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Analyzing Role of Big Data and IoT in Smart Cities

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Abstract— *Big data and Internet of Things (IoT) technologies have evolved and expanded tremendously and hence play a major role in building feasible initiatives for smart city development. IoT and big data form a perfect blend in bringing an interesting and novel challenge to attain futuristic smart cities. These new challenges mainly focus on business and technology related issues that help smart cities to formulate their principles, vision, & requirements of smart city applications. In this paper, the role of big data and IoT technologies with respect to smart cities is analyzed. The benefits that smart cities will have from big data and IoT are also discussed. Various challenges faced by smart cities in general related to big data and IoT have also been described here. Moreover, the future statistics of IoT and big data with respect to smart cities is also deliberated.*

Keywords— Big data, benefits, challenges, IoT, smart cities

I. INTRODUCTION

Smart Cities are using big data and Internet of Things (IoT) for exchange of digitized information and communication in order to improvise the city services with respect to performance, quality, and wellbeing of citizens. The applications related to Smart City are developed keeping in mind the improvement of urban flow management. The people living in cities are expected to get doubled by 2050. The experts predict the urban population will reach to six billion by 2050 in contrast to 3.6 billion as of now. This will increase the enormous pressure on the available resources [3].

IoT and big data are together very significant technologies which will be implanted into each smart device and become available to billions of people directly or indirectly. As the Internet is ubiquitous, with the government's initiative towards making every city smart, everything will be IoT enabled and will produce enormous data. Thereafter, big data analytics will be applied to deduce various inferences and give an insight into the Service industry. Thus IoT and big data will eventually raise the standards of quality of people's lives in years to come.

II. UNDERSTANDING BIG DATA, IOT AND SMART CITY

Big Data: The term "Big Data" describes a massive volume of structured/unstructured data which complex to manage using traditional databases. SaS defined as, "Big data is a popular term used to describe the exponential growth, availability, and use of information, both structured and unstructured" [7]. IBM defined big data as "Data, coming from everywhere; sensors used to gather climate information, posts to social media sites, digital pictures and videos, purchase transaction record, and cell phone GPS signal to name a few" [7]. The big data system will stock, mine information from smart cities applications in an effective way and provide enhanced information regarding smart city services. In addition, this enhanced information help the decision-makers in planning various new smart city services.

Features of Big Data:

1. **Volume:** It talks about amount of data.
2. **Variety:** It talks about structured and unstructured data from multiple sources which can be diverse in nature.
3. **Velocity:** It talks about the speed in which the massive and continuous big data flows in from different sources.
4. **Variability:** It talks about the constantly changes taking place in the structure and meaning of data.
5. **Value:** It talks about the advantages big data provides to a business w.r.t. good big data collection, analysis, management.

Hence, the above mentioned features clearly depict huge potential for gains and advancements bounded by the available technologies and tools. In order to achieve goals in smart cities, big data requires correct tools and methods that give efficient and effective results.

Internet of things (IoT): It may sound new to many people around, but it is the buzzing word for the world of smart gadget users. IoT is an enormous network of devices that can connect and share the information with the help of these physical objects or "things" ranging from smartphone, wearable gadgets, and headphones to smart television sets [2]. The IoT permits objects to sense and control remote access across given network infrastructure,

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and provide a direct link between the real world and PC-based systems, thus increasing accuracy and efficiency and improving economic benefits [3]. Hence IoT can also be described as providing connection between internet-connected objects such as consumer electronics, environmental sensors, security monitoring equipment and wearable devices and record and/or transmit data that can be used for various purposes

Smart City: A smart city is best described as a one solution connecting variety of day to day aspects like transportation, power, and buildings in a smart and effective manner, thus improving the life quality of city people. The data in smart cities is gathered in huge abundance from the real time devices, sensors, video/audio, log files, networks, web, transactional applications and social media. Hence smart cities incorporate IoT, smart infrastructure, M2M connectivity to manage power, resources and improve urban planning [1].

III. BIG DATA & IOT BENEFITS IN SMART CITIES

The first paragraph under each heading or subheading Big data and IoT together provide various benefits to the citizens of the smart city and thus improve the power, resources and inculcate excellent urban planning. The IoT sensor network gives numerous benefits to both its citizens and the government authorities. Some of the benefits are listed here as under:

- Water waste management
- Increasing Relevant Use of the Resources only when it is required
- Avoiding the unnecessary use of Irrigation systems during rain or street lights during day time.
- Automating public transport using cloud based big data automation
- Traffic management
- Avoiding time wastage at bus stops using location-based advertising
- Smart metering that monitors the optimum usage of energy, gas, water etc.
- Monitor pollution levels in city streets and enable automatic alarms above alarming levels.
- Noise and Pollution management
- Water Management –wastage of water due to leaks can be detected and curbed.
- Waste disposal management
- Waste management
- Citizen Information system
- Energy management, for example, the city of Santander in Spain saves tons of money due to utilization of RFID sensors, GPRS and IEEE standards and provides cost- effective waste and energy management.
- Transport management – Enable smooth traffic flow with the use of Real time traffic maps, also provide information regarding free parking slots available in nearest parking slot in advance will save time and fuel and reduce traffic jams and pollution level, thereby improving quality of life[5].
- Saving millions of wealth if better fuel efficiency is shown regarding heavy goods train and locomotive engines based on carrying heavy cargo weight and engine type.
- Using big data, information taken from vehicles can be used to reduce pollution levels. IoT technology can also be applied in the form of sensors fitted beneath the roads that could calculate amount of traffic in a day. Such information can be used by traffic controllers to divert the extra traffic and thus reduce carbon emission from particular road. For example, the Los Angeles city in USA has deployed road sensors and cameras that regulate traffic and avoid congestion.
- As less energy is consumed, the environment will surely be more clean, green and cool. The Bristol city is a good example of using an IoT- based wireless network which is considered to consume less energy and bandwidths than the traditional networks. This in turn will make mobile phone batteries to work longer and stay better [4].

As Internet of Things and big data are changing the scenario of the world by acting on issues like traffic control, waste management and energy conservation, it is needless to say that smart cities will also get benefitted with this technological transformation.

IV. BIG DATA & IOT CHALLENGES IN SMART CITIES

As smart cities are evolving and have dynamic environments, following challenges may be faced during design and implementation of smart city solutions Using Big Data and IoT.

- The biggest challenge that can be seen is related to multiple sources and their various formats. Processing such varied data using traditional software is very difficult.
- Another important challenge is data integration from various environments, organizations, and variety of intelligent devices. The scenario becomes all the more challenging when information is passed among various departments. Smart City solution should be designed to prevent the privacy of the people's lives.

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- As the data is collected from various organizations, maintaining the quality if data is a challenging task. With big data incorporated in the form of big data warehouses, data needs to be stored in a specific format without tampering the quality of data. Proper mechanism should be applied while dealing with third party data and ensuring data integrity and quality.
- The data security in a big data environment is even more challenging as the size and volume of data here is quite high. Data security refers to the fact that correct data should be disseminated to correct person and correct time. While designing a secured smart city, data breaching needs to be avoided; data should be masked and encrypted properly so that it doesn't fall prey to unauthorized access.
- Another challenging issue is to keep pace with the ever changing technology. The smart city solutions should be so designed that they may be able to get accustomed and adapt themselves as the technology advances with time. The upgrading of entire system should be flexible.
- There are no standards and protocols set with respect to smart city and IoT or big data and their use. Hence lack of common platform is a challenging aspect.

V. FUTURE OF BIG DATA & IOT IN SMART CITIES

The technology advances are rapidly paving the way for smart cities. One of the surveys conducted by an organization predicts that 26 to 28 billion connected devices will be in use by year 2020. The companies around the world are ensuring that products developed in the future should incorporate IoT to keep pace with the future market [2].

A smart city is one urban area that will believe in IT advancements in order to improve the quality of life of citizens, maintain available resources like roads and water in sustainable manner and reduce environmental pollution. As per facts given by New Jersey Institute of Technology (NJIT), smart city technology will raise to an industry costing $27.5 billion by 2023. Thereafter, the entire world will have around 88 smart cities by 2025[6].

Hence the companies have to gain experience and use big data and get equipped with this latest technology. 30 to 40 percent organizations are utilizing Big Data; out of which around 40 percent have started taking advantage of IoT. Analyzing current trends we assume that Big Data and IoT will rule IT technology world and give new prospects to the smart city development [2].

VI. CONCLUSION

The role of Big Data and IoT is essential in building smart cities. Consistent technology & infrastructure is required that can challenge M2M, machine to human, communication and provide public services to all cities. Big Data will assist to analyze, predict information collected by smart devices in smart cities. Various benefits that can be applied with the help of big data and IoT have already been discussed in the paper. The scenario has some challenges also as the data is from various heterogeneous sources. Hence, the technology must be implemented with proper understanding. Thus, managing big data and applying IoT related technology infrastructure will soon transform normal cities into smart cities.

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