The Role of Big Data in Developing Smart City

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Abstract— Everyone is living in the age of information technology; here all things from smallest to largest are getting smart. At this time, "smart cities" are developing to improve the living standards and many governments are adopting "smart city" concept for their cities. Presently, Indian government is additionally doing likewise for some cities. Smart cities utilizes various technologies to improve the performance of security, healthcare, transportation, energy, environmental protection, traffic management, education, water services and waste management leading to higher levels of convenience of their citizens. One of the recent technologies that have a great potential to enhance smart city project is Big Data. Big Data analytics plays a significant role in smart city's development, governance and management. The data created by smart cities will analyse by utilizing big data analytics. Effective analysis and use of big data is the key factor for achieving smart city area. This paper reviews the applications of big data to support in achieving the goal of smart cities. It systematically examines and compares various definitions and aspects of smart city and big data and it explores the opportunities, challenges, advantages and solutions of consolidating big data applications for smart city. In addition it endeavors to recognize the requirements that support the implementation of big data applications for smart city administrations.

Key words: Applications of Big Data Analytics, Big Data, Data Management, Smart City, Smart City Applications

I. INTRODUCTION

Smart city is a development model to consolidate different Information and Communication Technology (ICT) and Internet of Things (IoT) solutions in a protected form to manage a city's assets. The city's assets include universities, schools, libraries, transportation systems, roads, railroads, hospitals, power plants, buildings, water supply systems, waste management, law enforcement, and other community services [8]. The goal of building a smart city is to enhance quality of life by utilizing urban informatics and technology to enhance the proficiency of administrations and meet resident's needs.

To accomplish the objective of smart city, big data is an essential part of a smart city and on individuals' lives. Big data offers solutions to cities to maintain the requirements of smart city attributes. These attributes include transparent governance, enhanced quality of life, sustainability, smart management of natural resources, resilience, Renewable energy, smart traffic management, smart education, smart health facilities, innovative urban agriculture, waste management, development of urban area and many more [4]. To facilitate all such services, we require huge storage and computing facilities. Big Data represents a massive collection of complex data that it gets to be distinctly hard to process utilizing on-hand database management tools. We have to extract valuable information that is called 'Smart Data' or 'Data Analytics' from the big complex data. Smart data depict data that have valid, meaningful and well-defined information that can accelerate information processing. The data created by smart cities will analysis utilizing Big Data analytics.

Currently, some innovative work and research projects have done in this field and produced some documents that highlight the significance of big data in supporting smart city applications and services. Additionally, some work examined the issues of utilizing big data in the smart cities. The primary commitment of this paper is reviewing the applications of big data in smart city and exploring the opportunities, advantages, challenges and solutions for using big data in smart city. Additionally, the paper explores the general prerequisites for the plan and execution of big data based applications for smart city administrations.

II. BIG DATA ANALYTICS

Big Data is a developing term that port rays any massive volume of structured, semi-structured and unstructured data that can be dug for useful information. It is enormous and complex, so it is hard to process utilizing traditional databases and software techniques. Big Data can help government and organizations to improve operations for smart cities and make speedier and more intelligent decisions. This data, when captured, designed, controlled, stored, and analysed can help government and organizations to gain useful insights to increase revenues and improve operations for smart cities.

A. Some definitions of big data

- As demonstrated by IBM: "Every day, we create 2.5 quintillion bytes of data — so much that 90% of the data in the world today has been created in the last two years alone. This data comes from everywhere, sensors used to gather climate information, posts to social media sites, digital pictures and videos, purchase transaction records, and cell phone GPS signals to name a few. This data is Big Data."[1]
- As indicated by SAS: "Big data is a term that describes the large volume of data – both structured and unstructured – that inundates a business on a day-to-day basis. But it's not the amount of data that's important. It's what organizations do with the data that matters. Big data can be analysed for insights that lead to better decisions and strategic business moves."[2]

– As indicated by Gartner: "Big data is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation."[3]

The big data system can collect, store, process and mine smart city applications' data in an effective way to create facts to upgrade multiple smart city services. Additionally, the big data will assist leaders to plan for any development or expansion in smart city services, resources, or zones [4].

There are a few characteristics of big data that are known as the Vs of big data management.

1) Volume: It refers to the quantity of data that is generated and stored from all the sources.
2) Variety: It refers to the type and nature of the data. It is common now that Data comes in all types of formats – from structured to unstructured that cannot be easily categorized.
3) Velocity: It refers to the speed at which the data is created, stored, analysed and processed.
4) Veracity: It refers to the quality of captured data can vary greatly, affecting accurate analysis. It deals with quality, trustworthiness, accuracy of data.
5) Variability: It refers to how the structure and meaning of data constantly changes, particularly when dealing with data generated from natural language analysis.

III. SMART CITY BENEFITS AND OPPORTUNITIES

Smart City will be the future trend of urban development. Smart city implies distinctively to different individuals. Its conceptualization changes from city to city, nation to nation depending on the level of development, willingness to transform and reform, assets and goals of the city inhabitants. A smart city would have a different implication in India than say, Europe. Indeed, even in India, there is no one way of defining a Smart city.

"Smart city" is defined by IBM as the use of information and communication technology to sense, analyze and integrate the key information of core systems in running cities. At the same time, smart city can make intelligent response to different kinds of needs, including daily livelihood, environmental protection, public safety and city services, industrial and commercial activities [6].

These are a few of the benefits of having a smart city:

A. Proficient Resource Utilization

Now days, numerous resource turning out to be either rare or extremely costly. It is essential to coordinate better and controlled usage of these resources by the utilization of the technological systems. The important aspect of smart city applications is that they are designed for smart interconnectivity among different resources and smart data collections which also facilitate better collaboration across applications and services.

B. Good Quality of Life

With better administrations, more proficient work and living models, smart city citizens will have a good quality of life. This is the outcome of better planning of living/work spaces and locations, more proficient transportation systems, better education, resilience, better healthcare facilities, better and faster services, and the accessibility of enough facts to settle on educated choice.

C. Higher Scale of Transparency and Openness

Better administration, high transparency in governance and better control of the different smart city facets and applications, will drive the interoperability and openness to a higher scale. Additionally, this will amplify information transparency for everybody involved. This will support cooperation and correspondence among entities and making more administrations and applications that further improve the smart city.

IV. CHALLENGES

There are many challenges in the design, development and deployment phases of big data applications for smart cities. Smart cities are viewed as extremely dynamic and advancing situations, in this way it is imperative to avoid or at least reduce the challenges involved in the smart application design, development and deployment for smart cities. There are also some disputes related to the definition, utilization and advantages of big data for smart cities.

Here we will address some of the key challenges in utilizing Big Data in smart cities.

A. Data Sources and Attributes

Data is created from a wide range of different sources in a wide range of different formats. There are a lot of new data formats a significant number of which are unstructured (e.g. social sites data, images, audio, tweets, video, text documents, server logs, etc.). This data should be managed and arranged into a structured format utilizing some form of advanced database system. There are many identified different Vs of big data the most agreed are the 3 Vs: Volume, Velocity and Variety. Several more were added, for example- Validity, Veracity, Volatility and Value [7] as well as Variability.

The current algorithms, methods and software tools of data mining cannot deal the size and complexity of data. Developers are facing more difficulties like data analytics, system architecture, data compression, data evaluation; big data distributed mining, data visualization, maximum time evolving data and hidden data.

B. Data and Information Sharing

Sharing information and data information among various departments of city is another challenge. Every government and city office or department commonly has its own particular warehouse of confidential or public data. The greater part of which are frequently hesitant to share what may be viewed as exclusive information.

C. Data Quality

The smart city will create vast amounts of data, developer's needs to keep only essential and informative data. As to store an extensive amount of data distributed databases is required, to adjust the server load developers need to store only quality data in standard formats. The challenge for a developer is to keep data consistency, data integrity and data diversity at large scale otherwise will cause challenges like data uncertainty and trustworthiness. Looking at more fundamental aspects of Big Data, there are various difficulties that are related to the quality of the data. Data captured by various individuals under extraordinary administrations and stored in distinctive databases is rarely stored in any standard formats [8].

D. Security and Privacy

One of the major challenges in a smart city and by using Big Data is the security and privacy issues. In fundamental terms, this means that databases may include highly confidential information related to the government and people, so they need high levels of security and mechanisms to protect this data against access of unauthorized people and attacks of virus, Trojan, spyware and malware, etc. Furthermore, smart applications integrated together across agencies also require high level of security and privacy, since the data will move over various types of networks.

E. Expenditure

In development of smart city, high level software and hardware system, Big Data solutions and new tools and technologies are required, For example: sensors, ICT (information and communications technology) solutions, IoT (Internet of Things), distributed databases, smart energy management system, smart traffic management, smart signal system, smart waste management system etc. So expenditure is a sensitive issue since it is a government developed system for their citizens. Government needs to create cost-effective solutions. For example, using a smart traffic management system, which forces the government to use new technologies, systems, components, tools and features to monitor traffic and record data. However, it is also a very expensive to implement. Moreover if such a project is not implemented correctly from the starting, it may cause a major problem, result in very high expenditures, and the city may be adversely affected.

V. FUTURE WORKS AND OPEN ISSUES

To effectively utilize Big Data for smart city applications, there are some future works and open issues that should be addressed and resolved. Several of these future works and open issues originate from the different challenges we discussed about before, while some may identify with different angles we didn't consider. Yet many of these future works and open issues are currently under investigation and examination by industry and research communities. However, there are no full solutions available and there is always room for improvements and innovations in this field. Some of these future works and open issues include, but are not limited to the following:

- How communication will look like among government, citizens, and businesses? When everything is associated and integrated, should all public and private entities have access and rights to all the information and knowledge?
- Security and privacy of data is another critical issue to be considered carefully. When all systems are integrated, data will be shared among all systems in the smart city. Accordingly, how the infrastructure, data and platforms must be secured? And how privacy must be preserved and information must be completely protected?
- There is additionally the need to set common estimations and control strategies for smart city applications. Monitoring and control of activities and implementations using different tools and techniques are required in a smart city to make sure the correctness, effectiveness and quality of deployed smart city applications.

VI. CONCLUSION

Smart city and big data, both are two new and important concepts. Both concepts need to be integrated to develop smart city applications that will help to achieve sustainability, better resilience, better security, effective governance, smart traffic management, enhanced quality of life, openness and intelligent management of resources. This study gives both concepts and their definitions, challenges and some common attribute.

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