example of remote-controlled electrical equipment, notably in smart homes. Smart energy-efficient middleware (SEEMPubS) initiatives for public spaces are using IoT networks in their service-oriented architecture (SoA). A heating, ventilation, and air conditioning (HVAC) system was used in the project, to remotely regulate SoA's heating and cooling system". The SEEMPubS project is carried out via a specifically created mobile phone application that is linked to the database. Users may simply monitor the temperature of the building by routinely uploading SoA status (occupancy, residual room temperature, external temperature, device capacity, and so on) to the database.

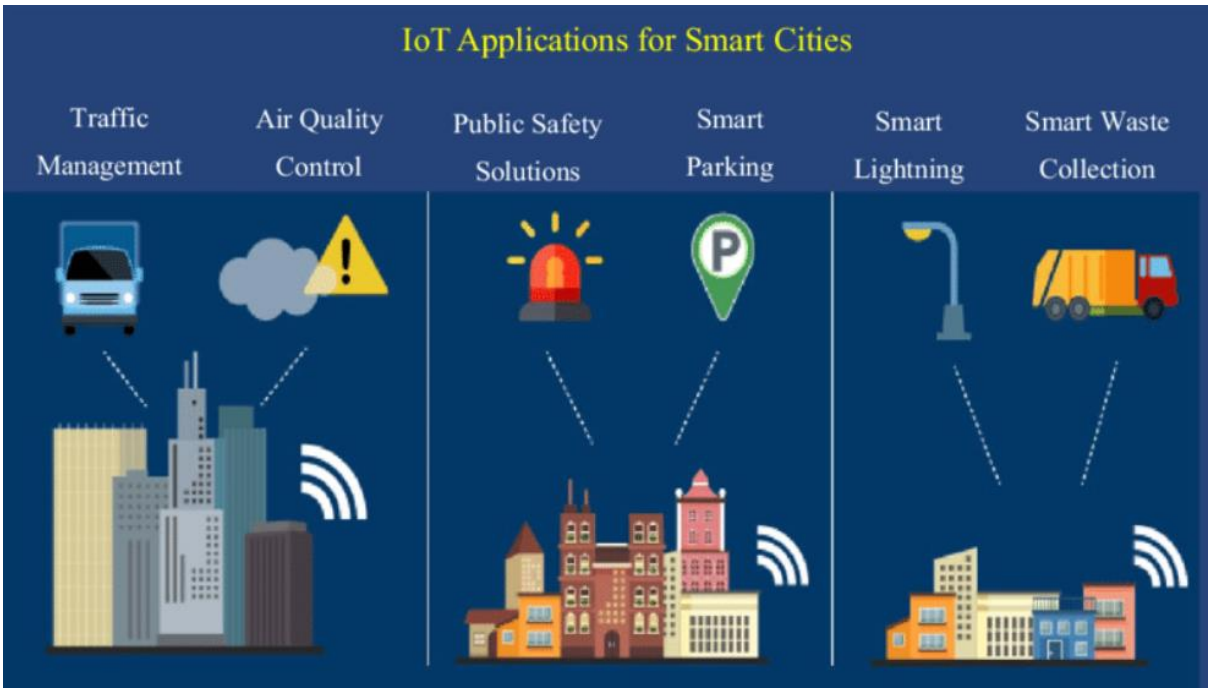

Figure 2: IoT applications for Smart Cities

III. CHALLENGES OF IOT IN THE BUILDING OF SMART CITIES

There is no question that smart city technologies will drastically alter our society's environment. Service providers may utilise the acquired city data to enhance sustainability and security while using limited resources more efficiently as cities grow increasingly equipped with sensors and digitally linked. It is anticipated that it will be put to good use. This begs the issue, of what are the unexpected (bad) implications of smart city solutions, and what is the best method to minimise these repercussions. Risks linked to cybersecurity and privacy are among the most well-known issues in the present state of digital technology. The fast development of public asset connections to the Internet and the rising dangers associated with cyberattacks are not new security problems. Smart cities must be prepared for security challenges as cybercrime and data theft become more prevalent. Otherwise, smart cities' advantages are swiftly outweighed by their disadvantages. Recent ransomware attacks on government institutions (as well as schools and companies) have made people more aware of the dangers that cities confront as they grow more connected and digital.

Infrastructure systems have already been hacked into pieces with the intentional purpose of disrupting services and disseminating public displeasure to elected authorities who look unable of dealing with the disruption. When a hostile attacker joins and controls an automated system to wreak massive harm to society, many additional apocalyptic scenarios might be created. Cities have sensors and cameras installed on roadways, highways, and public meetinghouses, but these technologies are not without flaws. Hostile attackers exploit weak security defences and purposefully fool these sensors into producing "poor" data or false information in order to deceive the global system's controllers. Terrorists may attack physical weaknesses by simply pushing a sensor. All of these tales' point to the same conclusion. All functional parts of a smart city must be safeguarded, but the dangers associated with a security breach must be explicitly disclosed. The data acquired by smart city sensors and information platforms provides numerous advantages to community members, but the expense of these benefits may jeopardise professionals' privacy and equality. There has been an increase in public discussion in recent years concerning the appropriate usage of face recognition technology in public areas.

On the one hand, public camera surveillance and face feature recognition may be utilised to increase public safety. Reducing traffic congestion, capturing criminals, and discouraging offenders are just a few of the advantages claimed. Community members, on the other hand, are nonetheless apprehensive about technology's privacy consequences. Public

conversations on these difficult problems are encouraged, and communities may discover smart city solutions that match their culture and beliefs. Finally, challenging problems such as how long this data is maintained, under what conditions (if any), and who, rather than the machine, should authorise the use of public data when (if any) were resolved. Is it permissible to study while making legal decisions? The problem of data security and justice is more than just about data. Smart city data analysis might be equally sophisticated in order to meet the community's ideals. Predictive analytics based on spatiotemporal crime data, for example, has been used to make better use of limited police resources and increase public safety. This strategy produced an inherent bias in monitoring, and the presence of the innocent proven to be guilty. When private enterprises are engaged in the building of sustainable smart cities, data privacy challenges transcend well beyond local administration.

One of the most critical challenges that must be handled in a smart city project is what data is gathered and how it is utilised and secured. Public policy often requires long-term collaboration with a variety of municipal stakeholders. Private policy, on the other hand, moves at a quicker pace and may not be the best location to collect many perspectives before moving on. The lack of public participation and openness in making critical choices on how public privacy is exposed via sensors and gadgets has been criticised in many high-profile tech initiatives. Solution for a smart city. Regardless of whether the project is led by a public or private entity, present privacy standards that predate the current technological environment may not be enough to meet the potential threats provided by urban technology. The correct and lawful use of smart city technologies, creates substantial issues for both people and government. The promotion of economic growth is one of the motivations for the creation of smart cities. Unlike in other countries, where the central government has a significant role in funding and management, most smart city initiatives in the United States are often sponsored locally by the municipal or business interests such as public-private partnerships. Incentives for private individuals to participate in enterprise-led models might take the shape of financial and technological investments, for example. However, since the company or enterprise model focuses exclusively on economic development, the absence of social and cultural integration has been questioned. To reconcile ICT-based urban innovation with care for persons, society, culture, and the environment, a move to a more holistic, human-centric approach is ongoing, at least as urged by academics and the scientific community.

By integrating local governments, communities, and corporate stakeholders, the true difficulty is to combine a business-centric goal with a people-centric vision. The congestion of the physical infrastructure systems that support many smart city solutions is another difficulty that is sometimes disregarded in smart city initiatives (for example, new mobility services continue to rely on roads). Reinvestment in physical infrastructure may be required as a result of public investments in sensors and digital links. The city is not "smart" if the streets are full of potholes, the water is contaminated, and the bridges are on the edge of collapsing. The solutions to these challenging problems are fascinating. Smart infrastructure, for example, might stimulate greater private investment in physical infrastructure. Research has started to seek at methods to tokenize infrastructure investments, as well as new ways for infrastructure owners to generate income streams based on the data that smart infrastructure will surely provide.

IV. PRACTICAL IMPLICATIONS

Use of Sensing as a Service and Everything as a Service in the Smart Cities

Waste Management

One of the most challenging difficulties that contemporary cities confront is waste management. Trash management encompasses a wide range of activities, including waste collection, transportation, treatment, disposal, management, and management. These procedures are quite expensive in terms of money, time, and human resources. By optimising the waste management process, money may be saved that can be used towards other issues that smart cities face. Multiple stakeholders are engaged in the waste management process in contemporary smart cities. Instead of putting sensors one at a time to gather data, the "sensing as a service" concept enables all parties involved to share the equipment and expenses. The cost reduction that individual parties must endure is the most crucial feature of such collaboration. To fulfil their objectives, each party may gather and analyse sensor data in real time. The price is determined by the interest group's data requirements. For example, local governments may utilise sensor data to develop improved waste collection plans, saving money on garbage truck fuel. Furthermore, recycling organisations may utilise sensor data to anticipate and track the amount of garbage entering the facility for processing in order to improve internal procedures. Furthermore, without spending a lot of money on manual supervision, health and safety organisations would be able to oversee the waste management process. The uniqueness of employing a sensing model as a service to share sensor data has a synergistic impact (that is, multiple elements in the system interact to achieve an effect greater than the sum of the individual effects). The IoT infrastructure's long-term viability is ensured by the sensing model as a service.

Smart Agriculture

Cities may perform scientific study and research more efficiently and effectively using the sensing-as-a-Service paradigm. Furthermore, it brings up a number of study options that would be impossible to achieve using traditional research techniques. Phenonet is a sensor network that collects data on experimental plants in the outdoors. In addition,

researchers at the High-Resolution Plant Phenomenon Center are investigating a network of smart sensor nodes that can track plant development and provide meteorological data. The primary purpose of utilising sensors to gather data is to better understand plant development in various climatic circumstances, although the same set of sensors may be utilised for many research activities in several fields. Data from many organisations and research institutions throughout the globe may be shared. Many research institutes may not be able to support the deployment of large-scale sensors due to a lack of funds (for example, academic institutions, especially developing countries). Nonetheless, the Sensing-as-a-Service model allows all stakeholders who are unable to establish their own sensor deployment to conduct research using real-world data at a far lower cost using real-world data. In addition, the detection model as a service offers up new opportunities in a wide range of disciplines. For example, data from the aforementioned sensors might be used to better understand the need for pest control and other similar occurrences.

Environmental Management

This industry is distinct in that it may make use of sensors that have already been deployed for a variety of reasons. In environmental monitoring, a vast variety of sensors have been utilised. Weather forecasting, forest fire detection, and structural condition monitoring are some of the other uses. Users may get meaningful sensor data without needing to utilise the sensor using the Sensing-as-a-Service strategy. Similarly, environmental management is a large topic that no one body can handle (eg. forest fires). Sensing as a Service models encourage innovative solutions that use the same data but provide different results via alternative processing and analysis methods (prediction, visualization, simulation, etc.). Sensor data users may use ESP to integrate existing services into a range of data processing and analysis processes.

V. CONCLUSION

Smart cities, in which digital technology plays a significant role, are unquestionably the way of the future. This article discusses technological developments and IoT adoption in smart cities, as well as some of the problems associated with investing in cybersecurity, cyberprivacy, and infrastructure. Smart cities are built on the concept of urbanisation, which fosters innovation and economic advancement. However, urbanisation has a huge influence on communities' social and cultural elements. Smart cities, rightly or wrongly, are thought to benefit largely the upper and middle classes, and that the advantages of digital access are confined to a small number of individuals. The fundamental problem is determining how smart technology can provide fair and equal outcomes for its inhabitants. Smart city engineers and designers must have a thorough grasp of smart technologies, as well as the advantages and hazards that come with them. Smart cities are, in theory, not just places where technology and economic progress are interwoven, but also places where people may live in a humane, environmentally healthy, and liveable environment.

FUTURE SCOPE OF IOT IN SMART CITIES

The Internet of Things (IoT) is as pervasive as the objects it connects. According to Gartner, there are already 3.8 billion linked devices in the globe, which include smart automobiles, trains, parking lots, garbage cans, and even tennis rackets and toasters. According to researchers, that number will continue to rise at an exponential rate. By 2020, 25 billion of these devices will send data to the cloud, communicate with one another, and generate meaningful data. City Hall is an IoT implementation since more than half of the world's population resides in the city centre as part of the increasing trend towards urban living (official UN forecasts suggest that two-thirds of humankind will live in cities by 2050). This technology promises a viable solution to handle increasingly complicated city planning initiatives for those who seek to develop so-called "smart" cities. After steam, electricity, and, of course, computers, many are pleased to speak about the Internet of Things' quick ascent as the fourth industrial revolution. It may be a bit early, but this new technology has the potential to alter practically every element of our lives that we spend (at least in part) in cities and other metropolitan regions. If IoT is used to make cities smart, the following features will be included in their future.

1. No Traffics

With the rise in population in the cities indicated above (work and housing are becoming more concentrated in the city centre, and people are pursuing more and more people), the cities' transportation systems must be immediately reviewed. Most of the time, these systems are severely overburdened, and in the worst-case scenario, the automobile produces exhaust fumes for long periods of time, leading traffic to become permanently clogged and significantly impacting the area's air quality. However, IoT technology is still in its infancy and will undoubtedly aid cities in better managing traffic flows in the future. A video-integrated traffic sensor, for example, may connect with other devices to modify green and red lights depending on the car's location and time, therefore reducing traffic congestion. Another technology that makes a significant impact is parking sensors. Using GPS assistance for vehicles, information about available parking spots may be supplied to the app. Even parking drones are being developed by entrepreneurs to navigate automobiles to open spots. It is believed that up to 30% of urban congestion is caused by cars looking for parking, whereas ordinary traffic alone may generate more than 64% of air pollution.

2. Efficient use of Energy

The Internet of Things will make our lives simpler in the near future, but if there is one group in society that will benefit most from new technology, it is those who care about the environment. Early indications show that the linked "things" are poised to alter the game when it comes to controlling carbon dioxide emissions. Take, for example, LED streetlights, which are already in use in numerous places across the globe and turn on when walkers and cars approach. This change, for example, may save local governments $ 250,000 per year. They can, of course, conserve all of the energy that would otherwise be squandered. Sensors that are now being tested in garbage cans throughout the globe provide comparable results. Solar power, for example, may shred garbage as required and send a message asking pickup only when necessary, reducing both travel and CO2 emissions. Most notably, "smart grid" technology is transforming how energy is priced and delivered to households and public areas. Energy pricing is demand-based under this system, and metres, thermostats, and smart devices may give energy during off-peak hours, assuring the lowest costs.

3. Better Transport

Transportation has been transformed by the Internet of Things. IoT sensors are being used by automakers all around the globe in self-driving prototypes. Ford has said that it intends to open its doors to the general public by 2025. These automobiles may save passengers energy and time by using wearables, cloud-based transportation, and enormous data collecting and analysis using GPS services. Safer driving results in fewer accidents, resulting in fewer insurance claims and cheaper rates. The electric car is another technology upheaval that advanced city planners are fast planning for. Many cities currently have charging stations where citizens can park and charge their vehicles, which has proven to be an excellent investment. The worldwide market for electric vehicles is expanding. Tesla produces 500 electric vehicles every week in California, so demand hasn't dropped. Even the initial prototype was found to be much more energy efficient than the gasoline-powered version. It's no surprise that several manufacturers are on the verge of adopting Elon Musk's supercharged batteries, including Nissan, BMW, Ford, and Honda. One thing is certain: future drivers will use electricity only when it is absolutely necessary.

Much more will probably definitely happen even after the vast and inventive advancements outlined above have been implemented. Most critically, IoT development is still in its early phases. Analysts have projected that the Internet of Things would have the same effect as the "fourth industrial revolution," which includes steam, electricity, and, of course, computers. Smart technologies are being used by cities all around the globe to satisfy their particular day-to-day management demands. With 54 percent of the world's population living in cities, and this figure constantly increasing, investing in linked urban infrastructure is a prudent investment to solve future urban management concerns. Cities from Seoul to Edinburgh are recognising the immense social and economic advantages of IoT-enabled smart city systems. WIFI's smart digital infrastructure, in terms of technology, provides a safe platform for people, companies, and technologies to connect and engage, allowing communities to benefit from data-driven insights.

REFERENCES

[1] Ahad, M. A., Paiva, S., Tripathi, G., & Feroz, N. (2020). Enabling technologies and sustainable smart cities. Sustainable cities and society, 61, 102301.

[2] Ahmed, S. H., & Rani, S. (2018). A hybrid approach, Smart Street use case and future aspects for Internet of Things in smart cities. Future Generation Computer Systems, 79, 941-951.

[3] Alavi, A. H., Jiao, P., Buttlar, W. G., & Lajnef, N. (2018). Internet of Things-enabled smart cities: State-of-the-art and future trends. *Measurement*, *129*, 589-606.

[4] Anagnostopoulos, T., Zaslavsky, A., Kolomvatsos, K., Medvedev, A., Amirian, P., Morley, J., & Hadjieftymiades, S. (2017). Challenges and opportunities of waste management in IoT-enabled smart cities: a survey. IEEE Transactions on Sustainable Computing, 2(3), 275-289.

[5] Angelakis, V., Tragos, E., Pöhls, H. C., Kapovits, A., & Bassi, A. (Eds.). (2016). *Designing, developing, and facilitating smart cities: urban design to IoT solutions*. Springer.

[6] Arasteh, H., Hosseinnezhad, V., Loia, V., Tommasetti, A., Troisi, O., Shafie-khah, M., & Siano, P. (2016, June). Iot-based smart cities: A survey. In 2016 IEEE 16th international conference on environment and electrical engineering (EEEIC) (pp. 1-6). IEEE.

[7] Avdeeva, E., Davydova, T., Skripnikova, N., & Kochetova, L. (2019). Human resource development in the implementation of the concept of "smart cities". In E3S Web of Conferences (Vol. 110, p. 02139). EDP Sciences.

[8] Baig, Z. A., Szewczyk, P., Valli, C., Rabadia, P., Hannay, P., Chernyshev, M., ... & Peacock, M. (2017). Future challenges for smart cities: Cyber-security and digital forensics. Digital Investigation, 22, 3-13.

[9] Bruneo, D., Distefano, S., Giacobbe, M., Minnolo, A. L., Longo, F., Merlino, G., ... & Tapas, N. (2019). An iot service ecosystem for smart cities: The# smartme project. Internet of Things, 5, 12-33.

[10] Castro Lundin, A., Ozkil, A. G., & Schuldt-Jensen, J. (2017, January). Smart cities: A case study in waste monitoring and management. In *Proceedings of the 50th Hawaii international conference on system sciences*.

[11] Din, I. U., Guizani, M., Rodrigues, J. J., Hassan, S., & Korotaev, V. V. (2019). Machine learning in the Internet of Things: Designed techniques for smart cities. Future Generation Computer Systems, 100, 826-843.
[12] Dlodlo, N., Gcaba, O., & Smith, A. (2016, May). Internet of things technologies in smart cities. In 2016 IST-Africa Week Conference (pp. 1-7). IEEE.
[13] Ejaz, W., & Anpalagan, A. (2019). Internet of things for smart cities: overview and key challenges. *Internet of Things for Smart Cities*, 1-15.
[14] Ejaz, W., Naeem, M., Shahid, A., Anpalagan, A., & Jo, M. (2017). Efficient energy management for the internet of things in smart cities. *IEEE Communications magazine*, *55*(1), 84-91.
[15] Farahat, I. S., Tolba, A. S., Elhoseny, M., & Eladrosy, W. (2019). Data security and challenges in smart cities. In Security in smart cities: models, applications, and challenges (pp. 117-142). Springer, Cham.
[16] Ghazal, T. M., Hasan, M. K., Alshurideh, M. T., Alzoubi, H. M., Ahmad, M., Akbar, S. S., ... & Akour, I. A. (2021). IoT for smart cities: Machine learning approaches in smart healthcare—A review. *Future Internet*, *13*(8), 218.
[17] Ghosal, A., & Halder, S. (2018). Building intelligent systems for smart cities: issues, challenges and approaches. In Smart cities (pp. 107-125). Springer, Cham.
[18] González-Zamar, M. D., Abad-Segura, E., Vázquez-Cano, E., & López-Meneses, E. (2020). IoT technology applications-based smart cities: Research analysis. Electronics, 9(8), 1246.
[19] Hamid, B., Jhanjhi, N. Z., Humayun, M., Khan, A., & Alsayat, A. (2019, December). Cyber security issues and challenges for smart cities: A survey. In 2019 13th International Conference on Mathematics, Actuarial Science, Computer Science and Statistics (MACS) (pp. 1-7). IEEE.
[20] Hammi, B., Khatoun, R., Zeadally, S., Fayad, A., & Khoukhi, L. (2017). IoT technologies for smart cities. IET networks, 7(1), 1-13.
[21] Hashem, I. A. T., Chang, V., Anuar, N. B., Adewole, K., Yaqoob, I., Gani, A., ... & Chiroma, H. (2016). The role of big data in smart city. International Journal of information management, 36(5), 748-758.
[22] Joshi, S., Saxena, S., & Godbole, T. (2016). Developing smart cities: An integrated framework. Procedia Computer Science, 93, 902-909.
[23] Kazmi, A., Jan, Z., Zappa, A., & Serrano, M. (2016, November). Overcoming the heterogeneity in the internet of things for smart cities. In International workshop on interoperability and open-source solutions (pp. 20-35). Springer, Cham.
[24] Kitchin, R. (2015). Making sense of smart cities: addressing present shortcomings. Cambridge journal of regions, economy and society, 8(1), 131-136.
[25] Korczak, J., & Kijewska, K. (2019). Smart Logistics in the development of Smart Cities. Transportation Research Procedia, 39, 201-211.
[26] Kumar, H., Singh, M. K., Gupta, M. P., & Madaan, J. (2020). Moving towards smart cities: Solutions that lead to the Smart City Transformation Framework. *Technological forecasting and social change*, *153*, 119281.
[27] Lea, R., & Blackstock, M. (2014, December). City hub: A cloud-based iot platform for smart cities. In 2014 IEEE 6th international conference on cloud computing technology and science (pp. 799-804). IEEE.
[28] Lom, M., Pribyl, O., & Svitek, M. (2016, May). Industry 4.0 as a part of smart cities. In 2016 Smart Cities Symposium Prague (SCSP) (pp. 1-6). IEEE.
[29] Medvedev, A., Fedchenkov, P., Zaslavsky, A., Anagnostopoulos, T., & Khoruzhnikov, S. (2015). Waste management as an IoT-enabled service in smart cities. In Internet of Things, Smart Spaces, and Next Generation Networks and Systems (pp. 104-115). Springer, Cham.
[30] Mehmood, Y., Ahmad, F., Yaqoob, I., Adnane, A., Imran, M., & Guizani, S. (2017). Internet-of-things-based smart cities: Recent advances and challenges. *IEEE Communications Magazine*, *55*(9), 16-24.
[31] Misbahuddin, S., Zubairi, J. A., Saggaf, A., Basuni, J., Sulaiman, A., & Al-Sofi, A. (2015, December). IoT based dynamic road traffic management for smart cities. In *2015 12th International conference on high-capacity optical networks and enabling/emerging technologies (HONET)* (pp. 1-5). IEEE.
[32] Mohanty, S. P., Choppali, U., & Kougianos, E. (2016). Everything you wanted to know about smart cities: The internet of things is the backbone. IEEE Consumer Electronics Magazine, 5(3), 60-70.
[33] Nambiar, R., Shroff, R., & Handy, S. (2018, January). Smart cities: Challenges and opportunities. In 2018 10th International Conference on Communication Systems & Networks (COMSNETS) (pp. 243-250). IEEE.
[34] Patti, E., & Acquaviva, A. (2016, September). IoT platform for Smart Cities: Requirements and implementation case studies. In 2016 IEEE 2nd International Forum on Research and Technologies for Society and Industry Leveraging a better tomorrow (RTSI) (pp. 1-6). IEEE.
[35] Rajab, H., & Cinkelr, T. (2018, June). IoT based smart cities. In 2018 international symposium on networks, computers and communications (ISNCC) (pp. 1-4). IEEE.
[36] Rhee, S. (2016, April). Catalyzing the Internet of Things and smart cities: Global city teams challenge. In 2016 1st International Workshop on Science of Smart City Operations and Platforms Engineering (SCOPE) in partnership with Global City Teams Challenge (GCTC)(SCOPE-GCTC) (pp. 1-4). IEEE.

[37] Sadhukhan, P. (2017, September). An IoT-based E-parking system for smart cities. In 2017 International conference on advances in computing, communications and informatics (ICACCI) (pp. 1062-1066). IEEE.
[38] Saha, H. N., Auddy, S., Chatterjee, A., Pal, S., Sarkar, S., Singh, R., ... & Maity, A. (2017, August). IoT solutions for smart cities. In *2017 8th Annual Industrial Automation and Electromechanical Engineering Conference (IEMECON)* (pp. 74-80). IEEE.
[39] Samih, H. (2019). Smart cities and internet of things. *Journal of Information Technology Case and Application Research*, *21*(1), 3-12.
[40] Scuotto, V., Ferraris, A., & Bresciani, S. (2016). Internet of Things: applications and challenges in smart cities. A case study of IBM smart city projects. Business Process Management Journal.
[41] Sharma, M., Joshi, S., Kannan, D., Govindan, K., Singh, R., & Purohit, H. C. (2020). Internet of Things (IoT) adoption barriers of smart cities' waste management: An Indian context. Journal of Cleaner Production, 270, 122047.
[42] Sikder, A. K., Acar, A., Aksu, H., Uluagac, A. S., Akkaya, K., & Conti, M. (2018, January). IoT-enabled smart lighting systems for smart cities. In 2018 IEEE 8th Annual Computing and Communication Workshop and Conference (CCWC) (pp. 639-645). IEEE.
[43] Toma, C., Alexandru, A., Popa, M., & Zamfiroiu, A. (2019). IoT solution for smart cities' pollution monitoring and the security challenges. Sensors, 19(15), 3401.
[44] Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M. (2014). Internet of things for smart cities. IEEE Internet of Things journal, 1(1), 22-32.