



Big Data Analytics Architecture For Smart Cities And Smart Companies

¹ SHANET SABU, ² MINLA K.S

¹MSc Scholar, ²Assistant Professor

^{1,2} Department of Computer Science,

^{1,2} St Joseph's College (Autonomous), Irinjalakuda, Thrissur, Kerala

ABSTRACT: Today mobile internet, social media and internet of things have a broader application predominance, that paved the way for the age of big data. Digitisation has won prominent parts of people's way of life. Both people and government are more inquisitive about Smart City trends or Smart Companies to attain greater sustainability and better norm of living. This research is an endeavour to discuss those big data applications are highly beneficial for implementation of smart cities as they impart ample opportunities but even have multihued challenges and problems. Smart cities are well known for the human dynamics within which we are connected by devices called the Internet of Things. Big Data Analytics aids in decision making from both Smart City intelligence or smart business domain. This research article is about framework of big in smart cities or smart companies with a composite of urbanization and Computerization and furthermore discusses the requirements, challenges of how big data analysis is utilized for decision making.

Keywords- Big Data, Internet of Things, Smart City, Smart Company, Data Analytics, Emerging Technologies, Decision Making

I. INTRODUCTION

The paradigm shift from custom desktop computing to progressively sophisticated computing, as well as the rise of connected devices and sensors, paved the way for a smart environment. Smart homes, perspicacious grids, keenly intellectual cities, perspicacious healthcare, perspicacious conveyance are smart intellectual environment applications. Future smart cities comprise fundamental necessities and unrivalled advancements for an effortless and elementary life. The key empowering agent of smart city applications is IoT in which all objects and gadgets are associated with network innovations. Big Data offers the city the possibility to acquire important data from a lot of information, gathered through different sources. Big data for smart city and smart endeavours can create changes in the country's economy, for example, the acknowledgment of attributes like sustainability, administration, resilience, improved Norm of living and intelligent Management of natural resources and city amenities. The smart city takes advantage of emerging technologies like wireless sensor networks. As of now, a huge volume of data is being created. Big data analytics helps to extract meaningful insights from large amounts of data that directly aid the success of business and service domains,

including smart city applications. Data growth through IoT has contended a crucial role in the big data landscape. Therefore, IoT big data analytics aims to help companies to achieve a better understanding of the data and, therefore, to make proficient decisions. The cumulation of astronomically immense data and the Internet of Things (IoT) has raised incipient challenges in the area of smart cities. This document starts with the concepts of smart city and big data then we tend to discuss at emerging technologies and general requirements for implementing smart city applications/smart companies based on Big Data, in next section we tend to discuss the big data framework in the smart city domain. finally, we tend to discuss the applications and challenges of using big data in smart cities and smart companies.

II. METHODOLOGY

i. Concept of Smart City and IoT

The key components that address the city's smart areas are institutional framework, physical framework, and social framework. These smart attributes are concerned with all aspects of life for its resident's well-being, education, security and safety, transportation, water, power, innovation, equity, and value for all citizenry. A smart city is a well-performing city composed of smart fields. Six smart domains portray the insightfulness of a Smart City. These are keen individuals (social and HR), brilliant living (personal satisfaction), savvy economy (competitiveness), shrewd governance (participation), keen portability (transport and ICT), and keen climate (normal resources). city's smartness is acknowledged by keeping up the cross-domain interrelationship and sharing of information. Intuitively, this is reachable using ICT-based arrangements. with smart city concept we could upgrade the adequacy of metropolitan administration and improve the personal satisfaction of residents.

Data is collected through information development components in smart urban areas of metropolises, otherwise called the Internet of Things (IoT). Smart metropolitan urban areas for the most part use IoT contraptions to acquire data and to deal with it beneficially to coordinate it into one explicit region. Smart city sensors and related devices gather data from different setup stages in a city and afterward analyse it for compelling dynamics. The utilization of ICT in savvy metropolitan urban areas will help to diminish regular impressions and guarantee the ideal utilization of resources.

ii. Concept of Big Data Analytics in Decision Making for Smart Companies

Big Data Analytics is a vital factor in data driven dynamic (DDD). Big Data and IoT highly affect resident wellbeing, metropolitan arranging, powerful transportation, compelling clinical offices and so on. A few calculations are utilized in BDA, including man-made brainpower, AI, information mining, and profound learning. Contrasted with conventional factual techniques for information investigation, these advanced strategies are portrayed by the treatment of organized and unstructured information just as the extraction of quantitative and subjective markers.

Furthermore, there are a few attributes of Big Data known as Vs of Big Data.

- **Volume:** alludes to the size of the information made from all sources.
- **Velocity:** insinuates the speed at which data is made, taken care of, inspected, and arranged.
- **Variety:** alludes to the various sorts of information that are created.
- **Variability:** alludes to how the construction and significance of information are continually changing, particularly in the event that it is, for instance, information created from normal language examination.
- **Value:** alludes to the potential advantage that enormous information can bring to an association dependent on great huge information assortment, the executives, and investigation.

Strategic decisions are significant components for activity and it impacts in the whole or fundamental pieces of a venture. Such choices are made at a high administration level. These decisions contribute straightforwardly to the accomplishment of the shared objectives of the company. They affect the organization. Vital choices have generally been unstructured, so a manager should utilize business judgment, judgment, and instinct to solve the issues.

iii. Emerging Technologies aiding Smart Environment

An effective correspondence is conceivable through interfacing different types of equipments to gather real time data which is important to make a city smart. For the smart city to be embraced, the IoT innovation that permits various items to be detected and controlled distantly across existing organization foundation should be executed. This will set out opportunities for accomplishing flexible integration of the different items in the smart city. Such development will improve proficiency and exactness.

- **RFID**

RFID works subject to electromagnetic fields to recognize and follow marks affixed to objects. The marks contain electronically set aside information. The RFID innovation can be utilized to distinguish basically any article, including creatures, garments, and surprisingly people. This strong use of RFID has made the innovation appropriate for savvy urban communities; RFID can be applied in emergency clinics, libraries, and for observing load. RFID is at the edge of building implanted gadgets with full tracking functionality.

- **WSN**

WSN is a network of circulated self-ruling detecting hubs that utilize low-power coordinated circuits and remote correspondence innovation to distribute data among associated sensor gadgets. The WSN can adapt to huge scope arrangement in any environment, and it is subsequent component for smart city coordination. The WSN can screen physical and ecological conditions continuously, like temperature, pressure, light, and stickiness. These attributes empower WSN to be useful for smart homes, savvy structures, and for shrewd wellbeing.

- **WIFI, Ultra-Wideband, ZigBee, Bluetooth**

A city is said to be smart on the off chance if it has consolidated wireless correspondence stages. wireless correspondence gives expanding adaptability and portability. wireless innovation offers dynamic organization development, minimal expense, and simple deployment. WIFI is a wireless convention that fills in as a substitution for the standard cable networks and licenses customers to get the Internet at broadband rates when associated with access points or when in specially named mode. Ultra-wideband is situated with high-data transferring capacity indoor short-range remote organizations over multi-media connections. ZigBee is likewise intended for short-range wireless correspondence with course of action for long lifetime battery use ability. Bluetooth is standard dependent on a wireless radio framework intended for short-range and modest contraptions to substitute connections for PC peripherals, like mice, consoles, joysticks, and printers.

- **4G LTE, LTE-A, 5G**

4G is shifting the paradigm from hybrid data and voice networks to a pure data IP network-Advanced (LTE-A) overcomes issues between 4G and 5G by maintaining high data transmissions and guaranteeing speed multiple times higher than the LTE basic networks and incorporates transporter aggregation, expanded

MIMO, composed multipoint, relay stations and heterogeneous networks. Moreover, 5G is an improved innovation that gives a chance of gathering hundred billion gadgets and supports data transfer capacity up to 10 Gbps with moderately low idleness. The introduction of 5G networks will provide new frameworks, for example, cloud RAN and virtual RAN that can work with progressively unified network arrangement.

iv. General requirements for implementing Smart City /Smart Company applications based on Big Data

Gathering and capturing data from sensors, clients, electronic data readers, and many others is the primary issue to be faced in the face of rapidly growing volume. Storing, organizing and processing this data for useful results in the next issue.

- **Big Data Management and Big Data Processing Platforms**

The data created and gathered in huge amounts, consistently offers a real time outline of what's going on in the city consistently. To guarantee legitimate utilization, firstly we need appropriate and effective big data management tools set up, including the development and execution of models, approaches, practices and strategies that cover the whole data lifecycle all through its use in Smart city applications. There is a requirement for cutting edge data management functions that helps in, organizing, overseeing, characterizing and controlling this heap of types and structures, furthermore giving a versatile dealing with massive data to support offline - applications. Big data applications for smart urban communities need to perform data analysis, which regularly requires tremendous processing capabilities. This prompts a requirement for versatile and reliable programming software and hardware platforms that offer powerful computing capabilities, be enhanced for the hardware utilization, be steady and solid for the different data escalated applications being done, support stream pre-processing, offer an undeniable level of dependability and be upheld by a well trained and equipped team and providers. Big data can also be processed in the cloud, with both Big Data Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).

- **Smart Network Infrastructure and Advanced Algorithms**

Most big data applications for smart environment need to have smart networks connecting their segments that should be capable of proficiently moving gathered data from their sources to where big data is gathered, stored and handled and to transfer responses back to the various entities that are to be in the smart city. filtering and aggregation are significant steps in this situation to ensure quality particularly for smart city as it can help reducing the measure of produced network traffic and accelerate data processing. Standard algorithms utilized in normal applications may not be sufficiently proficient to deal with big data applications because of their unique prerequisites and higher need for high volume high velocity processing. It is important to execute productive and more complex algorithms to manage big data productively across heterogeneous conditions and be fit for overseeing and working in exceptionally unique conditions

- **Open Standard Technology, Security and Privacy**

Since big data smart city applications contain large heterogeneous frameworks and data, it is advantageous to follow an open norm for the development and implementation of such solutions. This builds the flexibility for updating, maintaining and adding other application functions for smart cities. Furthermore, the coordination between smart city components and big data components is facilitated. It is important to ensure that all innovation and application components incorporate and maintain an acceptable level of security and data protection mechanisms. The possibility of illicit access or malevolent assaults on such infrastructure can prompt calamitous consequences for urban infrastructure, its government agencies and its residents. It is

necessary to incorporate security and privacy policies and procedures as a vital part of the design and implementation of your applications.

- **Citizen Awareness and Government Role**

Citizens must understand how to use smart city ICT solutions correctly and safely. Their knowledge and practices in good safety, security and privacy practices are also important. Adequate training and advocacy activities are needed to ensure that people are aware of and capable of protecting their data and environment. Government entities of smart city governance must establish the guiding principles of openness, transparency, participation, and collaboration, and control the exchange and flow of big data. The government must review and recalibrate information and data policies, when necessary, by focusing on privacy, data reuse, data accuracy, data access, archiving, and preservation.

v. Proposed Architecture for Smart City based on Big Data

The smart city architecture includes three levels: data generation and acquisition level, data management and processing level, and application level. the layered architecture and workflow of the smart city architecture are outlined in Figure1. layering and workflow are presented in hierarchical manner starting from data generation and acquisition level to data management and processing level to application level. The city structure envelopes smart community development department, smart traffic control department, smart weather forecast department, and smart hospital and health department. the cited is liable for the assortment of heterogeneous data in the suburbs of city, thus acting as the base layer of the framework. these components are further connected with the smart decision making and control system through heterogeneous access innovations such as GSM, Wi-Fi,4G, and 5G. the self-governing decision-making uplifts the dependability as well as the practicability of the framework. after receiving the collected data, insightful decisions are executed by the smart decision and control system, situated in the centre level of the smart city framework. besides, the centre level supervises the events conform to the decision.

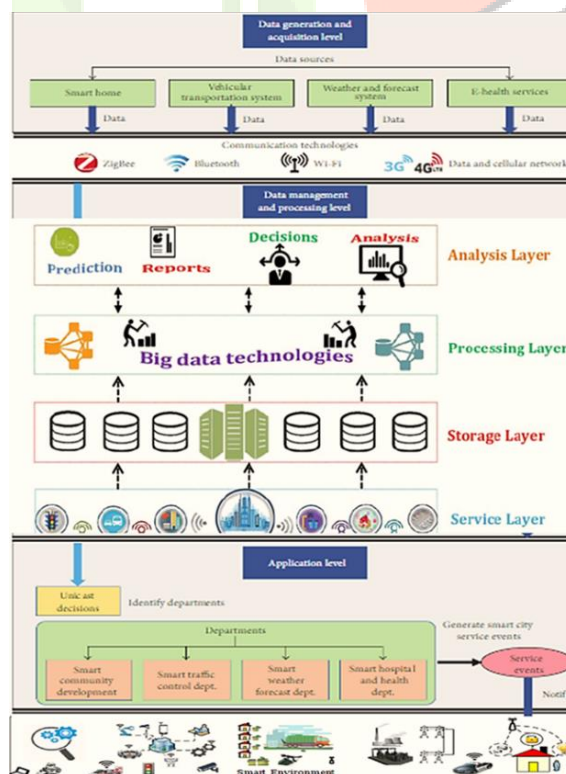


figure 1: framework of smart city based on big data

The framework is then partitioned into multiple layers, where each layer is liable for a specific task. The first layer is responsible for correspondence and data generation. It comprises of various objects and IoT embedded devices in smart city. The Second layer is responsible for collecting and storing data in a conveyed environment after applying pre-processing. The generated data are stored with the assistance of big data innovations such as Google cloud, Microsoft Azure, Amazon, etc. In the third layer, the stored data will process favourably using Map Reduce structure. MapReduce is an advanced model for appropriated and parallel processing. It enables various groups of data for processing. The Analysis layer is the last layer, which provides convenience of directly interacting with individuals and devices to make real-time decisions. The output of analysis may be used for forecasting, report generation, and creating proposals for smart city. The Application level dwells on top of the framework. thus, it is obliged to generate actions corresponding to the distributed self-governing intelligent decision. the application level is the intermediary between data management level and the end client. the application level is partitioned into, departmental layer, services layer, and sub-services layer. The Department layer is the limit of the data management and processing level. The Sub-services layer acts as the limit for end users. independent decision-making from the data processing level is unicasted to the particular departmental services, namely, smart community development department, smart traffic control, smart weather forecast and smart hospital and healthcare departments. the astute decisions of the data processing level portray the decision according to a shared common jargon.

vi. Proposed Architecture for Smart Company based on Big Data

Smart city and big data serve as the critical part for reforming the future business models. a business model contains a group of elements and their relationships that allows expressing the business rationale of a specific firm. The big data collected from a smart environment can play a significant role in speeding up the process of business model. Uncovering hidden patterns, inter relationships, and other insights from large amounts of smart environment data can empower entrepreneurs to improve their businesses and serve their clients. The analytics of data gathered from the smart environment can assist in acquiring knowledge to oversee market trends. Various product recommendations can be provided in wake of dissecting seasonal variations. For promotion purposes, analytics can help in deliberately placing an advertisement, thereby empowering people to make a significant decision in terms of understanding clients and commodities, and can aid in recognizing potential risks and opportunities for a company.

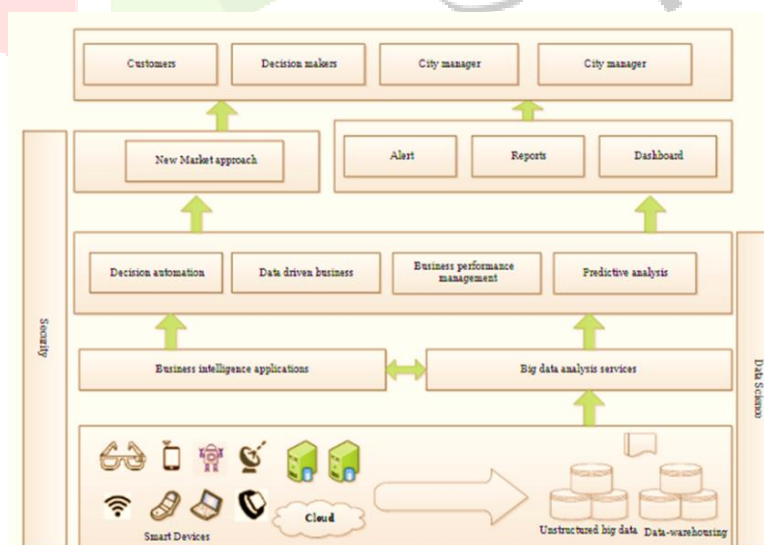


figure 2: framework of smart companies based on big data

Additionally, analytics can help enterprises make brilliant strategies after analysing employee data. Analysing the products that people search for and buy can help entrepreneurs increment their income by fulfilling the demands of the customers depending on their necessities. Subsequent to analysing the

grievances datasets of clients, companies can analyse the products that lead toward income loss. After analysing the big data, speculations can be recommended that can later be tentatively checked

vii. Applications and Challenges of using Big Data in Smart Cities and Smart Companies

Various applications of big data in smart environment are:

- **Smart Health Care:** Smart medical care systems oversee health-related e-data. In smart city, different health-care communities are connected through sensors and IoT gadgets to give an Efficient Framework for Smart City Using Big Data .communication between clinics, patients, doctors, and diagnosis machines. It incorporates online medical benefits like online appointment, advanced record storage, remote home services, alert system, and remote patient monitoring
- **Smart Transportation:** The purpose of smart transportation is to lessen traffic clog. Number of accidents can be decreased by providing alternate routes to vehicles. With the usage of various IoT sensors, cameras, smart vehicles and RFID techniques transportation can make effective. This framework is competent to foresee real-time traffic patterns which are valuable for safe and secure traffic
- **Smart Grid:** This frame work uses advanced meters, readers, and communication network to understand continuous power demand and consumption. In smart grid, real-time monitoring can be accomplished through PC-based remote controls. These regulators used between power producers and consumers to build efficiency.
- **Smart Governance:** The public authority can easily analyze various results utilizing big data technologies which are beneficial for residents of a smart city. Big data strategies can assist the government to make policies, implement, and screen them in real-time

Numerous challenges face the design, development and deployment of big data applications for smart urban communities. They are:

- **Data Quality:** Relying on publicly sourcing and collaboration of different providers will bring about data that suffers from an absence of structure and consequently consistency, heterogeneity, and dissimilarity issues will have more noteworthy chance to occur. That will cause more challenges like data vulnerability and trustworthiness.
- **Security and privacy:** In fundamental terms this imply that databases may incorporate confidential information related to the public authority and people, so they need undeniable degrees of security policies and mechanisms to ensure this data against unauthorized use and pernicious assaults. most big data technologies today, including Cassandra and Hadoop, experience the ill effects of an absence of adequate security.
- **Cost:** Cost is a sensitive subject that include the ways public authorities may influence people when they use ICT arrangements. For instance, using an energy usage reduction system, which powers the public authority to use new frameworks, components or highlights to monitor consumption and record

data. This prompt creating a smart energy management framework; however, it is extravagant to carry out.

- **Smart City Population:** As the populace develops, the size of generated data also rapidly develops and can get enormous. This is one of the fundamental challenges because the fast growth will generate traffic congestion, contamination and expanding social disparity besides expanded urbanization. Accordingly, smart city applications need to develop quickly and extend efficiently to deal with the developing volume and variety of big data to keep away such issues.

III. CONCLUSION

The rapid expansion of connected devices in cities has promoted the rapid growth of data. This article aims to provide a broad perspective on the role of massive data in smart cities. In this context, we discussed the empowering innovations used in smart cities and smart companies. In addition, a viable smart city service framework is proposed, which is valuable for monitoring the persistently generated data. These big data are consistently created by different IoT implanted devices served by smart cities. It also proposed the future business architecture that determines the rule of smart city big data, and discussed smart city applications in which big data analysis can play a crucial role. Finally, some challenges are explained. Big data can play a crucial role in obtaining valuable information and utilizing it for dynamic purposes.

IV. REFERENCES

- [1]Amol Madhav Bapat, Neeraj Kumar, Anjuri Agrawal, Sheetal Pikle, internet of Things and Big Data Analysis in Smart Cities, December 2019Journal of Advanced Research in Dynamical and Control Systems 11(8(special issue)):2922-2925
- [2]Ibrahim Abaker Targio Hashem, Victor Chang, Nor Badrul Anuar, Adewole K. S., The Role of Big Data in Smart City, October 2016International Journal of Information Management 36(5) DOI: 10.1016/j.ijinfomgt.2016.05.002
- [3]K. K. Mohbey, An Efficient Framework for Smart City Using Big Data Technologies and Internet of Things January 2019 DOI:10.1007/978-981-13-0224-4_29
- [4]Abdelkhalek Alastal, Usama Badawy, Big Data in Smart Cities: Exploring Possibilities in Terms of Opportunities and Challenges, May 2020Journal of Scholarly Publishing
- [5]Nader Mohamed, Jameela Al-Jaroodi, Applications of big data to smart cities, August 2015Journal of Internet Services and Applications 6(1) DOI:10.1186/s13174-015-0041-5
- [6]Eiman Al Nuaimi¹, Hind Al Neyadi¹, Nader Mohamed^{2*} and Jameela Al-Jaroodi³, Al Nuaimi et al. Journal of Internet Services and Applications (2015) 6:25, DOI 10.1186/s13174-015-0041-5
- [7]Fang Liu¹, Jianyuan Gao², The Application of Big Data Technology in Smart City, E3S Web of Conferences 251, 01053 (2021), TEES 2021
- [8]Maria Grazia Fugini, Jacopo Finocchi, Politecnico di Milano, Paolo Locatelli, Politecnico di Milano, Big Data Research A Big Data Analytics Architecture for Smart Cities and Smart Companies Article in Big Data Research · January 2021 DOI: 10.1016/j.bdr.2021.100192
- [9]Ahmed M. Shahat Osman, Ahmed Elragal, Smart Cities and Big Data Analytics: A Data-Driven Decision-Making Use Case, *smartCities* **2021**, 4(1), 286313;
<https://doi.org/10.3390/smartsities4010018>
- [10] Bhagya Nathali Silva, Murad Khan , Kijun Han, Big Data Analytics Embedded Smart City Architecture for Performance Enhancement through Real-Time Data Processing and Decision-Making, Volume 2017 |Article ID 9429676 | <https://doi.org/10.1155/2017/9429676>