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Review On Urban Data Management using Cloud Computing and IOT

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Abstract: *Considering quick growth of technical knowledge, it is pertinent for the metropolitan stake-holders to improve the urban living standards by implementing effective policies assistance from data analysis using the Internet of Things (IoT). The IoT involves usage of various sensors for recording data that corresponds to different aspects of urban life, such as health, transport and governance. The interconnection of these sensors enables data analysts and governing bodies to decipher patterns in data, and in turn better understand the urban environments for efficient city planning, eventually creating smart cities. The design and implementation of smart cities is a hot topic nowadays in the field of urban development. This paper reviews the modern technologies that are being used to implement the smart city concept, in turn making it sustainable and more environment-friendly. The necessity of having a variety of sensing platforms for sustainable urban development is discussed. There is a discussion on different data collection and processing frameworks being deployed in smart cities, highlighting the key benefits of utilizing modern technologies like big data, cloud computing, machine learning (ML) and artificial intelligence (AI) with the IoT. The challenges encountered during these processes are also examined, which create new research opportunities. This paper will serve as a guideline for researchers working in the field of sustainable urban development using IoT along with the other modern technologies.*

Keywords: Urban Data Analytics IoT Sensor Networks Cloud Computing for IoT Real-time Data Processing

I. INTRODUCTION

Having various platforms for sensing data in urban environments is the building block for any smart city. The collection of data is a very crucial task for equitable urban development. Because due to the growing use of a wide array of wireless technologies like RFID tags and embedded sensors, we can already see a widely connected world through the internet, and that the IoT has evolved onto a whole new level [1].

We are all witnessing the increasing usage of technology around us. In the past era, most of the devices or 'things' that we interact with in our daily lives had all been upgraded to the extent of automation. With the purpose further enhancing the standard of our lives, the constant need for advancement has led to the concept of these 'things' to be connected to each other through a medium, so that they can all be centrally controlled and utilized. The utility devices are referred to as 'things', whereas the medium used for communication of these devices is the internet, hence the origin of the concept mentioned as the Internet-of-Things (IoT). The IoT has a huge array of applications, ranging from home automation [2] to the smart city concept and beyond.

Homes can be automated by connecting the utility electrical appliances like refrigerators, lights, HVACs and coffee-makers, as well as the traditional non-electrical devices such as door locks and window shades for scheduled and intelligent control, making their utilization efficient and their access much easier. Smart cities can be thought of as the home automation concept extended to a city-wide level [3]. The smart devices used here are the urban sensing units that monitor the various aspects of urban life, such as: (1) natural features like air quality, humidity, rainfall and ground water

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levels; (2) and the human-centered features like transportation, waste management, energy management, ehealth and intelligent governance.

These sensors are connected to each other using the Internet Protocol version 6 (IPv6), which has almost unlimited capacity of handling devices for communication [8]. The basic idea behind IoT is the exchange of data between different entities (people, machines and places) for various intelligent use cases. The huge number of sensors continuously generate data, which has to be further transmitted, maintained, processed, stored and analyzed. For this purpose, there is a whole new field known as the big data. Big data involves the tools and techniques used for the handling of giant amounts of data. Big data employs various tools and techniques for computing in a distributed fashion. A large cluster of utility computing machines are clustered and connected together to process the assigned chunk of data from a single huge volume task assigned to them. Each computing machine performs its particular assigned task and shares the results to the central framework for consolidation. Hadoop, Spark and MongoDB are some of the software tools used to achieve the big data tasks [9].

Cloud computing is another computing technique used with the IoT for achieving greater efficiency in the sense of management and accessibility of the IoT data. Using this technique, various data handling software are deployed on data centers that are placed geographically distant to the actual data processing places. Cloud computing enhances the computational power by the instant availability of almost unlimited capacity of hardware components available ondemand as per the computational requirements through autoscaling features [10]. Auto-scaling enables a certain data processing program to automatically balance the allocation of hardware resources when the processing power requirements change as per the scenario. IoT sensors can transmit the recorded data to the cloud edge nodes (geographically nearer cloud data centers), which can then extract the useful data and only transmit that to the main IoT data analysis platform, hence improving the latency and preventing the hassles of bandwidth choking.

When we talk about the latest computational technologies, Artificial Intelligence (AI) is always on the fore-front. AI is perhaps the oldest field of computer science which got popular in the twenty first century, thanks to the advancement of computing hardware technologies that made it possible to compute the huge AI-related tasks. Machine Learning (ML) is a sub-domain of AI pertaining to various algorithms that intelligently learn from the provided data, and automatically perform various tasks that would otherwise require human cognition.

1.1 Modern urban development

A. Smart cities

1) Features of a smart city

There are four major attributes of smart cities i.e., sustainability, Quality of Life (QoL), urbanization, and smartness [16]. Some other sub attributes also constitute sustainability such as administration, pollution, health, energy resources and climate trends, social problems and economical structure. Sustainability is defined as a city's ability to support the ecological balance regarding every mentioned aspect, during execution of the operations of city. The tech-based, economic structures and other administrating factors of transformation from urban to rural habitat is controlled by the attribute of urbanization. So as a result, the goal to maintain the intelligent city's sustainability, there is a need to secure energy resources and heritages [17].

Enhancing the quality of life was considered as a key element while proposing the structure of intelligent cities in the past. The intelligent cities distinct social policies enable professional citizens to accomplish the task. As a result of skilled work, the services are improved. This also positively impact the financial status of workers and ultimately the living standards are elevated. This finally encourages the QoL to improve. Institutional infrastructure deals with the administration of smart cities. It works for making decisions and provide social services. They also aim to make governance transparent and improving political strategies. [18]. Additionally, it works along with regional and national governments to increase the advantages of smart cities. The institutional infrastructure of the smart city has merged all of its governmental and commercial entities. Many literatures are available to run the economic cycle of smart city through smart economy more productively and efficiently. Research budget and development, Gross domestic product, power consumption indicator, civil society projects, level of employments are the factors that evaluate the achievement of economical infrastructure [19].

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2) The IoT in smart city

The most effective applications of IoT are based on present technology solutions and their implementation on smart city [20]. The implementation depends on some factors such as accessibility of electric gadgets, smart software, broad databases and highquality sensors ample energy supply. The technology of IoT in cities is a big challenge to implement due to the already adopted global structure. The reason is that the availability and synchronization of equipments in a huge metropolitan is a difficult task. However once installed the efficiency will be very much increased because the utilization of services such as transport, water, security etc. through gadgets will make it very much easy to access. Moreover, the detection of problems will be earlier due to high quality sensors. As the problems will be identified earlier, they will also be solved on the spot which will reduce the time of chaos. Some application areas of smart cities are briefly described here:

a) Healthcare

IoT can allow medical workers to be extra vigilant by using smart devices. Patients' safety and security can be tracked through devices. [21] Different human mechanisms can be detected using the advanced IoT devices. Treatment for serious diseases or recovery after serious diseases can also be done through this technology.

b) Power supply

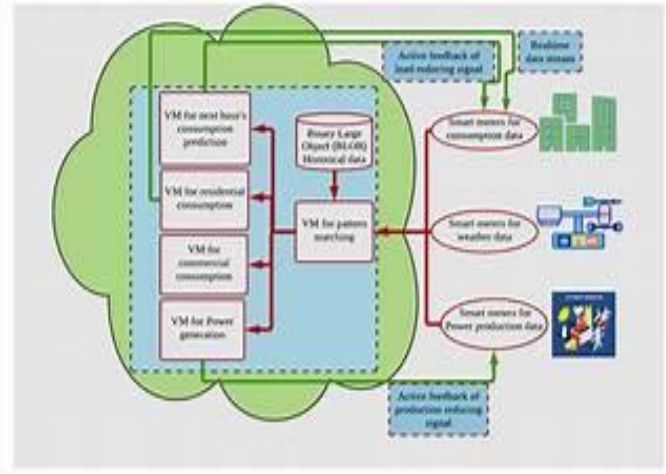
The concept of saving electricity by the use of smart grids [22] can help us a lot. The main purpose is to save electricity which will result in low costs as well as saving electricity.

c) Transport

IoT in the field of transportation can bring a huge revolution in this field. [23] The use of electric vehicles and making them smart by introducing the concept of Internet-of-cars (where the vehicles can communicate with each other on roads) is the demand of atmosphere right now. So introducing smart electric cars and imposing a ban on diesel based vehicles can serve the purpose.

d) Waste management

The smart management of waste and innovative ways [24] of recycling them is possible through IoT. IoT devices such as smart waste operators, smart waste transport, smart level detections allow the management to be more efficient. Similarly, smart recycling devices will help to recycle waste more efficiently.



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II. ARCHITECTURE OF A SMART SUSTAINABLE CITY

A. Composition

It is very important to discuss the composition of any idea before the execution, therefore one can easily understand the idea properly. Here some of the compositions of a smart city are mentioned like smart community, transportation, healthcare, and energy. For a specific smart society, anything can be considered as 'smart' at the time of implementation according to the interest of the society. For example, one smart society may implement the system of transportation while other implements the smart system of waste management system.

The main purpose [35] of smart communities is to provide all smart facilities to the urban citizens. Smart community covers different aspects of a society like the provision of smart waste and management system, smart buildings and smart houses and offices in them, smart schools, and smart infrastructure relate to different aspects of the society. The main goal of a smart community is to maximize the benefits of the citizens of the smart city through connecting with all components.

In smart buildings, everything is smart. For example, smart appliances, software, and hardware are used. All smart buildings share common goal i.e., energy management energy conservation and energy optimization. Smart buildings have the ability of data-driven decision-making techniques for the effective use of energy to preserve the natural habitat. Moreover, smart buildings have smart security and surveillance systems to take care of the citizens. This is one most the most important aspects of a smart community. In the modern world, there is a dire need of smart waste and management systems to decrease all kinds of environmental pollution and to manage the waste of the whole city smartly and effectively. Any kind of waste is divided into three parts i.e., gathering waste materials, getting rid of, recycling process, and then reproduction. Smart management of waste system is the most important part of any kind of smart city and community as waste lefts a very bad impact on human health and the surrounding [36].

B. Collecting and processing urban big data

Smart sustainable urban development is a recent topic, the next major target is the collection, measurement, or processing of information collected in the smart cities. For this purpose, exerts introduced the 'sensors. These sensors will be able to measure, process, and manipulate the data. These sensors are used in different kinds of devices in higher rate for accuracy and proficiency [37].

The aim of using such advanced technology in urban smart cities is to automate the decisions. In this way the whole system will be integrated and embedded with more measuring devices and communication systems. The focus of building this system is to support all these components of the ecosystem of big data which are mentioned below [36]:

- Acquisition of data
- Management of data
- Integration of data in database logically
- Processing of data
- Evaluation of data models
- Data visualization
- Data transformation
- Better decision making from data

Moreover, there is a recent change in the advancement of sensory technology Modern signal analysis approaches, efficient hub-fusion methodologies, and rapid circuitry are characteristics of [38].

C. Communication networks for smart cities

The recorded history of the world shows that 'tyre' has been the most revolutionized invention in the world so far. The whole industry of transportation is based only one thing and that is 'tyre'. It is the necessary of human beings as long distance travels has been very difficult for the human beings from the beginning of humanity. Conventional transportation mediums were never inter-connected and intra-connected. On the other hand, modern world transportation systems relate to various satellite and navigation systems. [39] Vehicular adhoc networks (VANET) are integrated with intelligent

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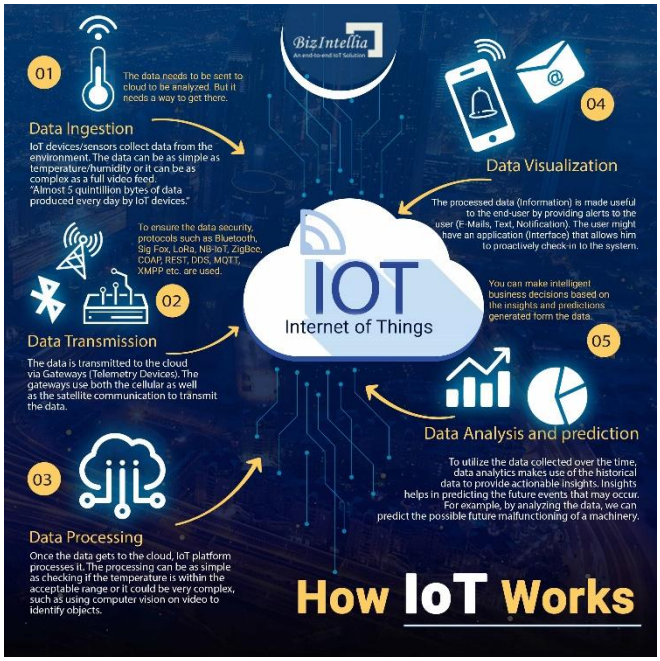
transportation systems (ITS). Today, VANETs are widely used in different parts of the world for traffic management using different kinds of communications like vehicle-vehicle (VV) communications and vehicle-infrastructure (VI) communications. Smart transportation systems are responsible for decrease in the number of accidents in the world. Cities are comprised of citizens and the safety of citizens at any cost must be taken care. There are different kinds of transpiration i.e., water transportation, air transportation, road transportation, and train transportation. All these sectors of transportation are now using integrated systems and smart technologies to increase their efficiency.

D. Smart data center for smart cities

The organization of every task is based on the already given or provided data and the further decision making is also based on the organization of available data. For a smart city, where a lot of people live who use smart devices all the time, the use of data is involved in every other minute. When all the data of the city is gathered, it becomes 'big data'. For the preservation of this big data, data centers are made which are the repository for the smart cities. In data centers, many IoT devices are required to integrate, connect, organize, and manage the data. For this purpose, permanent internet connectivity must be provided all the time. A data center should be eco-friendly [40]. If it is not an eco-friendly, it will release a lot of energy because the system will be running all the time for which a lot of energy is required. Green technology must be used to convert all big or small data centers to decrease the effects of emissions, which are hazardous, on the environment.



III. SMART CITY CHALLENGES

A. IoT and big data utilization challenges

Due to the rise in demand for big data analytics and internet of things (IoT) to serve the urban domain of the country in the name of environmental sustainability, different kinds of challenges are also increasing because, today, the world is rapidly moving towards smart urban cities [47]. The obstacles related to the planning and creation of data-centric software and applications. These difficulties have been connected to scientific and computational, and the field of analytics. Some basic challenges are mentioned below:

- Evaluation of IoT data
- Handling of heterogeneous IoT data
- Integration of databases
- Issues of privacy

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- Storage of big data its processing
- Growth of data and its sharing
- Big data security
- Quality of data

The main challenge is the handling, integration, analyze, and evaluation of big data because of its nature that is heterogenous. Apart from these primary technical challenges, some other challenges are also considering as hurdles like Big data execution, preservation, or diffusion throughout the fields and units of urban sustainability are accompanied by economic, corporate, administrative, governing, or moral difficulties. [58].

B. Smart city implementation challenges

There are three main stages of challenges on the stage of realistic adoption of intelligent cities. First stage is the thorough design of the intelligent city, then the implementation of a design and the last challenge is the operational stage of smart cities. Moreover, a few of the primary problems include the expense of building and functioning, device diversity, a huge gathering and analyzing of data, privacy, and security, and a long-term [59].

The cost of design and maintenance is very important factor before the process of implementation. Cost is further categorized into two major categories: (i) the cost of design; and (ii) the cost of operation. The cost is so high because the of the assurance of the sustainability of services which will be provided in smart cities. The cost of design is a one-time challenge but the cost of optimization of a smart city is bigger because the process of optimization is a continuous process. The other thing is 'heterogeneity' – the varying ecosystem of sensors. In a smart city, hundreds and thousands of smart devices are used, consisting of gadgets and detectors with many uses. Implementation of intelligent city is based only one notion i.e., the integration of all heterogenous things with each other on application level. On the other hand, "platform incompatibilities result from heterogeneity hinder the ability to integrate and inter-operate at the application layer" [60].

One of the main issues nowadays for the big data companies is the information secure and confidential, as it is a widely known phrase: 'data is the new oil'. The challenge of data protection is a primary issue nowadays. All the information which is collected is highly sensitive and should be protected from different kinds of threats like data leakage to some hackers. In the recent years, some big tech giants were allegedly involved in using the data of users for some political purposes. That is why, the security and preservation of data has become a highly essential task. Some challenges after these giant challenges include management of natural environment and waste materials of smart cities. All the challenges pertaining to the smart citizens', as well as the citizens' [61] consent must be addressed.

From the viewpoint of mobility, the issue of pollution is very important. In a smart city, what would be the plan of action to control the air pollution, released by big data centers, the waste which will be produced by the citizens. The waste produced by human beings will surely not 'smart waste'. Therefore, the issue handling of such kind of waste management is still unanswerable.

In October 2020, Markets and Markets released a market research study named "Smart Cities Market by Component (Hardware, Software, and Services), Application (Smart Transportation, Smart Buildings, Smart Utilities, and Smart Citizen Services), and Region - Global Forecast to 2030".A compound annual growth rate (CAGR) of 13.8% is projected for the worldwide smart cities market revenue, which is estimated to rise from 392.90billionin2019to1,380.21 billion in 2030. The expansion is attributable to the growing use of IoT and cloud computing technologies in smart cities, which offer resource optimization, cost savings, and improvements to residents' quality of life. The report also says that this trend will be advantageous for cloud computing and IoT service providers. [65]. Here is a graph which shows this revenue.

IV. OPEN AREAS

A. Opportunities

There are a lot of opportunities for researchers to work in the field of smart cities or sustainable urban development. IoT and machine learning are constantly evolving, and are being used to manage so many aspects of the social life of citizens, which is the guarantee of efficiency and accuracy. For example, the issue of urban traffic is very challenging, and because of artificial intelligence and the integrated devices, it is very easy to control the flow. The integrated smart cars will soon

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substitute the traditional driver-only operated vehicles, which can solve a lot of road related issues. The use of IoT can make our lives easier and comfortable. It will help in the identification of problems that would alert the government and urban authorities on time. Citizens would be able to check the status of their issues. In urban areas, the Internet of Things technology appears to have more advantages in improving our standard of living. However, the creation of new technologies requires a lot of energy and results in accidental releases of pollutants or electronic trash.

As in any field, open research is more accessible, accurate, collaborative, and transparent. In the field of IoT, cloud frameworks and network protocols are being developed by many different organizations. Therefore, a lot of things are needed to be addressed. Apart from the generic security solutions in the present literature regarding IoT, there is a dire need of detailed reference model related to the issue of data security and integrity. Moreover, recently, the blockchain technology [62] has emerged as a source of connecting millions and billions of devices connected the IoT networks, giving birth to a whole new field which is being referred to as Blockchain-IoT (BIoT). A lot of researchers are now considering working in this nascent field.

B. Future trends

Drones are a promising technology of the twenty first century and helping a lot in making the IoT devices get green. Drones [62] are contributing in the way that it helps in reducing the electronic waste and charging the IoT device without the consumption of energy. Through the use of drones, we can charge IoT devices wirelessly and even can replace the batteries of IoT. Drones can collect the data by getting close to the nodes, and perform actions in a much efficient manner. Attaining the high quality of service (QoS) is considered as the future of green IoT [35]. To increase QoS parameters and make them more environmentally friendly, it is necessary to identify sustainable improvement methods. There must be less energy consumption IoT devices before shaping the green sustainable future for the people to minimize the adverse effects of a toxic environment on human health problems. Moreover, machine to machine communication in this regard must be taken into consideration. In smart cities, many systems are integrated to offer effective services. So, web inspired Wot approach has been found beneficial for this task. Consequently, the components of intelligent city can communicate efficiently and the glitches can also be avoided.

V. RESULT

The whole paper is based on secondary data which means the author uses different papers and tries to pull up different argument and finishes the limitations on urban development. As the author uses smart cities concept for the urban development. After keeping to much research, the author comes to end that nowadays technology is being so much used in recent time to make the environment friendly and sustainable. After accessing the articles, the author found so much challenges and to overcome such challenges there so much opportunities available for the new researches to sort out as well. The challenges which were being faced were the design of the model, how it should be applied on a big level such in cities, countries or in continents, and also it could be operate and who is the right person for its operation. Most important the cost of the model that if apply in a city that this city could afford its cost.

Similarly, one of the biggest problems for nowadays is big data companies is the security and privacy of the data. The security of data is big issue because if we apply such environment friendly program on a city using IoT, we use AI for the use of personal data which is sensitive and it should be secure from different threads like data leakage etc. so this paper is so much helpful for the current researches to opt the challenges from this paper and try to resolve it.

VI. DISCUSSION

Considering the rise in figures of IoT devices, there comes the necessity of deploying the latest technologies and techniques to the IoT infrastructure in such a way that it is much more efficient, productive, and available to everyone. By utilizing the modern computing technologies, there are countless benefits in the fields of smart urban development, but some nascent problems are also born along with them.

Considering the rise in figures of IoT urban sensing gadgets, the user-generated data, also known as big data, is also increasing exponentially. In order to cater the demands of this massive amount of data, cloud data centers are also expanding. When the computing machinery multiplies, the need for energy also increases. This results in the consumption

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of more and more energy resources that add up to the carbon footprint of the cities. And this vicious cycle continues. Now, when we look at the whole picture, the basic idea of making the citizens' lives more comfortable does not make sense when the citizens' environment is polluted along the way. And this vicious cycle continues. So there comes the addition of the sustainability factor to the smart cities concept.

Numerous studies that explore the characteristics of smart, sustainable cities have been covered. The four main characteristics of smart cities 1) sustainability, 2) quality of life (QoL), 3) urbanization, and 4) smartness—are all covered in this article. The application areas of smart urban areas are covered in several articles that are surveyed; some of them address smart health care, smart mobility, smart energy management, and smart waste management. There are studies about some of the best smart cities in the globe.

Sustainability involves the whole smartness concept to be aligned towards being more environment-friendly. Here it gave birth to the new sub-field known as the Green IoT, which has caught the attention of researchers recently. A lot of emphasis is given on studies that involve the green-ness and sustainability factor of smart urban development. Several approaches have been proposed to address this challenge of making the smart urban environments greener and more efficient. Approaches like the bicycle sharing system prove to be fruitful for the Intelligent Transportation System (ITS). Enhancement of energy efficiency is the main goal for the deployment of intelligent community as depicted in [17], [22], [34], [36], [52] -[55], by deploying optimization techniques in: collecting and processing urban big data [36] -[38]; communication networks for smart cities [39]; and smart data centers [40], [42].

A wide scope of related studies has also been performed on challenges faced when implementing smart sustainable city solutions, like challenges in handling of urban big data [47], heterogeneity of sensor nodes [60], data security issues [61], with the aim to reduce traffic congestion in cloud data centers, so that computation is only applied on the necessary data, thereby reducing energy consumption, and ultimately reducing pollution in urban environments [56].

A lot of studies have already been performed to resolve so many technical challenges for the IoT smart city sustainability factor, however, many challenges yet remain to be solved.

VII. CONCLUSION

The physical world and the virtual one are now connected because of the Internet of Things. It has enabled intelligent decision-making in a lot of fields particularly in the smart urban development industry. Recently, the smart cities have been facing challenges in implementation, with the major concern being their sustainability. A positive aspect of the basic idea of smart cities is the idea of environmentally friendly urban development., as it can overcome the limitations and hazards associated with it.

This review paper provides a summary of the latest trends and ongoing research on the smart technologies used for urban sensing and Green IoT. A variety of application scenarios such as the bicycle sharing application, smart waste management, smart grids, smart e-health, and smart mobility are considered in this paper. The ultimate goal is to make the smart urban areas as greener and efficient as possible. Furthermore, the challenges encountered for implementation of smart sustainable cities are also pointed out. This survey will help the research community in understanding the contributions of IoT in creating smart as well as sustainable urban environments.

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