STUDY ON ICT, IoT AND BIG DATA ANALAYTICS IN SMART CITY APPLICATIONS

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Abstract – *Administration of city is a huge task involving many functions, infrastructure and organization. Managing the resource efficiently without compromising the requirement of citizens, quality and maintaining healthy environment is necessary for any city. The cities need complete makeover or need to be smarter, so that it can face the new challenges due to rapid changing of environment. Thus, new methods and concepts are discussed, which can be employed in the day to day activities of the city. In this study, the different devices involved in the smart city and integrated data management center is discussed. A comparison is made between the smart city and normal city; various applications have been discussed with few case studies. This thesis work is an opportunity to study the smart city concept and contribute to make the cities smarter and stable.*

Key Words: Data management centre, Smart education, Smart water management, Traffic congestion management, Bus rapid transportation system

1. INTRODUCTION

Planning for development is an envisioning process which requires practical assessment of ground realities and providing a sustainable development, within the physical, jurisdictional, socio-economic and financial aspects. It is a constant process in which the implementation must be evaluated regularly. Urban development ushers an organized planning in urban, suburban and rural areas. It involves in the development of settlements and is responsible for scheduling as well as development of waters supply and management, recreational area and preserving the areas of environmental importance.

Globally, the more urbanized countries are better prospered and have higher incomes. In India also the trend is same, at the same time the urbanization is linked with pollution, congestion and lower quality life. This calls for urban development that brings higher level of prosperity without any negative effects.

1.1 Smart city

Basically the notion of smart and sustainable city brings about the systematization of technologies and policies that are designed to meet the current needs, moreover considering the future generations and environment.

The perspective of smart city varies with person who is defining it. The interpretation of smart city varies based on the development of different cities and countries. Although there is smart city trend globally, the definition is not clearly defined. Though, urban planners define smart city as a modern city with the intention of utilizing digital information and to improve quality of life, effectiveness of urban operation and services, and competitiveness, without compromising the requirements of present and future generations with respect to economic, social and environmental aspects.
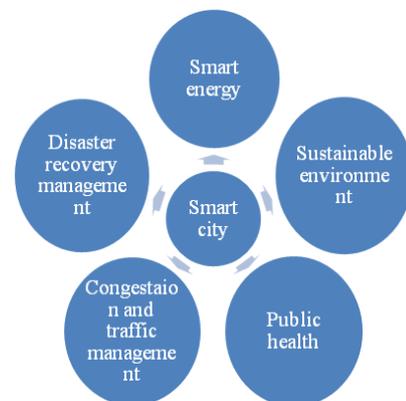

Fig-1 Core Areas of Smart City

1.2 Functions of smart city

In an approach of this concept, the idea is to create a model that focuses on sustainable and inclusive development, whose main functions are:

- Promoting diverse transport options

- To enhance the characteristics of city based on its economic activity such as cinemas, health education, culture etc.
- Promoting and preserving open spaces such as playgrounds, recreational spaces that are promoting eco balance.
- Encourage varied land use in area based developments.
- Maintaining the health, safety and security of the citizens.

2. Information and Communication Technology (ICT)

A city may face many challenges like increasing population, disaster, geography and other social problems that may create hindrance in even functioning of city. These problems can be mitigated by facilitating different methods, one of which is the application of ICT in urban planning. This technology can be included in city planning to create innovative, intelligent and sustainable urban centres. The city that facilitates ICT has sustainable, intelligent and innovative systems, where the urban planners and decision makers can communicate information about the activities through sensors and networks.

ICT is a digital platform, from which a network of information and knowledge can be created. This system of network allows the data to be aggregated for the purpose of analysis, besides it improves the understanding of functioning of city in terms of resource consumption, services, and lifestyles.

3. Internet of Things (IoT)

The Internet of Things (IoT) is the network of absolute items that is fixed with electronics, software, sensors, and network connectivity, that facilitates these objects to assemble and exchange data. The IoT allows objects to be sensed and controlled, thus creating opportunity for direct interaction between the physical world and digital world across existing network infrastructure furthermore, results in improved efficiency and accuracy. The final aim is to achieve smart homes, parking, weather and water systems and traffic surveillance systems.
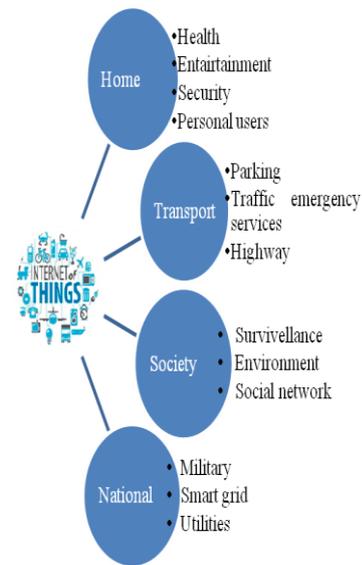

Fig-2 IoT based Smart City Applications

3. Big Data

Big data consist of large amount of unstructured and disorganized data. These data are generated through devices like smart phones, computers, environmental sensors and even people. A variety of applications such as social networking site, digital pictures and commercial transactions have led to increase in the data collection. Figure1.5 shows the different sources from where the big data is generated, which is unstructured and less organized. Big data analytics enhances sustainability and governance in urban planning. It improves the quality of life in urban spaces and introduces intelligent management of resources and infrastructure.

For a city to be more efficient and sustainable, it is necessary to make use of ICT based technologies. Prior to study, the scope and objective is defined. Different technologies and management systems are used around the world for the handling of big data generated at various sources. However, integrated data management center is one of the methods adopted in handling of the data and forms an important part of the system. This is a central system which can be positioned anywhere in the city and consist of different layers having various functions.

4. Integrated Data Management Center

It consist of four tier system for handling the big data that is collected from sensors, interceptors, web applications and other internet sources.

Bottom tier: Here, it involves data integration that is generated from various sources to provide unified view. Since, many IoT sources are involved, there is significant quantity of heterogeneous data is generated which needs to

be interlinked. The data collected must be gathered and aggregated to provide a summarized report that can help in data analysis. Another function of this layer is validation of the data that needs to be compiled with quality benchmarks.

Intermediate tier 1: In this layer, the data obtained from the bottom layer is processed; these data must be protected so that it cannot be misused. One of the main tasks of this layer is data anonymization or masking of information. This is done so as to maintain the privacy; this technique removes personally identifiable information from the datasets in case for the people whom the data describe remain anonymous.

Intermediate tier 2: This is the most important layer in the system. The main task of this layer is extraction, analyzing and identifying the data that is anonymized for data processing. Before the data is transferred to the next layer in the system the data is processed, masking and unmasking of the data, and analyzing the data.

Top layer: The function of this layer is to interpret the data that is obtained from tier 3, and also to evaluate accuracy and reduce conflict in case of contradicting information. These data are analyzed and a summarized report is made. This report helps in taking decision that might help a city to function effectively.
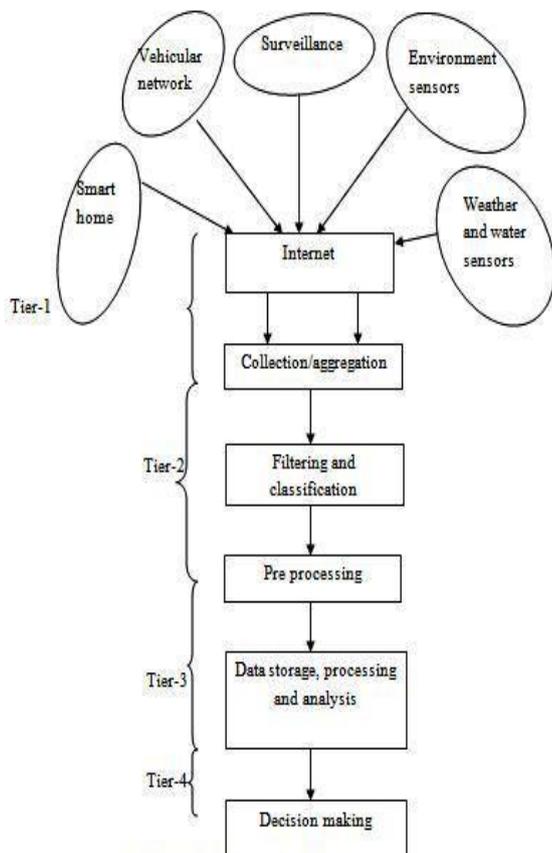

Fig-3 Different tier of data management center

5. Tools used in smart city

From the studies, it is obvious that for a city to be smarter and for obtaining best results from the system; internet is necessary. This system is dependent on the network, devices embedded with sensors and other technologies.

1. **Radio Frequency Identification Devices (RFID):** This device identifies the electronically stored information (tags) that has an important role in the framework. It tracks and identifies the location of the objects also helps in management. The tag is as important as a sensor because it is not only contains data but also capture the environmental data. It provides applications in smart grid, healthcare, parking area management etc.
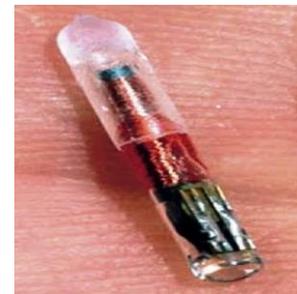

Fig-4 RFID chip

2. **Zig Bee:** It is a low cost and low power communication technology. This technology helps in creating wireless personal area networks (WPAN) and other low power, low bandwidth. For applying of Zigbee, extra equipments like coordinator, router and zigbee end devices are require. This technology can be used in wireless switches and traffic management system.

Fig-5 Zigbee module

3. **Dash 7:** It is wireless sensor and accutor network. It operates on 433MHz which has better penetration through walls and also appealing for HANs. Some of its applications are hazardous materials monitoring,

warehouse optimizations and smart meter development. This technology needs fewer infrastructures and the cost is lower compared to other technologies.

4. **Global positioning system (GPS):** It is space based radio navigation that provides geo location and information to GPS receiver anywhere on the earth. Availability of GPS enabled devices has grown in the last decade. It is technology that not only for sensing location and activity of humans it also provides easy to handle sensing data on location and activity.

5. **3G and long term evolution (LTE):** These are standard for communication for mobile phones and data terminals. The wireless communication has expanded all over the world in minimum time. It was essentially designed for WAN i.e. that require long distance range. One of the major hurdles is high data cost by the service providers.

6. Advantages of smart cities

Efficient resource utilization: With help of monitoring systems, better distribution of resource can be achieved due to early recognition of waste points.

Better quality of life: With improved services, more efficient work and living models thus saving time and resources.

High level of transparency: Due to inter-operability and openness to higher level, there will be better management and control of different aspects and applications of city.
Security: With the help of surveillance, identification systems, sensors; the security of population is ensured.

7. Limitations of smart cities

Capital: It is one of the critical resources and non-availability of capital may lead to half-finished cities

Existing cities: There are huge numbers of cities and upgrading it will be an enormous task.

Socio economic difference: Different classes of people reside in a city, thus it is important to develop a plan that is beneficial for everyone.

Less awareness: More awareness in the citizens has to create about the different services about the city.

8. Comparison of Smart City and Conventional City

Table 1. Comparisons of smart city and conventional city

Smart city	Conventional city
Smart cities are installed with smart meters so that energy usage is measure accurately.	May have long hours of power cuts and need smart ways to track usage.
Smart water management for efficient use of water and recycling of water is done with latest technologies	Needs better for water management.
With deployment of sensors and smart traffic management, the citizens can commute hassle free	Citizens are burdened with the high traffic and parking issues.
Connected communities, many web applications and portals helps in keeping track of the development work	Need more apps and facilities to access the citizen services.

9. Challenges of smart cities

The smart cities are very dynamic and evolving quickly, there are many advantages of the smart cities, likewise there are challenges faced while deploying various tools and technologies associated with the smart city. The few challenges are mentioned below.

Data sources and sizes: The data is collected in multiple format, storing and processing each data is huge task. Due to changing environment it is difficult to predict growth of data.

Quality of data: Since the data will be from different sources, there will be no standard format of data. If the data is collected from third party, it must be ensured that they have standard mechanism of collecting data.

Security of data: The data collected should be properly protected, if some sensitive data is leaked, it may be a threat to city. It is important that how a data is masked and secured, so that it cannot be reached to unwanted persons.

Technology advancements: Competing with technology is very difficult and costly effort; the city must be designed such a way that upgrading the system will be achieved easily.

Skill gaps: managing and analysing large data also framing policies based on it needs skill that is short in supply especially in public sectors.

10. Applications in smart cities

Adopting these technologies will help in addressing different problems and also provide storage and analysis tools moreover, it encourages collaboration of different entities of smart city and helps in finding solution to challenges in transportation and crowd management as the information easily flows across different devices. Some of the applications are.

a. Smart water management (SWM)

Observing the challenges faced by the water sector, the urban planners have developed intelligent tools that use ICT to mitigate water issues. The role of smart system is to improve the efficiency, effectiveness and flexibility of water and waste water infrastructure and management. Implementation of smart water management can make significant improvements in water distribution, helping to decrease loss and enhance waste water and storm water management.

Benefits of smart water management

- **Economic savings**: SWM tools decrease non-revenue water significantly by identifying leaks and illegal connection, recovery revenue necessary to maintain the infrastructure.
- **Improved services**: Smart metering can augment the relationship between the water utilities and the customers by providing more transparent water consumption information.
- **Improved wastewater management**: These benefits are linked to improvements in the performance and economic efficiency of the wastewater treatment.
- **Environmental protection and enhancement**: Reduced demand and improved environmental monitoring helps to maintain and restore ecosystems that rely on a healthy aquatic environment.
- **Flood control and storm water management**: Improved weather awareness and prediction through weather intelligence allows cities to plan more competently their flood prevention strategies, at the same time to manage urban drainage systems and storm waters accordingly.

b. Smart energy

The usage of the ICT allows smart management and control of energy distribution, the ICT is a tool that has capabilities like sensing and networking that increase the possibility of optimum development of energy providers. Smart grid is one of the smart energy management methods, it is renovated electrical grid system that uses ICT to congregate and act on available data. It improves the efficiency, economics and sustainability of the production and distribution of electric power.

The SG uses computer based remote controls with two way communication technologies between the power producers and consumers to increase grid efficiency and reliability through feedbacks and self-assessment. This system involves placing sensors and meters, transmission and distribution system to get real time data about the current power production.

Features of the smart grid

- **Reliability:** With help of technologies, it enhances fault detection and allows self-healing of the networks without the intervention of technician.
- **Flexibility in network topology:** Next generation transmission and distribution handle the bi direction energy flows better allowing distributed generations from solar on roof tops and other sources.
- **Peak curtailment and time of use pricing:** Here, prices of electricity are increased during high demand periods and decreased during low demand periods.
- **Efficiency:** Demand side management is one of contributors for the overall improvement in efficiency of energy infrastructure.

C. Traffic congestion management

The cities are growing very rapidly by 2050 about 70% of the world population is expected to be living in cities. There has been increase in number of vehicles and according to national highway authority of India, Indian roads carry 67% of freight and 80% of passenger annually. The accident rate in India is highest in the world. Smarter cities with new technologies and insights might transform the systems operations and services

A congestion management plan must take into consideration all relevant factors like expanding vehicle population, geometry of the city roads, travel needs of citizen and needs of various administering authorities

Bus rapid transport system (BRTS)

It is one traffic congestion management method; it is a bus priority system that provides affordable, safe and faster public transit. The system can be flexible based on any city context and demand. This system was an urban planning exercise with strong focus on integrating mass transit with land use and density. This system became widely known after successful operation around the worlds.

Fig-6 BRTS

BRT system addresses following principle concerns:

- Reduction in private vehicle dependence
- Reduction in travel time
- Passenger safety and comfort
- Reduction in delays (due to merging with traffic, fare collection, etc.
- Reliability public transit

11. CONCLUSIONS

The various method and techniques adopted in different cities across the world, in creating a sustainable city is studied so that these techniques can be applied to the Indian cities. Applications these methodology using new techniques and tools, must be with proper insight and understanding of the challenges and limitations of the local conditions. The ICT, IoT and Big data analytics are very useful in urban planning and management. There are various applications of new technology in modern cities, which can help to achieve the objective of the organization.

However, there are certain drawbacks and limitations associated with the concept such as

- Initial cost of implementing the technology is high
- Application of the concept depends upon the local development and population growth.
- The local government or local authorities must be supportive of the concept or else it may lead to failure of the work.

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